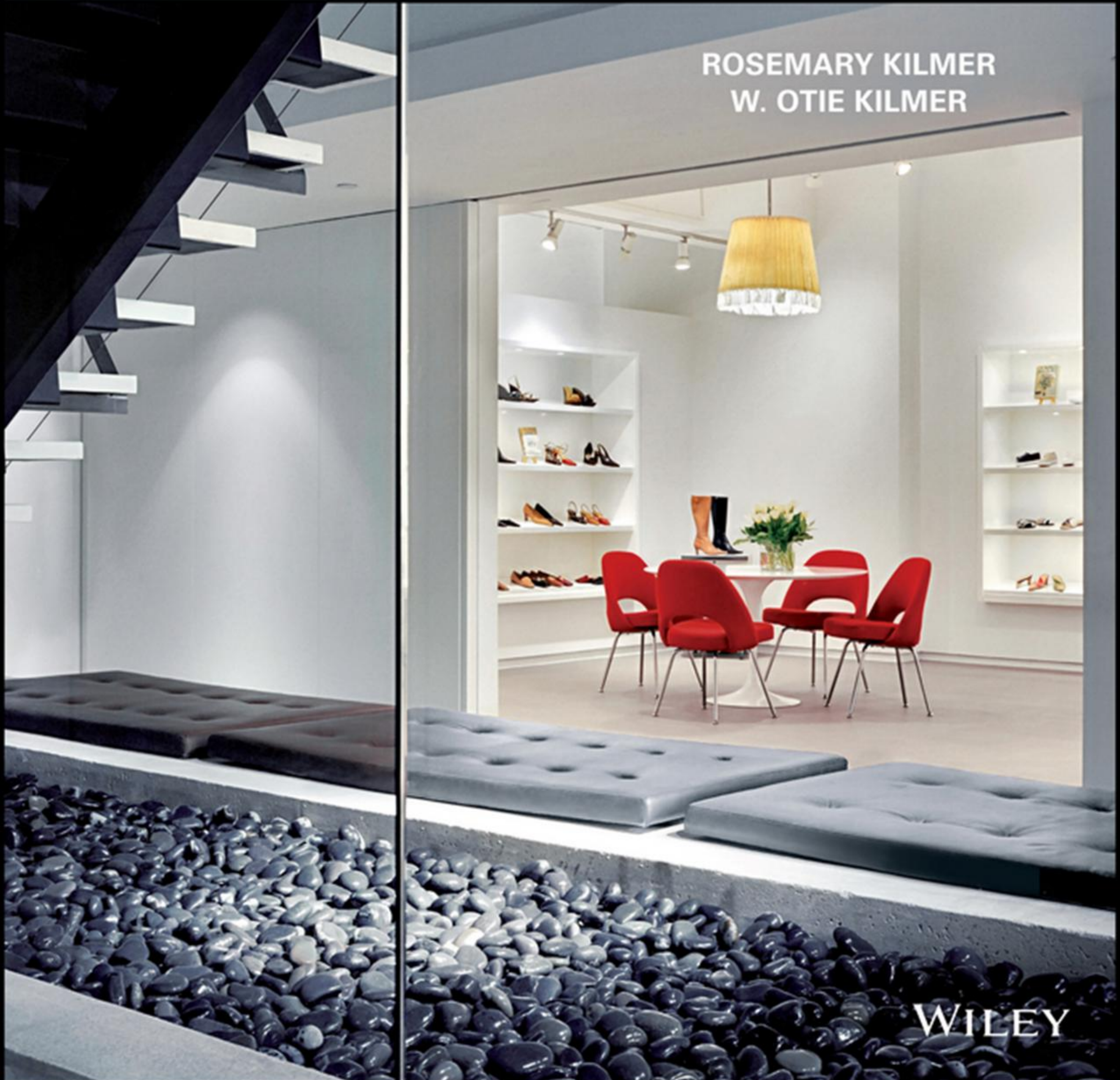
SECOND EDITION

Designing Interiors

ROSEMARY KILMER
W. OTIE KILMER



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Second Edition

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WILEY

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For our creative daughters, Courtney, Lisa, and Teresa
who all have a passion for interior design

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PART TWO: PLANNING RESIDENTIAL AND COMMERCIAL SPACES

Preface

Interior design is an exciting and expanding profession. The responsibilities of an interior designer encompass all spaces, components, and elements within environments built for human needs and aspirations. The education of the professional interior designer aims for the highest levels of creativity, knowledge, and skill in designing for our increasingly complex and technological society. Interior designers are also actively responsive to issues that concern our societies, our people, and this planet. These professionals have a commitment to conserving energy, ending pollution, preventing global warming, and recycling our resources. They support the preservation of endangered life and plant forms, as well as cultures and buildings. Interior designers try to understand the interrelationships of local and global factors and to make positive design decisions on both the macro and the micro levels. Above all, the interior designer is cognizant of human needs, cultural differences, and the contextual links necessary for responsive and responsible environments.

It has been many years since we wrote the first edition of *Designing Interiors*. The intent of the first edition was to provide a strong introduction and understanding of the process of designing interiors from the conceptual ideas to the final implementation. At the time it was first published, it was one of the few books on the market that included this process for both residential and commercial design.

The second edition of *Designing Interiors* follows a similar format and organization to the first edition. The second edition includes updated information and incorporates how interior design is taught and practiced today. This includes an emphasis on issues such as sustainability, universal design, practicing in a global society, and respecting social values.

We have added a great deal of new information, illustrations, and photographs to reinforce current design and construction methods, materials, and practices. However, some of the material we presented 20 years ago still remains relevant today. This includes our commitment to the planet, people, and natural resources we sought to emphasize back then.

This book is intended to serve as a comprehensive overview of the basic knowledge required for the education of the professional interior designer. As the field of interior design becomes an increasingly regulated and licensed profession, education and practice will continue to emphasize a solid expertise in designing for people, their environments, and a better quality of life for all. Complex technical knowledge and creativity will be required to implement environments while protecting the health, safety, and welfare of the public. *Designing Interiors, 2nd edition,* incorporates material essential to the preparation of a designer who has a holistic view and is capable of communicating with other professionals to help create successful and responsive interior spaces.

Interior design is presented in this book as an integrated process applicable to both residential and nonresidential (commercial) interiors. Although interior designers and some colleges focus on one or the other of these, the design of residential interior environments and the design of commercial interior environments are presented herein as similar processes with similar concerns. Although each area has special considerations, the education of interior design students must have a foundation applicable to both.

This book is intended to be used primarily as an introduction to interior design at the college level. However, as the interior design profession is so complex, this book could easily be used in subsequent studio courses that go beyond a mere introduction. As beginning interior design courses can vary in their content, breadth of coverage, and approach, some parts of this book may not be applicable for a single course or for a particular instructor's teaching methods. Some chapters or sections might be bypassed or rearranged according to an instructor's preferences. Some of the technical matter might be saved for use in upper-level courses. However, this book can serve as an introduction to those topics and as a comprehensive reference for interior design students throughout their education.

The text is organized into six parts consisting of related chapters. Content is introduced at basic conceptual levels and applied to the practice of interior design; then more complex information is added. This structure parallels the education and practice of interior designers from initial problem awareness and definition to incorporating various materials and building systems to create interior spaces.

Photographs and other illustrations have been updated and carefully chosen to reinforce ideas within the text. These images enhance the reader's appreciation and understanding of the principles and relationships of interior spaces.

Each chapter ends with a list of books, articles, etc. for further reading.

"PART ONE: INTRODUCTION TO THE INTERIOR DESIGN PROFESSION AND THE HISTORICAL AND THEORETICAL BASIS OF DESIGN" introduces the reader to the field of interior design, discussing the foundations of design from early to modern times. The relationship of interior design to society and built environments is defined and explored. The second edition includes information about current design issues that have changed the emphasis of the interior design profession, such as universal design, globalization, sustainable design, and technological advances. Updated information on professional organizations related to the practice of interior design, academic preparation, and licensing and/or registration laws that affect an interior designer has also been added. An overview of design history helps the beginning student understand the influences that created a particular solution or style. These insights provide the student with a contextual sense in design purpose, drawing from the past to understand tomorrow. We expanded the area on Non-European architecture and interiors to further a student's awareness of global design influences. The timeless elements and principles of design are defined and applied in making functional and aesthetic decisions about the conception and construction of interior spaces. Color and light are examined as interrelated concepts affecting our perceptions of our surroundings. More photographs and illustrations have been added to show students how color theory can be applied in interior environments to create specific moods/atmospheres and enhance the overall aesthetics of a space.

"PART TWO: PLANNING RESIDENTIAL AND COMMERCIAL SPACES" provides an in-depth look at the active, creative processes interior designers use to identify, organize, analyze, and solve problems in the built environment. Various sequences describe how designers achieve effective and unique solutions. Programming is detailed as a method for defining user needs and activities, researching and evaluating facts, and arriving at specific parameters for the interior design. Updated information on evidence-based design research has been added. Space planning is presented with more examples and applications, and expanded to include a variety of additional facilities that an interior designer is involved with today.

"PART THREE: THE EXTERIOR AND INTERIOR ENVIRONMENTS" encompasses the relationships and influences of the exterior and interior environments. Updated information on current concerns for energy conservation and efficiency, historical preservation/restoration, regulatory codes, design for the physically impaired, and other issues are discussed in relation to interior design. Environmental issues and technical systems, such as renewable energy sources and applications, that support and control interior spaces are defined and described as integral parts of the interior designer's practice. Designing with daylight and new artificial light sources has been updated in this second edition. Coordination with other design professionals as an integrated partnership or part of the team needed to construct buildings and interior spaces is discussed and updated.

"PART FOUR: INTERIOR MATERIALS, ARCHITECTURAL SYSTEMS, FINISHES, AND COMPONENTS" examines materials used for constructing and finishing interior spaces; and how these materials and assembly methods generate forms and serve as integral components for creating interior environments. This second edition reflects more on the social and environmental responsibilities of interior designers. It emphasizes the impact that interior designers have on the sustainability of our natural resources and how to be more responsible in their choices of materials, systems, finishes, and products. This second edition also includes many new materials and products that were not available since the last edition.

"PART FIVE: FURNITURE, FURNISHINGS, AND EQUIPMENT" includes a discussion of "accessories" as an integrated part of the furniture, furnishings, and equipment (FF&E) package that interior designers work with. FF&E items are planned for in the beginning of a project and refined to their specific function throughout the design process. This second edition provides a better understanding of how FF&E is incorporated into interior environments through more photographs and illustrations of their application.

"PART SIX: ASPECTS OF PROFESSIONAL PRACTICE" focuses on the professional practice and the designer's methods of communication (drawings, photographs, models, oral and written presentations, etc.). A business sense is essential for successful designers. Basic practices and business operations are discussed to help the student understand and appreciate the variety and comprehensive practices of interior design before entering the profession. This second edition also features the interior design profession's use of technological tools for designing tomorrow's interiors.

In conclusion, we are passionate about the interior design profession as it is an exciting, but very complex profession that demands more responsibility to issues that concern our societies, our people, and our planet. To be an interior designer is more complicated than in past years; however, the rewards are more satisfying due to the abundance of new materials, products, methods, etc. that create an aesthetic and responsive environment that is gratifying and responsive to the user of the space. The authors truly hope this book creates an interest and passion for learning how to create aesthetically pleasing environments that are responsive to the users, society, and our natural resources.

Rosemary and W. Otie Kilmer

Acknowledgments

Writing a second edition of a book is much like writing the original one, especially after 20 years, where the dynamic professions of interior design and architecture have experienced advancing technology and environmental concerns. To keep abreast of the issues and best practice standards facing the interior design profession, we would like to thank the many individuals and organizations for their invaluable help in shaping the 2nd edition of this book. Through their contributions of ideas, criticisms, photographs, and other illustrative materials has made this second edition possible. Our goal was to update this textbook to provide a substantive foundation for learning about the scope of interior design (conception to occupancy), set a professional standard, and express the social awareness of designing interiors for all people.

Without the help and encouragement of many special people, we could never have completed a book of this magnitude and complexity. Although we can't list the numerous individuals and their contributions, we do want to express our sincere thanks here to many. Special appreciation is expressed to the many interior designers, architects, and photographers who have provided illustrations, photographs, and permission to use their materials to make this book a truly visual experience. We are especially thankful to Allsteel; Perkins+Will; Herman Miller, Inc.; Skidmore, Ownings and Merril (SOM); Haworth, Inc.; Kohler; Knoll, Inc.; Kimball Office; Steelcase; National Kitchen and Bath Association (NKBA); EnviroMed Design Group; and Andersen Windows.

Every effort has been made to correctly supply the proper credit information identifying interior designers, architects, photographers, and their projects. We apologize for any errors or omissions that may have occurred in these credits, if any.

We are grateful to a number of interior design educators throughout the country for their reviews, criticism, and helpful suggestions as to the needs of the students and instructors in interior design. In particular, we would like to thank Lisa VanZee of Purdue University for her contributions and illustrations to the book. Special thanks to Jeff Johnston for some of his materials and line art.

The authors are deeply grateful to the dedicated staff at John Wiley & Sons, Publishers. Without their guidance, assistance and dedicated work, this edition would have never become a reality. Among these individuals the authors are particularly indebted to Paul Drougas, Acquisitions Editor who encouraged us to seek publication with Wiley and helped us in the beginning, even after some doubtful setbacks, and moved this project into reality. His tireless efforts, support, and perseverance throughout this project are much appreciated. Thank you, Paul, for believing in us. To Michael New, Editorial Assistant, who enthusiastically helped us in securing some photographs for the art program and with some technology issues. To Doug Salvemini, Senior Production Editor, for guiding us through the editing and production phase of this project. We are grateful to Devra Kunin, copyeditor, and Cheryl Ferguson, proofreader, who were both exceptional in editing and proofreading the manuscript. To the rest of the editorial, production, and design staff at John Wiley & Sons, who helped turn the manuscript into a finished publication.

Finally, we wish to express our deep appreciation for the continual support of our family and friends through this long project.

Rosemary and Otie Kilmer

Interior Design, an Introduction

1

Interior design is one of the most exciting and creative professions. A combination of art, science, and technology, interior design, in practice, manipulates space, form, texture, color, and light to enhance the quality of human life. This book is about interior spaces and their design and about interior design as a profession. The practice of actively designing interior space is a major commitment by those who enter the field, that is, people who work toward improving our built environments.

We spend an increasing amount of our lives indoors in built environments. We wake from a night's sleep in some form of interior space and go to learn, work, or play in another space that gives a sense of purpose to our lives. We may briefly go outdoors to get to the site of our day's occupation, but the amount of time spent outdoors is usually only a fraction of the time spent indoors.

Why should we be concerned about the design of interiors? Well-designed spaces can contribute substantially to our sense of well-being, not just serve as shelters. They can be positive influences on our socialization, learning, and general appreciation of life. People's behavior can be positively or negatively reinforced by interaction with environmental forces.

The task of those who design our interior spaces becomes increasingly important as more people spend greater amounts of time indoors. Designers must devise spaces that serve the basic needs of the users and at the same time create positive and uplifting effects. Properly designed environments are efficient and harmonious (Figure 1.1). They can have a pervasive positive influence, which interiors that are not carefully designed may not have.

CURRENT ISSUES IN DESIGN

Interior design is a dynamic profession that changes over time as the result of technological advances, research, codes, culture, and environmental factors. Some of the current issues facing interior designers include universal design, globalization, and sustainable design.

Universal Design

Universal design is a concept that encompasses the design of worldwide environments, spaces, objects, and communication with the intent of serving the widest range of users, regardless of age and physical abilities. Universal design can include accessible design, which specifically focuses on people with disabilities and their right of access

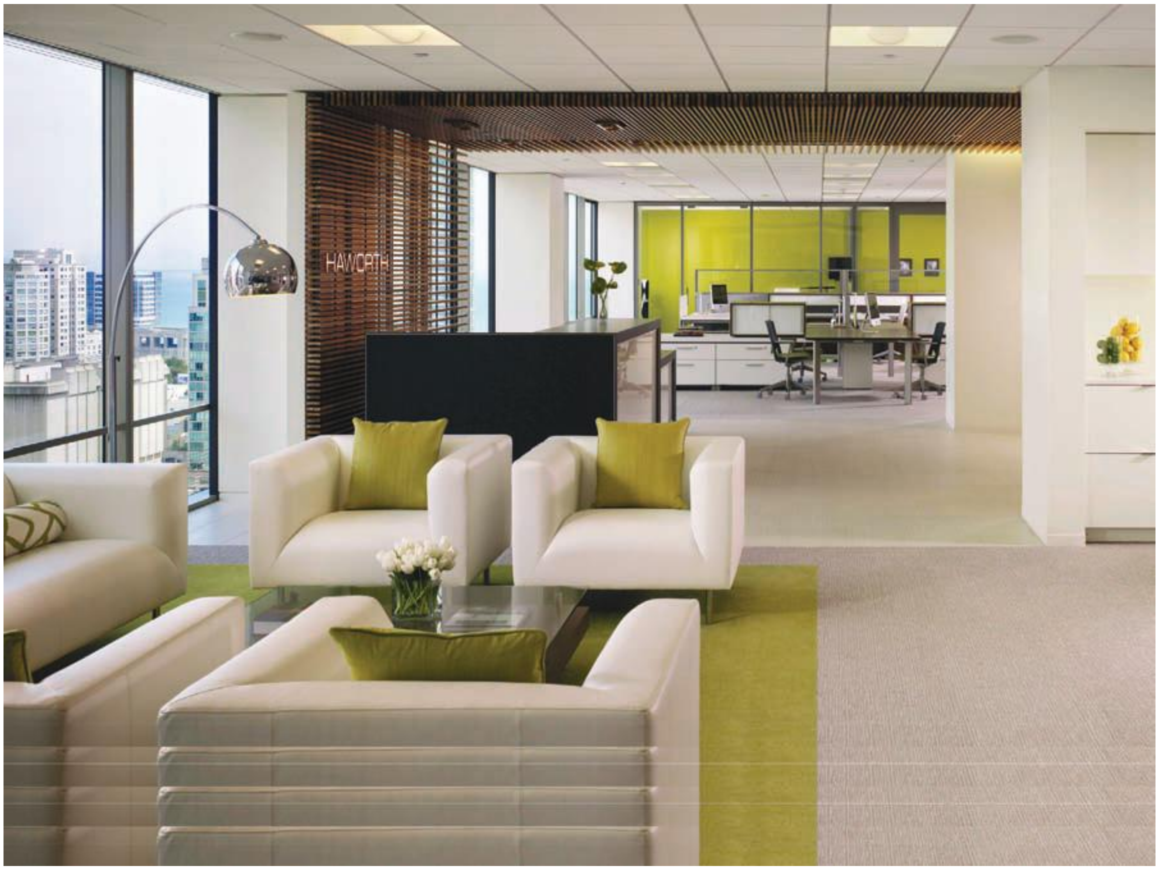

FIGURE 1.1 This Haworth showroom, in San Francisco, is an excellent example of a well-designed interior that serves the needs of the users and creates a positive and uplifting effect.

Courtesy of Perkins + Will; Photo Courtesy of Haworth, Inc.; Nick Merrick © Hedrich Blessing

to entities. However, the two terms should not be used interchangeably. Universal design is involved with more than providing minimal compliance with specific accessibility requirements and guidelines. It seeks to integrate accessible features into the design of the building, interiors, and objects. It addresses the usability issues of spaces and equipment, instead of merely setting standards and minimum requirements, which accessible design does. See Chapter 10 for more detailed information on accessibility. Interior designers are also involved with designing for special populations, which include people of all abilities and ages, including children, the elderly, and those with temporary or permanent special needs (Figure 1.2).

Globalization

Interior designers often work on a global scale and with multicultural communities and people. This is particularly true today as the Internet and other digital media allow designers and others to communicate worldwide. Designers may encompass a multitude of nationalities, cultural traits, physical needs, and preferences. The use of space and the meaning of color may vary among different cultures, regions, and countries. Materials indigenous to a region may also affect how environments are built. Therefore, designers must be aware of particular cultural beliefs and preferences in order to propose appropriate design solutions for a global market (Figure 1.3).

Sustainable Design

Sustainable design seeks to reduce the negative impacts on our environments, eliminate nonrenewable resources, and promote the interaction of people and the natural environment. The need for sustainable design is a direct result of global growth in human population, economic activity, damage to the earth's ecosystem, and depletion of natural resources. Sustainability principles include energy conservation and efficiency, recycled or sustainably

FIGURE 1.2 Mattel Children's Hospital UCLA is designed to serve the needs of its special population.
Courtesy of Perkins + Will; © fotoworks/Benny Chan

FIGURE 1.3 The Park Hotel in Hyderabad, India, infuses a modern, sustainable design with the local craft traditions, and is influenced by the region's reputation as a center for the design and production of gemstones and textiles.
© Skidmore, Owings & Merrill LLP | © Robert Polidori

FIGURE 1.4 Purdue University's net-zero energy house utilizes hickory flooring, white oak cabinetry, and poplar ceiling beams, which are all environmentally friendly, have longer life cycles, and need less replacement.

Jim Tetro/U.S. Department of Energy Solar Decathlon

produced materials, improved indoor environmental quality (such as air), and requiring performance standards for the quality and durability of products that last longer—reducing or eliminating their replacement cycles (Figure 1.4). Sustainable design is also referred to as *green design*, although the latter term can be somewhat overused to include many things that may not be up to sustainable standards.

The 2030 Challenge is an initiative first put forth in 2003 by the architect Edward Mazria that sets the stage for world reduction of greenhouse gases. It is believed that buildings produce over half of the greenhouse gas emissions on a global scale. The challenge asks the global architectural, design, and construction communities to adopt a series of target dates (2010–2030) as milestones that would result in decreased fossil fuel use, greenhouse gas emissions, and energy consumption. By 2030 the standard is projected to achieve a carbon neutral state for buildings.

HISTORICAL OVERVIEW

Presenting a history of interior design is a difficult task since no specific date, person, or space can be documented as the beginning point. The desire to create functional and pleasant interior environments existed long before freestanding buildings were being constructed. Designing interior spaces can be traced back to early cultures that painted pictures on the walls of their caves and furnished them with pelts for comfort. As people began to plan and construct buildings, the structure and the interior space within it were considered interrelated parts of a whole, which became known as architecture. Interior design, like architectural design, has been a basic part of the planning and building process from the beginning. Yet, the use and acceptance of the term *interior design* did not occur until after World War II. Previously, the term *interior decoration* described the finishing touches applied to the inside of a structure, but "interior decorating" was not recognized as a profession until the turn of the

FIGURE 1.5 Basic shelters use natural forms of grasses and thatch as design elements to protect the occupants from rain and wind.

twentieth century. Like architecture, interior design and its practice have evolved from primitive enclosures to highly sophisticated structures and space enclosures.

Before the Nineteenth Century

Developing civilizations created shelters to protect people from the elements and serve other basic needs (Figure 1.5). As people became less nomadic, they began to build more permanent shelters. As farming replaced hunting, people gathered into communities, with structures for storage, shelter, and protection from enemies.

The Egyptians produced enough crops that they often needed to store or trade off the surpluses. As their civilization developed, they began to construct temples, ceremonial spaces, and monumental tombs (Figure 1.6). This specialization of buildings and their interiors became more common and could be considered the beginning of nonresidential design.

Greek and Roman civilizations constructed more elaborate and specialized spaces, such as temples, bath houses, and large arenas. They also pondered the meaning of beauty and the proportions of their structures, seeking to create "perfect" buildings (Figure 1.7). Many of these early structures were monumental. Architecture and the design of the interiors were an integral act, not separate endeavors.

As civilizations prospered, structures improved in materials, strength, and flexibility to serve a multitude of needs. Geographical factors also promoted variety in style as people sought to "personalize" their built environments according to the availability of materials and workmanship in a particular area.

By the eighteenth century, interior spaces had become more than simply functional: they served people's sense of taste, décor, and embellishment (Figure 1.8). Many of these interiors were created for the rich to display their wealth and luxury. However, the not-so-rich people were also living in interiors that, while not opulent, provided a continuum of design examples throughout the ages.

During this time, interior decoration was the responsibility primarily of the architects, artisans, and craftsmen. For example, English architects in the 1700s were designing interiors and even their furnishings. This trend was continued in America by later designers and architects, such as Samuel McIntire, Thomas Jefferson, and others before 1900.

FIGURE 1.6 The Egyptian pyramids at Giza (2723–2563 BC) provided permanence and concealment.
CC-BY-SA-3.0/Ricardo Liberato

FIGURE 1.7 Temple of Athena Nike, Acropolis, Athens. This small temple (427–424 BC) is an excellent example of Greek architecture. The ionic order of columns is graceful, and the symmetry of the structure is well conceived.
CC-BY-SA-3.0/Dimboukas

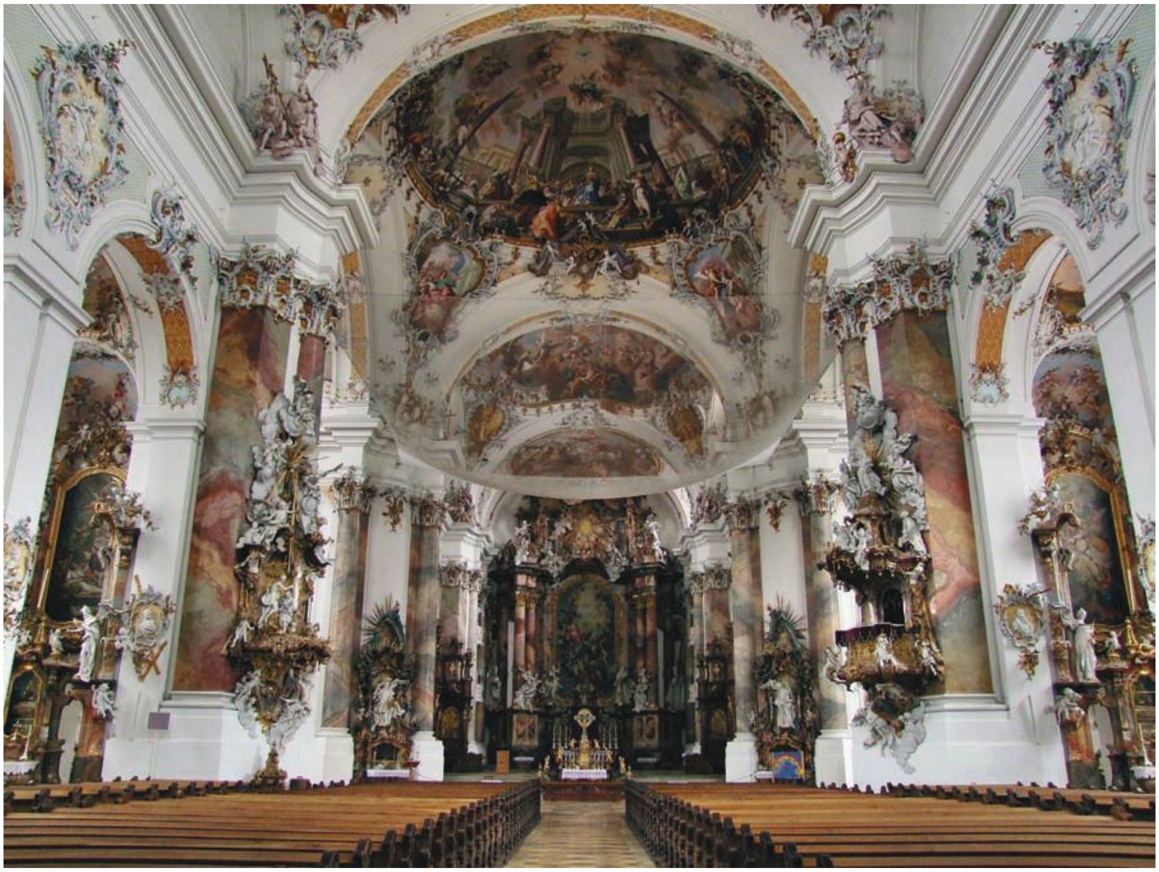

FIGURE 1.8 Abbey of Ottobeuren, Bavaria (c. 1748). The interior of this space is lavishly decorated and highlighted with colored stucco to imitate marble.

The Nineteenth and Twentieth Centuries: Decorating and Integrated Design

Interest in interiors and their furnishings was sustained through the nineteenth century and into the twentieth. During this time two distinct design directions developed. The first evolved from the term *decoration*, and the profession of decorating became established. Based on historical traditions, this direction was predominantly concerned with surface ornamentation, color, texture, furnishings, and accessories. The other direction was more concerned with the way things work, and it concentrated on innovation and invention. This design approach began to look at all aspects of interior design in terms of the overall shape of spaces, construction systems, activity patterns, manufacturing processes, and the use of new materials. This approach was predominantly concerned with the integration of all elements within an interior space, to achieve total design harmony. The work of Frank Lloyd Wright in the first decade of the twentieth century characterized this direction. Wright designed innovative interiors in which space was treated as a single entity where all materials, technologies, and ornamentation were integrated. His concept of total integration of all interior elements is called *organic design.* He defined interior space for specific activities by furniture arrangements, rather than with enclosed walls. Wright achieved spatial variety and different areas within a single room by means of stepped floors and ceilings, so openness was not impeded.

Women also became active in the field of design and interior decorating. Candace Wheeler, who worked with the decorative artist L. C. Tiffany in the late 1800s, wrote an article entitled "Interior Decoration as a Profession for Women." Elsie de Wolfe (1865–1950) has been credited as being the first self-proclaimed interior decorator in America. She was born in New York City and went to finishing school in Scotland. As a member of the upper class and London society, she became used to elegance, refinement, and good taste. She began her career

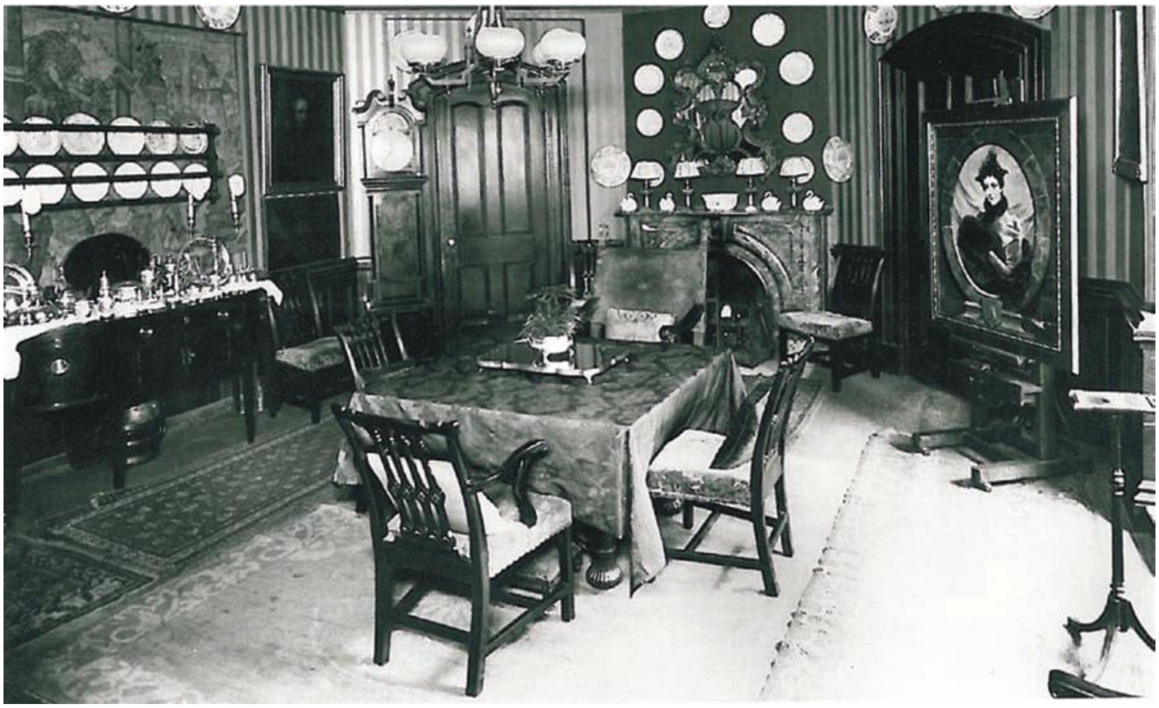

FIGURE 1.9 Elsie de Wolfe designed this dining room in 1896; it reflected a dark and somber style that was prevalent at that time.

in 1904 as a professional interior decorator and received her first commission in 1905, for the Colony Club in New York City.

De Wolfe had a great impact on the decorating of interiors (Figure 1.9) and inspired other women to enter the profession. However, it was not until 1904 that courses were offered in interior decoration, so it was difficult to obtain formal training. If formal coursework was unavailable or too expensive for some, they learned from magazines or books.

"Interior decorator" became the most recognized title for those who planned surface embellishments of interior spaces. These individuals were concerned with the decorative arts—i.e., ornamentation, finishes, furnishings, and furniture—and dealt primarily with existing spaces.

After World War I, as the middle class became more prosperous, interest in professional interior decoration increased. The sale and manufacture of home furnishings flourished. Department stores, such as Macy's and Marshall Field's, designed elaborate "vignettes" to display their merchandise. In the 1920s the art deco style revolutionized both the exterior and the interior design of office and other commercial buildings. Until that time, men had executed most of the interior design in commercial structures. Dorothy Draper (1889–1969) was one of the first American women decorators to specialize in commercial design. Her commissions included hotels, clubs, restaurants, shops, and hospitals.

After World War II, interiors of buildings demanded more than just decoration of the spaces. As commercial building industries flourished, the interiors became increasingly complex, requiring more attention to the functional needs of the users. Focus began to shift from the decorating of surfaces to establishing functionalism and activity-related support systems. There was also a shift from the exclusive involvement of high-income residential decorating to planning for commercial spaces.

Today, the role of the interior designer has expanded to reflect the highly complex problems that environments pose in our continually changing technological society. Office buildings, hospitals, shopping centers, restaurants, schools, airports, residential communities, entertainment centers, hotels, and public buildings are but a few of the areas in which highly skilled interior designers team up with architects, engineers, planners, and developers to create better environments for a better quality of life (Figure 1.10).

FIGURE 1.10 A team of interior designers, architects, engineers, and other consultants designed the specialized Baylor Charles A. Sammons Cancer Center at the Baylor University Medical Center in Dallas, Texas.
Courtesy of Perkins + Will; photography by Nick Merrick © Hedrich Blessing

INTERIOR DESIGN AS A PROFESSION

The professional interior designer is qualified by education, experience, and examination to enhance the function and quality of interior spaces for the purposes of improving the quality of life, increasing productivity, and protecting the health, safety, and welfare of the public. Interior design has grown rapidly and undergone many changes since the 1990s. It is a distinct, creative professional field closely allied with other design professions. One of the most exciting and expanding professional fields for dedicated students to enter, interior design is becoming more important every day as we remodel and build more interior environments. Interior designers of today and tomorrow must take up the challenge of creating more exciting, more energy conscious, and more technologically advanced environments in less and less space.

The Interior Designer

An interior designer is a creative person who develops ideas into objects and environments for other people to use or interact with. Although this may seem simplistic, the act of designing is a complex combination of art and science. Interior design is involved with creating or modifying interior environments, including the structure, the life-support systems, the furnishings, and the equipment. In addition, the interior designer must deal with the experiences, needs, and personalities of the people (or users) within. Working with lighting, color, materials, human behavior, and accessories, the interior designer plans and organizes interior spaces to serve specific needs (Figure 1.11).

The term *interior designer* has been defined and endorsed by many professional societies, schools, accrediting agencies, and states and provinces. At this writing, according to the National Council for Interior Design Qualification, the definition of interior design and the responsibilities of an interior designer are as follows:

FIGURE 1.11 This hospital lobby featuring bright colored furniture and artwork, made or inspired by children, is a place where children and their families feel immediately comfortable. A color-changing ceiling and lava floor tiles that change color when walked on are incorporated.

Photo Courtesy of Haworth, Inc.

Interior design includes a scope of services performed by a professional design practitioner, qualified by means of education, experience and examination, to protect and enhance the health, life safety and welfare of the public. These services may include any or all of the following tasks:

- Research and analysis of the client's goals and requirements; and development of documents, drawings and diagrams that outline those needs
- Formulation of preliminary space plans and two and three dimensional design concept studies and sketches that integrate the client's program needs and are based on knowledge of the principles of interior design and theories of human behavior
- Confirmation that preliminary space plans and design concepts are safe, functional, aesthetically appropriate, and meet all public health, safety and welfare requirements, including code, accessibility, environmental, and sustainability guidelines
- Selection of colors, materials and finishes to appropriately convey the design concept and to meet socio-psychological, functional, maintenance, lifecycle performance, environmental, and safety requirements
- Selection and specification of furniture, fixtures, equipment and millwork, including layout drawings and detailed product description; and provision of contract documentation to facilitate pricing, procurement and installation of furniture
- Provision of project management services, including preparation of project budgets and schedules
- Preparation of construction documents, consisting of plans, elevations, details and specifications, to illustrate non-structural and/or non-seismic partition layouts; power and communications locations; reflected ceiling plans and lighting designs; materials and finishes; and furniture layouts
- Preparation of construction documents to adhere to regional building and fire codes, municipal codes, and any other jurisdictional statutes, regulations, and guidelines applicable to the interior space
- Coordination and collaboration with other allied design professionals who may be retained to provide consulting services, including but not limited to architects; structural, mechanical and electrical engineers; and various specialty consultants

- Confirmation that construction documents for non-structural and/or non-seismic construction are signed and sealed by the responsible interior designer, as applicable to jurisdictional requirements for filing with code enforcement officials
- Administration of contract documents, bids and negotiations as the client's agent
- Observation and reporting on the implementation of projects while in progress and upon completion, as a representative of and on behalf of the client; and conducting post-occupancy evaluation reports

Interior design is practiced by interior designers, architects, and space planners. Each has a particular viewpoint and expertise, and the role and merit of each viewpoint will continue to be debated in the schools, the professions, and the professional societies. These debates promote self-evaluation and, hence, advancement of the field of interior design.

Interior design is an integral part of the built environment, which in turn is an aspect of environmental design (Figure 1.12). Environmental design encompasses the entire natural and built environment, both interior and exterior spaces.

Allied Professions

Interior design is closely related to architecture and other professions. Specialists in these other fields work with interior designers in a team effort to create environments that serve users and enhance the quality of life.

Decorator

As discussed earlier, the decorator's role evolved over time, and today the decorator provides many services in the design field. Although the public often uses the term to refer to interior designers, there are differences between the decorator and the designer. Decorators are involved mostly with decorative surface treatments, accessories, furniture, and furnishings and are not required to have a formal education, experience, or national examination to work in the field.

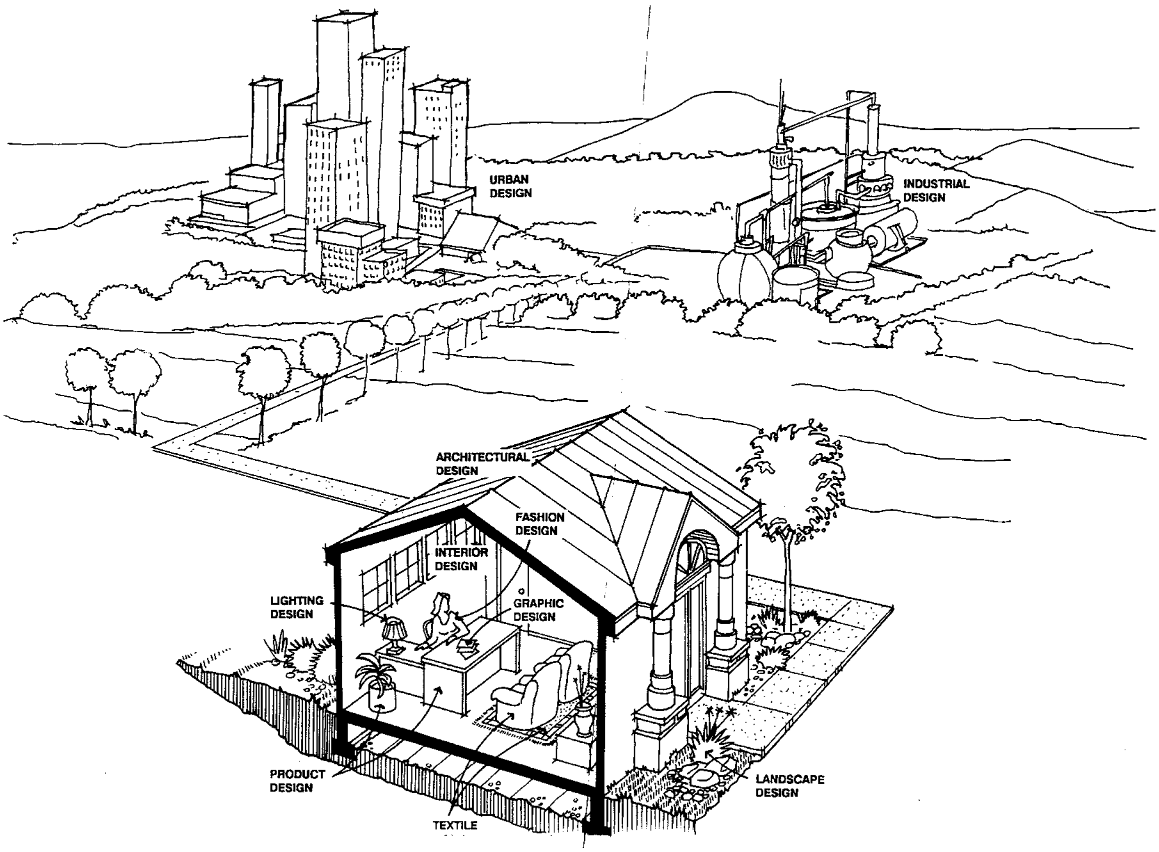

FIGURE 1.12 There are many areas or fields of design. The basic theories and principles are the same; however, the scale may change.

Architect

The architect today has been educated, served an internship, and been tested by a national examination to become registered (licensed). The title "architect" and the practice of architecture are protected and regulated by law. Architects design buildings, including the structural, electrical, mechanical, and other systems. Some architects also provide interior design services, including selection of furniture and other furnishings. However, many of these interior services are done by interior designers who are consultants to the architect or are part of an interior design department within the architectural firm.

The field of architecture has produced a series of specialized areas of expertise and practice: specification writers, systems architects, and interior architects, who primarily design the interior of a building. Some architects choose to practice in all areas of architecture, and others focus on a specialized area, such as residence, corporate, health-care, institutional, or hospitality architecture.

Landscape Architecture

Landscape architecture is a separate profession concerned with the exterior environment and has its own licensing laws. Landscape architects are involved primarily in site planning and design and in exterior landscaping.

Other Professionals

Industrial designers work integrally with the interiors industry to produce furniture and other accessories. Sometimes interior designers create these designs, and sometimes they hire industrial designers to design specific objects for the spaces.

Graphic designers also work closely with interior designers to create brand identities for the interior design firm, such as logos, web designs, letterheads, and business cards, as well as branding and signage for interior design projects.

The design of large corporate offices often requires the services of facility planners or managers to oversee the spatial needs of corporations as their personnel and equipment requirements change. A large number of these people are interior designers, yet some positions are filled by management and business graduates who in turn hire interior designers as part of the team.

The engineer also is a part of the team designing environments. Engineers are licensed and generally specialize in such areas as electrical, mechanical, structural, or acoustical engineering.

Professional Societies

Professional societies and organizations are established to serve and advance the various professions and to represent designers to the public. They provide information, resources, research, continuing education, codes of ethics, lobbying efforts, and many other services for their memberships. Each has its own requirements for and levels of membership. Several societies to which interior designers and design educators belong are listed in this section. Some belong to more than one.

American Society of Interior Designers (ASID)

One of the largest and oldest interior design organizations is ASID, which has more than 38,000 members. It was formed in 1975 by a merger of the American Institute of Interior Designers (AID), founded in 1931, and the National Society of Interior Designers (NSID). ASID serves to advance the profession of interior design, inform and protect the public, promote design excellence, and strengthen interaction with related professions and industries. ASID provides educational materials and seminars, conventions, newsletters, and related design activities, including student chapters.

International Interior Design Association (IIDA)

IIDA is a professional networking and educational organization with more than 13,000 members. IIDA was formed in 1994 as a merger of the Institute of Business Designers (IBD), the International Society of Interior Designers (ISID), and the Council of Federal Interior Designers (CFID). IIDA was formed to create an international association that would represent interior designers worldwide. Like ASID, IIDA also provides many programs and services to the profession, public, and students to shape the future of design.

Interior Designers of Canada (IDC)

IDC was founded in 1972 to serve the Canadian interior design industry, advancing the profession through high standards of education, professional development, professional responsibility, and communication. IDC has more than 2,000 members, and, with the support of its seven provincial association members, provides a forum for the unified voice of Canadian interior designers, so that the profession will continue to grow and receive recognition and respect locally, nationally, and internationally from government, industry, and the public sector.

International Federation of Interior Architects/Interior Designers (IFI)

IFI was founded in 1963 in Denmark and is made up of worldwide design institutions, associations, and schools in approximately 50 countries on every continent. It provides many of the services that other societies provide, but it functions primarily as a global forum for the exchange and development of knowledge and experience, in worldwide education, research, and practice. Worldwide, IFI collectively represents over 80,000 practicing interior architects/designers.

Interior Design Educators Council, Inc. (IDEC)

IDEC was founded in 1967 and serves to advance education and research in interior design. IDEC (more than 900 members) seeks to strengthen communication and education among educators, educational institutions, practicing professionals, and other organizations that promote interior design education. It publishes the *Journal* of *Interior Design Education and Research* (JIDER), a design research journal.

Council for Interior Design Accreditation (CIDA)

CIDA was established in 1970 under the name of FIDER (Foundation for Interior Design Education and Research); it was renamed CIDA in 2006. It was developed to evaluate and accredit interior design programs in the United States and Canada. CIDA is composed of a board of trustees made up of representatives from ASID, IIDA, IDC, and IDEC. It is committed to identifying, developing, and promoting standards for educational programs for entry-level interior designers.

National Council for Interior Design Qualification (NCIDQ)

NCIDQ was started in 1972 and establishes standards of competence in the practice of interior designers. NCIDQ's main purpose is to protect the health, life safety, and welfare of the public through these standards. NCIDQ serves to identify to the public those interior designers who have met the minimum standards for professional practice by passing the regularly updated NCIDQ examination, which is offered twice a year across the United States and Canada. Its membership is made up of organizations, not individual members. Passing the exam is often required to achieve the highest level of membership in some interior design societies. It is also the qualifying exam for those states that have licensing or registration laws governing the interior design profession.

NCIDQ also developed and administers the Interior Design Experience Program (IDEP), a monitored experience program for graduates of interior design programs, which provides documented proof of the high-quality interior design experience required by state licensing boards and provincial associations for licensure and/or registration. IDEP assists entry-level interior designers in obtaining a broad range of high-quality professional experience, and provides a structure for the transition between formal education and professional practice.

American Institute of Architects (AIA)

AIA was founded in 1859 and has more than 83,000 members. Although the organization is composed primarily of licensed architects, many interior designers are also architects and belong to this organization in addition to others. The AIA has several national and state committees on interior design that are open to both interior designers and architects. These cooperative committees also collaborate with many of the other professional organizations.

Building Owners and Managers Association International (BOMA)

BOMA is an international organization of over 17,000 commercial real estate professionals and developers, including owners, managers, design professionals, and real estate providers. BOMA provides programs in advocacy, education, and research throughout the world.

National Kitchen & Bath Association (NKBA)

NKBA is a nonprofit trade association for kitchen and bath professionals. It began in 1963 as AIKD (American Institute of Kitchen Dealers) and changed to NKBA in 1983. It has over 40,000 members. Through individual experience and testing, it offers the CKD (Certified Kitchen Designer) program and certification.

The Retail Design Institute (RDI)

RDI, which was founded in 1961 as The Institute of Store Planners, is dedicated to the professionals involved in the planning, design, and construction of retail establishments. In 2010, it was renamed the Retail Design Institute to reflect its worldwide membership of over 1,000 professionals.

The Illuminating Engineering Society of North America (IESNA)

IESNA is the recognized authority on illumination and has a diverse membership (over 8,000) of professionals involved with the design, manufacturing, and distribution of lamps, sources, accessories, and luminaires. These include designers, architects, engineers, contractors, manufacturers, and distributors. The society publishes technical documents; standards; design guidelines; lighting energy management materials; and lighting measurements, calculations, and testing guides.

The Environmental Design Research Association (EDRA)

EDRA is an interdisciplinary organization founded in 1968. It comprises an international membership of about 500 and is dedicated to the advancement and dissemination of environmental research. It seeks to improve the understanding of the interrelationships between people and their natural and built environments. The organization seeks to help create environments responsive to human needs.

U.S. Green Building Council (USGBC)

USGBC is a nonprofit organization committed to a prosperous and sustainable future for our nation through cost-efficient and energy-saving green buildings. It is composed of more than 18,000 member companies and organizations, and more than 140,000 LEED (Leadership in Energy and Environmental Design) Professional Credential holders. USGBC leads a diverse constituency of builders and environmentalists, corporations and nonprofit organizations, elected officials and concerned citizens, and teachers and students. USGBC's vision is that buildings and communities will regenerate and sustain the health and vitality of all life within a generation. USGBC supports this effort by providing educational programs and services to the building industry, public, and students, which gives the organization the flexibility to grow and respond to a rapidly changing market. One of USGBC's main focuses is the development of the LEED® Green Building Rating System™, which is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. (See Chapter 10 for more detailed information.) USGBC also developed an Emerging Professionals program, which provides educational opportunities and resources to young professionals, with the goal of integrating these future leaders into the green building movement.

ENTERING THE FIELD OF INTERIOR DESIGN

To become a professional interior designer, a person should have the proper academic training and a period of work experience in the professional field. In addition, in states that have passed a licensing act, the interior designer must pass the National Council for Interior Design Qualification exam and be registered with a state board. As interior design becomes more complex and technologically advanced, an academic preparation is of prime importance.

Academic Preparation

Many colleges, universities, and design schools in the United States and Canada offer academic programs for the education of interior designers. Today, more than 400 such programs are offered, ranging from four- or five-year baccalaureate degrees to two- and three-year degrees with varying titles. However, most programs are for four years and lead to either a bachelor of arts, a bachelor of fine arts, or a bachelor of science degree.

Interior design curricula are ever changing to accommodate the vast amount of knowledge and training needed for an expanding and complex profession. The introduction of the accrediting body CIDA in 1970 (see previous section) met the needs of standardizing the educational content of these programs. CIDA has established a set of minimum basic accreditation criteria for interior design programs and has become the officially recognized accrediting agency for interior design education. CIDA establishes guidelines for educational institutions to follow to apply for membership and to be reviewed for accreditation. These institutions' programs are then accredited if they meet the CIDA standards. The agency also has set procedures for periodic reviews of member schools' programs, and it schedules revisits as necessary to ensure that the schools adhere to CIDA standards. The names and locations of CIDA-accredited schools can be obtained from its website at www.accredit-id.org or by contacting its national headquarters, which is located in Grand Rapids, Michigan.

University and College Programs

Interior design education at institutions of higher learning is generally offered in one of three basic programs: art and design, home economics, or architecture. Within each of these basic areas, some variance exists in the way the program is structured, administered, and philosophically based. For example, an interiors program might be a subcomponent of an architectural department or school. The emphasis of such an interiors program might be parallel to the education of an architect. Or one might find an interiors program, along with industrial and graphic design, as a part of the "applied" arts. Interiors programs can also be associated with home economics. However, most home economics programs have been restructured to emphasize today's consumer and the behavioral sciences, rather than homemaking skills.

There is no one way to teach interior design, and both CIDA and interior design educators recognize this. In fact, the CIDA guidelines allow for the various programs to provide a particular emphasis and vary their curricula, while still meeting the required CIDA standards.

Private and Specialized Institutions

Four- and five-year programs at institutions of higher education (often state supported) are not the only means available for a student to prepare for the design profession. Numerous two- and three-year programs in community colleges or at technical, vocational, and even specialized private institutions also provide a basic foundation in interiors. Some students begin their preparation in these places and continue their baccalaureate studies elsewhere. Some graduates of these two- and three-year programs become paraprofessionals or technical assistants, and may eventually become professional designers.

Work Experience and Internships

An interior designer must have not only an academic preparation but also work experience before becoming qualified to sit for the NCIDQ exam. Usually this means post-educational employment with an established interior designer or related professional, such as an architect. Entry-level experience should include exposure to and guidance in all the various aspects of an interior design practice—not just drafting or some other narrow focus of professional practice. The length of experience varies in accordance with the educational background, type of firm, and the particular tasks the designers perform.

The Interior Design Experience Program (IDEP), a monitored experience program developed by NCIDQ, as described previously, for graduates of interior design programs, provides documented proof of the high-quality interior design experience required by state licensing boards and provincial associations for licensure and/or registration.

Most schools recognize a need for exposure to professional practice before a student graduates. These schools arrange intensive internships in a design or related firm to give their students valuable insight and a hands-on educational experience that cannot be duplicated in the academic setting. The duration of time for an internship can vary from school to school, but generally ranges from a few weeks or more to a full summer.

A few schools offer a more concentrated work experience through a cooperative education (co-op) program. These programs alternate between on-campus coursework and off-campus work experiences, to provide a balance of academic and practical work preparation. Co-op programs take longer, as students are generally placed in work environments for 12 to 15 weeks and must complete four or five work experiences. A co-op program may extend a student's graduation date by one or more years.

Career Opportunities

Many career opportunities are available for the graduating interior design student. Interior design firms, architectural firms, furnishings dealers (residential and nonresidential), and retail establishments all employ interior designers. Positions are also found with in-house design services of various corporations, hospitality businesses, institutions, government agencies, and healthcare facilities. In addition, design careers are found in education, research, historic preservation, and many other specialized areas.

A student can enter the interiors field at an entry-level position and advance to become a senior designer, a manager, and even a principal of a firm. Salaries and benefits vary greatly in the interiors field, depending on the type of services offered, location, volume of business, and reputation of the designer.

Licensing Interior Designers

Many professionals are licensed by the states, which test and monitor these individuals to protect the health, safety, and welfare of the public.

Licensing (sometimes referred to as registration) is also a means to protect the title and control the qualifications for practicing a particular profession—especially educational prerequisites, experience requirements, and ethical standards. The interior design profession has moved toward licensing for the protection of the title "interior designer"—and, in some states, the practice as well. Most of the activities that interior designers are involved with, such as space planning, interior construction and detailing, lighting, drawings and specifications, project management, building code regulations, and on-site inspection, are concerned with the health, safety, and welfare of the public. Therefore, interior designers are obligated to act in a professional and ethical manner and accept liabilities related to their work. The main reason for licensing interior designers is to ensure standard qualifications and competence for people performing work in the profession.

Licensing acts are on a state or provincial basis, and consist of two main types: a title act and a practice act. A title act is concerned with protecting the use of certain titles for individuals who have met specific qualifications and who have registered with a state board. This type of licensing act assures the public that anyone using the title has professional qualifications. A practice act establishes what an individual may or may not do in the practice of a profession. Anyone engaging in a profession with a practice act must meet certain professional qualifications and be registered with a state board.

The major intent of either act is to indicate to the consumer and general public which individuals are qualified to practice according to specific criteria of education, work experience, and tests. However, a title act does very little to limit who can engage in practice, whereas a practice act can make such limitations.

At this writing, many states have enacted either a title act or a practice act for the interior design profession. It is clear that the profession will become more and more complex, require more knowledge of the technical aspects of interior design, and become more accountable for the environments the designers create, as indicated by the increased number of lawsuits involving design projects.

The future will see more states pass title and/or practice registration acts and require licensing, as interior design gains recognition for protecting the public's health, safety, and welfare. Interior designers who are certified as a result of these acts will enjoy increased legal and public recognition.

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2

The Origins of Design

The word "design" means different things to different people, but a common belief is that design is an active, planned process with a purpose, or a meaningful outcome. Design can also mean creating physical form from a mental image. Webster's dictionary says design is (1) "to plan and make with skill. i.e., as a work of art," (2) "to form or make in the mind; conceive; invent," and (3) "the organization of all elements into a unified whole."[1]

Design can be related to small, simple objects or large, complex ones. We speak of the design of a piece of pottery, the design of the clothes we wear, even the design of a large city. In nature, we can see the minute designs of small plants, animals, or fish—and on a grand scale, we can appreciate the complexity of the design of the universe.

Design influences every aspect of human endeavor, from the visual arts to industry, communications, and transportation. It is a unique combination of art, science, technology, and human intuition, collecting information from diverse areas and applying it to a specific situation.

We speak of a design for living, statistical design, architectural design, pictorial design, interior design, graphic design, textile design, and other kinds of design. In each "field" of design, we are referring to design as order or organization or as a plan for something, the first step in the creative process. Even in an aesthetic sense, design is the organization of elements and forms in a particular manner to fulfill a specific purpose or need. Design is an intrinsically conscious process, and whether utilitarian or aesthetic, it is the deliberate act of forming materials and ideas to fit a certain function, need, or composition.

The impact of a design will depend on its successful organization of ideas or elements into unified wholes—the use of materials, the manipulation of form, aesthetic sensitivity, and satisfying a need. Design involves bridging the gap between people and things, improving human accommodation with physical surroundings, and increasing the safety and satisfaction of interactions between people and their environments. Design can increase efficient use of objects and spaces and act as a means of enhancing communication.

The established principles and criteria that determine the success of a design are based on the relationship between human needs and the efficiency of the design solution to meet these needs. Design principles apply to all fields or related areas of design (Figure 2.1), although the scale and application may change.

In this chapter we shall look at design from a theoretical viewpoint, that is, how its fundamental concepts have evolved over the centuries. In order to appreciate, understand, and apply the purposes of design, it is necessary to have some awareness of what has gone before in design movements and some idea of the direction design may take in the future.

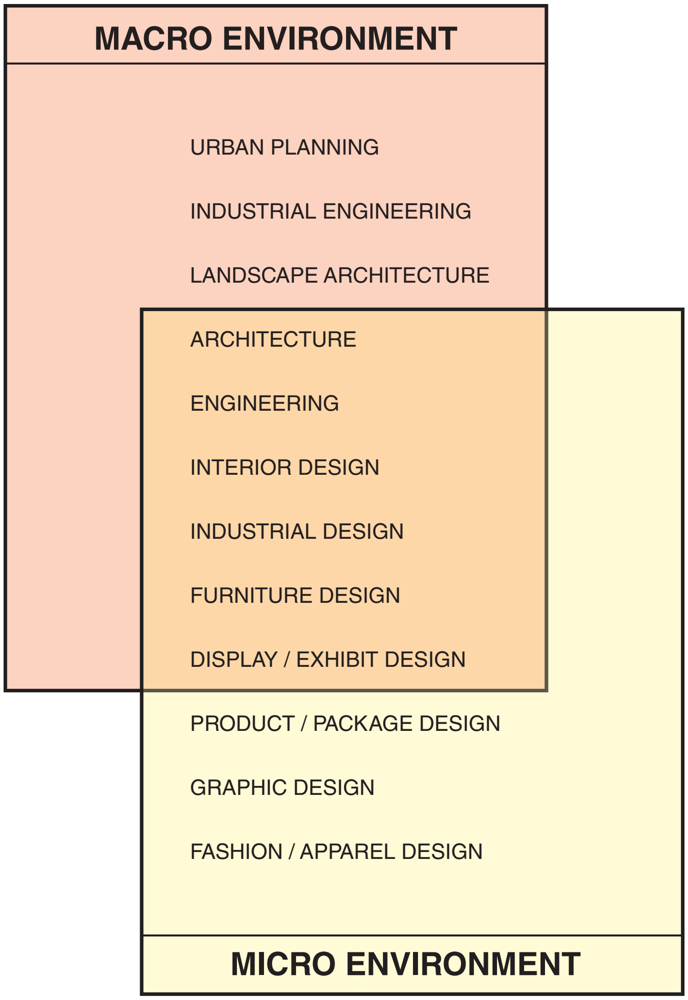


FIGURE 2.1 Design can be categorized into related fields of specialization on large and small scales. However, in practice, many of these areas overlap or are closely allied.

THE MEANING AND ESSENCE OF DESIGN

What are the underlying fundamentals in "design"? One functional relationship is derived from nature. Human beings seem to possess an innate appreciation of design in nature, perhaps because we are an integral part of the natural environment. We can recognize the rightness, order, and beauty of objects and living things that please us—for example, the beauty of a blooming flower (Figure 2.2) or the majesty of snow-capped mountain peaks.

It can be said that "order" is the essence of any design. Order, or organization, can seem to occur spontaneously in nature. We can observe relationships, sequences, or correspondences in the environment that seem to exhibit some underlying system or cause-and-effect principle. In the built environment, order is often planned through a systematic use of materials, spaces, and objects. For example, the classical architectural orders of the Greeks and Romans exhibit aesthetically balanced proportion, mass, and scale (see Figure 2.12 later in this chapter).

Human beings instinctively feel that most things in the natural environment "fit" or have a sense of rightness, but there are also things that we do not perceive to be beautiful or good, such as certain insects, snakes, or other creatures that may appear to be harmful or annoying (Figure 2.3). However, these creatures and elements are a part of the overall design scheme and natural order of things in the universe, and our negative perception of them doesn't mean that they are poorly designed. Many designers are inspired by natural forms and their relationships.

On the other hand, some people find man-made, or "artificial," designs ugly or poorly designed, including automobiles, buildings, and even cities. They may just be different from, or run counter to, the general design trend at the time (Figure 2.4). After time passes, these same objects may seem attractive to us, reflecting a response to something that may no longer be available or is considered rare, scarce, or an antique. The design itself has not changed, but society's judgment about it has.

FIGURE 2.2 This flower, like most things in nature, is a pleasing visual image to us.
CC-BY-SA-3.0/Pascalou petit

FIGURE 2.3 Although at first glance the praying mantis is a fearsome sight, its design has a sense of order and function.
CC-BY-SA-3.0/R. A. Nonemacher

Primitive people often imitated things in nature that seemed to have some sense of order. The grass huts in Figure 1.5 reflect the natural ability of leaves or tightly bunched thatch to repel water and provide basic shelter. Igloos and tents are also refinements of basic natural shapes and effects. Primitive people used design also: They used natural materials and shapes to create and form tools to meet specific needs.

Design moves through time and is influenced by time. The designs of nature have survived, disappeared, or changed according to the natural process in which characteristics held fast, evolved, or became extinct in response to various forces.

Originality in Design

Originality in design is generally associated with the uniqueness of expression or in the problem solving of the designer. Originality in design is considered the creation of something totally new, or the reinterpretation of something created before. This is a futile argument, for all things change, including our perceptions of established truths or ideas. Interpreting history changes history (from our viewpoint) as we attempt to redefine it, and the same is true of design. In any case, while most design today is probably redesign or reinterpretation—as in the "design"

FIGURE 2.4 The Ford Edsel's design was not well accepted by the general public at the time of its introduction; it appeared too radical.
CC-BY-SA-3.0/Bene16

of plates, silverware, and glasses—there are no exact former working models or examples in history for designing microcircuitry, lasers, compact discs, memory/flash drives, space travel hardware, and so forth.

The creation of something that has never existed before (so that we can have no preconception of how it should look) might be considered the most honest or purest form of design. The clay tablets of the Sumerian civilization show us that a chair has been something to sit on since 4000 BC, but an electronic space probe fired into outer space to send information about our universe back to Earth is totally new.

Functional and Visual Design Concepts

Basic concepts governing the practice of design can be expressed as functional and visual. Functional design deals primarily with physical needs (Figure 2.5), and visual design is basically aesthetic in nature and might not serve a physical purpose (Figure 2.6). The two concepts are often interrelated; many functional designs are visually satisfying, and many visual designs may be functional (Figure 2.7).

In functional objects, such as furnishings, automobiles, or cooking utensils, the purpose of the design is usually clear. Visual designs—paintings, sculpture, and other art forms—are created to elicit a response from the viewer and are mostly nonfunctional. An artwork can be created to excite, please, shock, intrigue, attract, or even repel a viewer. If the creation evokes the intended response, it must be considered an effective design.

Primitive people's shelters, tools, and even weapons were a utilitarian form of functional design that served their immediate needs for survival. The visual aspect of these pieces reflects their workings. In other words, the objects look like what they should do, with no ornamentation or aesthetic intent. In these objects, function has a direct influence on design.

To some designers, functional design requires an "integrity" or unity in the designer's idea and "honesty" in the method of transforming that idea into reality. This design integrity, from the Latin *integritas*, meaning state or quality of the overall whole, can be expressed in three areas: function, form, and materials.

Integrity in function is stated in the design axiom "form follows function," usually attributed to the American architect Louis Henry Sullivan and closely linked to the Bauhaus, a design school founded about 1919 in Weimar, Germany (see Chapter 3). One of the avenues the Bauhaus explored was using designs that could be produced by machine for furniture, textiles, and even architecture. These designs were simplified to the essential form that represented the function they were to support.

In fact, Sullivan applied ornamentation to his buildings, so his designs cannot be said to be strictly functional. However, we must consider his practice of using ornamentation in the context of his time, when most designers and architects were applying elaborate decoration and stylistic features to their designs. It was not until the 1920s that functionalism became a concept that many designers and architects followed.

Today, we must carefully scrutinize the concept that "form follows function," since there often exists more than one way to express function or solve a problem in function. A window can be a simple glassed opening in a wall to let in light and air, or it can be elaborately embellished, yet serve the same purposes. Function is important, but functional design is not necessarily inherently successful or beautiful.

FIGURE 2.5 This dishware set is primarily functional in design, as there are no decorative embellishments of the surfaces. However, their shapes do have an aesthetic composition.
PD-User: Marcus Linnér

FIGURE 2.6 Elmslea Chambers (1933) was one of the first buildings in Australia to use decorative terra-cotta in its façade, which features a fine relief of birds, flowers, leaves, and typical art deco sunbursts.
CC-BY-SA-3.0/ A Y Arktos

FIGURE 2.7 This cast-iron pot by Timo Sarpaneva (1959) is functional in purpose, yet has a distinct handle design that is a visual delight.
PD-User: Otto-Ville Mikkelä

THE DEVELOPMENT OF DESIGN

The development and the history of design are important to the interior design student. They serve as the foundation for understanding the way architecture, interior design, and furniture evolved through time. Designers create forms and elements that may seem new to us, but many of these are really copies or adaptations of, or references to, historical styles. In some cases, however, we do see something that does not seem to have a historical precedent. This uniqueness often occurs because of a new building material, manufacturing process, construction method, or other technological innovation. Nonphysical influences, such as the inspirational beliefs that gave us the towering Gothic cathedrals, can also set the stage for major design movements.

By studying the origins of design, architecture, interiors, and furniture, today's interior designers can create forms that incorporate great achievements of the past, or reinterpret them to suit current needs and practices. History helps us understand what caused the invention of the wheel, its development, and ways we can improve and use it today—without having to reinvent it. The same is true for design: It is helpful to understand the impulses that created major design movements and style changes and to use those findings in the context of our needs and aspirations today.

It is not feasible to include here more than a basic outline of the history of design. This chapter treats only the most important movements and people in the development of design from antiquity to the Victorian era. The Modern movement, beginning in the late nineteenth century, is covered separately in Chapter 3. Other books deal exclusively with the histories of architecture, design, interiors, and furniture, and most interior design and architectural schools have several courses devoted entirely to those subjects. Museums and surviving historical examples of architecture and furniture also can provide more detailed studies.

Context, Container, and Contents

In this chapter, we shall look at design movements as an integrated or contextual part of society, technology, and the process of constructing buildings (containers) and their interiors and furniture (contents). Interior design is an interrelated part of the built environment, which means that we must look at buildings and their interiors in the context of the whole. Context refers not only to the immediate surroundings of a building but to the region—the city, the nation, and other geographical influences that shape the container. We also speak of a building's context in relation to historical, political, sociological, and other forces that have an impact on the structure. In turn, the interiors and furniture (contents) of that building (container) have a contextual relationship to the physical and nonphysical characteristics of the enclosed space. Interiors and furniture are not just beautiful spaces and objects, but necessary parts of the overall fabric that serves our human needs and aspirations. The contents of a space do not always follow the design of the structure that houses them; interior and furniture design has a direct relation to, and is often a result of, the social, political, and economic conditions of a particular period of time.

Unfortunately, there is not ample space in this book to address all the interrelationships of the context, container, and contents of each era. Only the major periods and influences can be touched on. The student is encouraged to refer to the excellent sources listed at the end of this chapter and of Chapter 3.

Design and Style

It is difficult to talk about interior design or architecture without addressing the concept we often term "style." Style can be defined as a specific or characteristic manner of expression, execution, construction, or design, in any art, period, work, or employment, such as the Byzantine style or Modern style. Like the word "design," style can mean many different things. Style is associated with various social graces, literary productions, personal expressions, and mannerisms. We also speak of "lifestyles," which reflect a complex relationship of trends and their influences on the way an individual or group lives.

In architecture and interior design, style is generally associated with an individual, a time, or a philosophy. It can refer to an aspect of a cultural period, such as the Victorian style. It can be more specifically associated with countries or regions that expressed that style uniquely; for example, certain churches and medieval furniture using the pointed arch can generally be classified as Gothic (Figure 2.8). However, the proportions and shape of Gothic structures in England differ from those found in France, resulting in English and French Gothic styles.

Social and technological influences have also produced individual stylistic interpretations. Examples can be seen in variations of furniture styles that reveal the artisans of the period and their methods of crafting furniture. Their materials and technology produced certain stylistic forms.

The development of styles can be more easily understood when set in a wider frame of reference. We can summarize the development of architecture and interior design into three concepts in terms of space and style. The first

FIGURE 2.8 Chartres Cathedral (c. 1194) exhibits many features typical of the Gothic style of architecture. Pointed arches, flying buttresses, and vertical expression of structure are all characteristic of this style.
CC-BY-SA-3.0/Honge Benutzer

theory was typified by the ancient architecture of Egypt and Greece, where interior space was defined by the interplay between objects or volumes. For example, Greek sculpture, art, architecture, and philosophy were interrelated.

The second concept encompassed the theories of architecture and arts of the Roman, Byzantine, Romanesque, Gothic, Renaissance, and Baroque periods. This concept is characterized by the development of the interior spaces through techniques such as the vaulted ceiling. The Renaissance is also considered to be the age of realism and individualism, which in turn created new forms of architecture and interiors.

The third concept is the Modern movement, which began about the end of the nineteenth century and is covered in Chapter 3. Its theory evolved from the first two, for each concept has been built on the foundation of previous thought and development. However, new materials and technologies in our time have allowed an integral relationship between inner and outer space. Technological and social influences have permitted us to manipulate materials, construction methods, manufacturing methods, and even our way of life.

DESIGN HISTORY

A successful designer must have a good working knowledge of the development of design and its stylistic counterparts. The foundation of interior design is imbedded in the historical development of society, architecture, fine arts, and the crafts of the past.

Ancient Design

To understand how the design of interiors evolved over the centuries and how the various changes influence our ideas today, it is necessary to look back to our earliest built environments.

Not a lot of building history remains from the prehistoric, primitive, or ancient worlds. However, some secular buildings, such as huts and storage buildings, give us an indication of how early people adapted their local materials for shelter and other needs. The uncovering of various ceremonial temples and shrines has helped us to identify the way architecture and interior spaces advanced through the use of better material and better construction techniques, as well as through the intellectual pursuit of planning these structures and their groupings.

Egyptian, 3100–311 BC

Egypt is a good starting point for our understanding of ancient design, since many Egyptian building materials and the remains of Egyptian tombs, art, and hieroglyphs have lasted through the millennia to give some insight into that civilization.

The Egyptians used their understanding of the world as they built structures and furniture for their daily needs. They built with mud bricks and stone, and created design motifs based on their native vegetation—lilies, lotuses, reeds, date palms, and papyrus. They grew enough foods to consume and store, controlled the flooding of the Nile, domesticated animals, and traded profitably with other peoples.

The pyramids exemplify the Egyptians' architectural and engineering achievements (Figure 1.6). The pyramids, as well as the Egyptians' tombs and temples, were built of stone and fitted together with extreme precision. All these structures were developed with a sense of geometry, axis of circulation and strong ceremonial concepts that are still used today, as seen in Figure 2.9. The Egyptians developed post-and-lintel (trabeated) construction to span their roofs and interior spaces. Their columnar hypostyle halls allowed them to create larger interior spaces than were possible in earlier times (Figure 2.10).

The Egyptians constructed their sun-dried brick houses around small courtyards and gardens with systems of running water, pools, and interior sanitary facilities. The interior spaces were minimally furnished, but decorated in brightly painted colors.

Egyptians took pride in the craftsmanship of their furniture, developing joints that we still use today, such as the mortise and tenon. Wood was scarce and had to be imported from other areas. The lumber they obtained was small scale and had to be jointed to create larger pieces. Egyptian furniture is characterized by animal-shaped legs. The stool, designed in the form of an X, was the most common piece of furniture.

Greek, 650–30 BC

The Greeks achieved a high level of order in their architecture, art, and design (Figure 2.11). Their architecture and art have served as models for other civilizations to copy and refine for centuries. The many gods the Greeks worshipped served as inspirations for their temples and were a major influence in Greek architecture and art.

FIGURE 2.9 The Transamerica Building (finished in 1972 for the Transamerica Corporation headquarters) in San Francisco has often been compared to the ancient Egyptian pyramids.
CC-BY-SA-2.5/Daniel Schwen

FIGURE 2.10 The Hypostyle Hall (c. 1291 BC), part of the Great Temple of Amon at Karnak, consists of many symmetrically placed columns. This post-and-lintel construction features a raised center section over 70 feet (21 m) high, with clerestory windows for interior lighting.

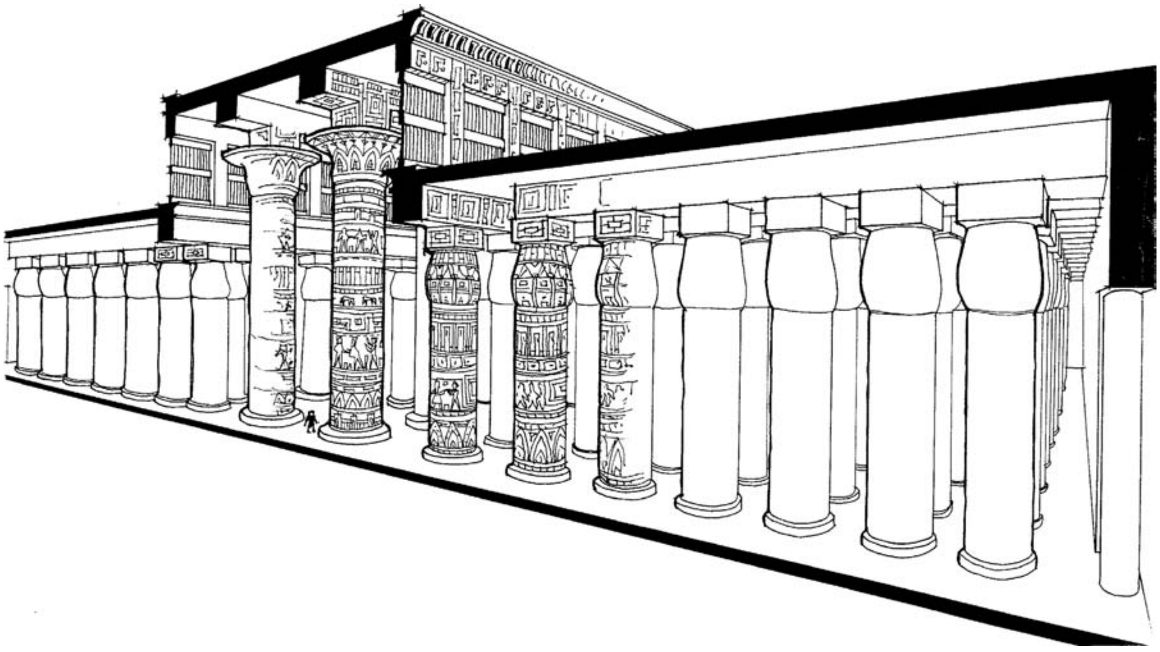


FIGURE 2.11 The Parthenon (447–432 BC) at Athens is one of the best-known examples of Greek architecture. It displays a high sense of order, proportion, and symmetry.

The Greeks standardized their architectural forms, developing "orders" to govern position, shape, and components. They had three major orders of column designs: Doric, Ionic, and Corinthian (Figure 2.12). Greek masonry techniques improved upon the Egyptians' stonework, with a precision method of fashioning hairline joints without mortar. The Greeks also developed the wooden truss, building extensions called the portico and the colonnade, and the pediment (Figure 2.13). Ornamental forms were taken from vegetation and interlocking geometric patterns. Many buildings and interiors today are inspired by these Greek forms, as seen in Figure 2.14.

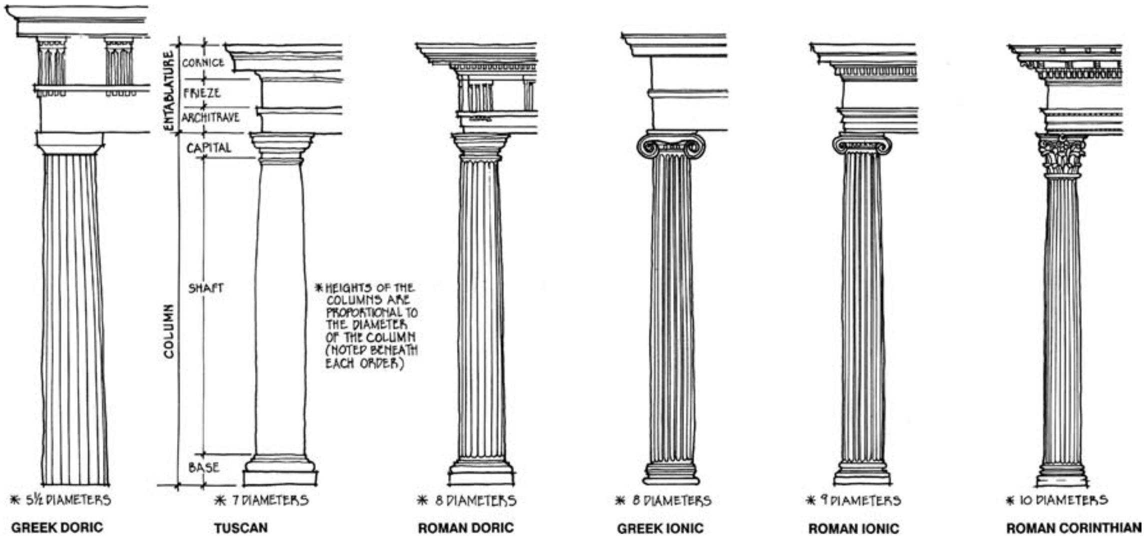


FIGURE 2.12 This illustration compares the Greek and Roman orders. Note the proportional changes in the columns and entablatures.

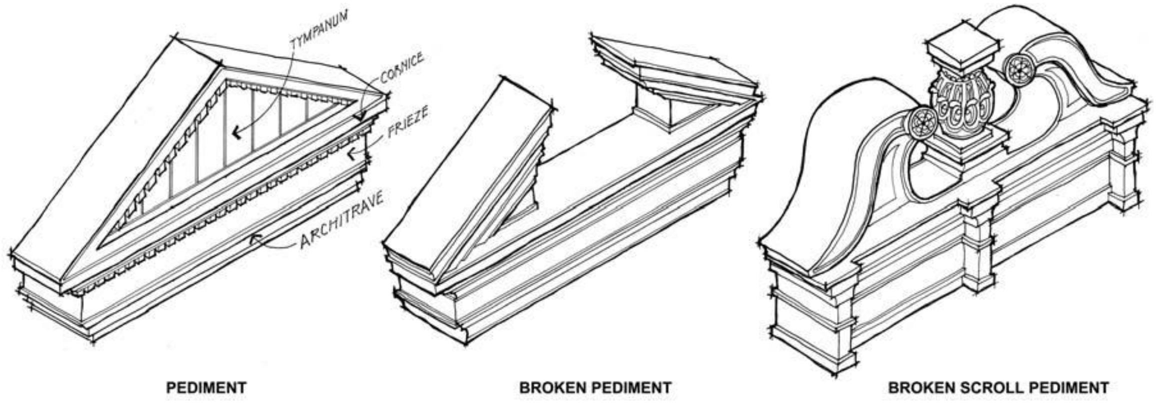


FIGURE 2.13 Pediment arches developed from the simple Greek origin to broken ones and later more stylistic ones using scrolls.

The Greeks used simple, sparse furniture, most of it carved from wood and decorated with paintings or inlays of metal and ivory. The construction was highly refined, matching that of the Egyptian era. The klismos chair shown in Figure 2.15 was developed by the Greeks and has been copied by many other cultures throughout history.

Roman, 753 BC–AD 365

The Romans organized and ruled much of Europe, the Near East, and northern Africa. They built roads throughout their empire, most of which led back to Rome as the center of authority. The Romans were for several hundred years a well-disciplined civilization, with orderly conduct of legal and public affairs. As with the Greeks, some public activities required large, specialized, and stately buildings, such as the Coliseum (Figure 2.16).

FIGURE 2.14 The columns in this new residence are inspired by classical Doric orders of Greek and Roman architecture.

FIGURE 2.15 The Greek klismos chair features a concave back and splayed legs.

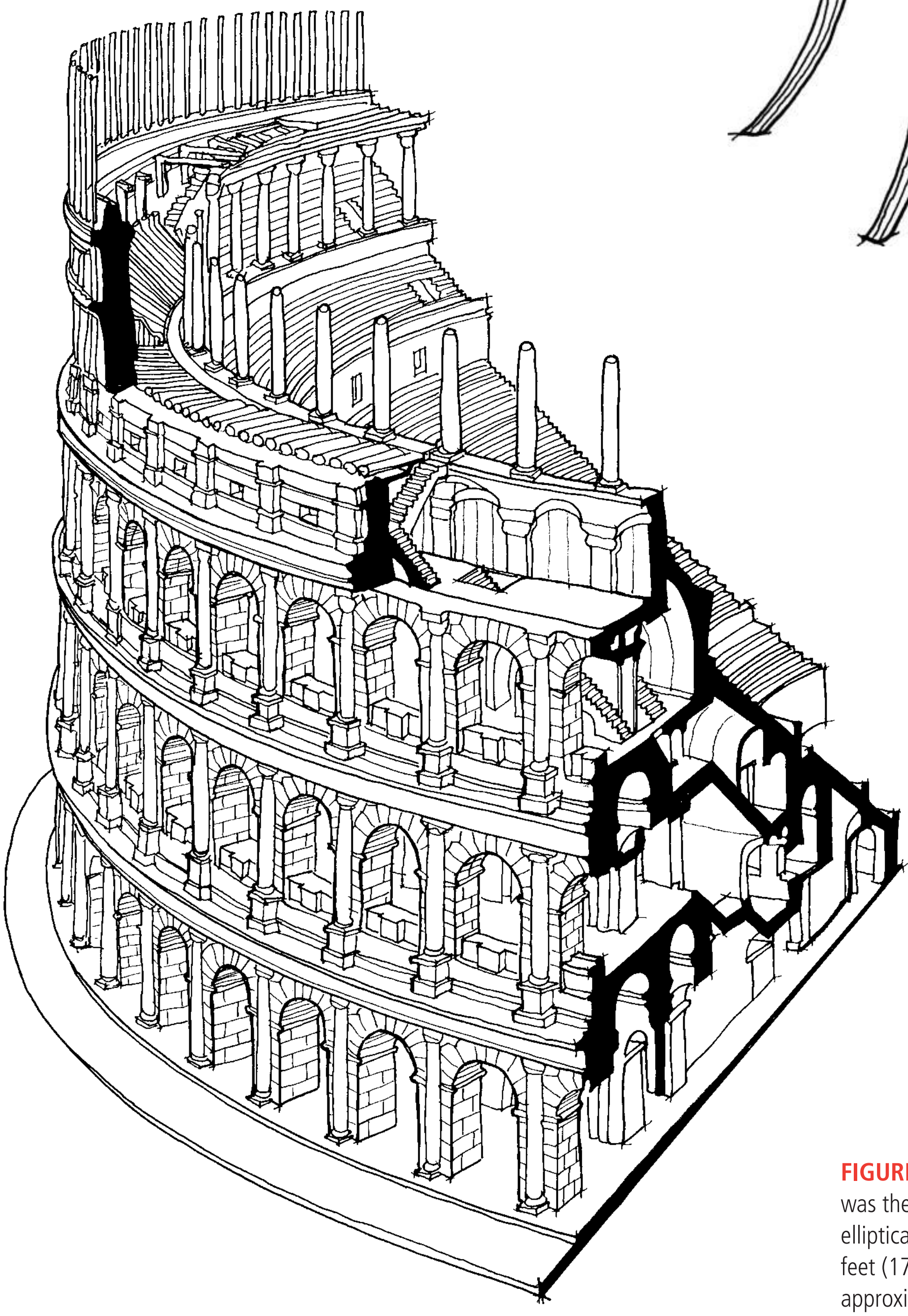


FIGURE 2.16 The Coliseum (AD 72–80) in Rome was the largest amphitheater in Roman times. Its elliptical form was 160 feet (48.5 m) tall and 510 feet (170 m) by 618 feet (206 m). It seated approximately 60,000 spectators.

FIGURE 2.17 The 70-foot-high (21.3 m) Arch of Septimius Severus at the Forum in Rome (AD 203) is a typical Roman monument that bears inscriptions telling of an emperor's conquest. These triumphal arches were constructed of brick, travertine, and marble throughout the Roman Empire.
CC-BY-SA-3.0/Jean-Christophe BENOIST

Roman architecture copied and further developed Greek forms and, in their desire for large-scale buildings, the Romans developed the dome, vault, and niche. Much of Roman architecture, like the large-scale arch in Figure 2.17, can still be experienced today.

One of the keys to the development of Roman architecture and interiors was the use of concrete, which strengthens masonry construction and allows for the span of great structures. It was also used as setting beds for tile, brick, and other finishes. The Romans utilized the Greek orders but made them lighter in proportion and added the Tuscan and Composite orders (Figure 2.12). As the Romans strove for grandiose spaces, their interiors became more distinctively Roman. The Pantheon (Figure 2.18) is a famous example of Roman architecture dominated by the dome construction, which is still used as a major design element today. From the preserved Roman wall paintings, we have examples of furniture designs and usage. Styles were borrowed and adapted from Greek pieces, but are generally heavier in scale and proportion, and the Romans used more veneering techniques and inlays of exotic woods and metals.

The Middle Ages

The fall and breakup of the Roman Empire threw Western Europe into a period of upheaval. Widespread poverty and ignorance dominated the land in this period, often called the Dark Ages. Most people lived in crude homes on feudal estates, and the development of interiors and furniture made little, if any, progress. Pieces from former civilizations were owned by the wealthy few, but it was the monks in monasteries who stored and recorded much of what remains, both physical and pictorial, of former civilizations. It was during this period that the churches began to serve as centers for religion, education, and social life.

FIGURE 2.18 The circular temple Pantheon (AD 120–124) in Rome was twice destroyed by fire in ancient times and rebuilt in brick, concrete, and stone. The building's interior dome is 143 feet (43.5 m) in diameter and in height to the oculus opening. This painting is by the 17th century painter, Giovanni Paolo Panini.

Giovanni Paolo Panini

Byzantine, 323–1453

In the Byzantine period the important architecture and interiors belonged to religious structures. Very few of the domestic buildings of this time have survived to give us a clear picture of the day-to-day life.

During this time the pendentive dome was developed. This system of thrust and counterthrust transmitted weight loads from the dome to four heavy pier supports. Well-known Byzantine structures include the famous Hagia Sophia, built about AD 530 in Constantinople (Figure 2.19). Originally a church, then a mosque, and now a museum, it used *pendentives* to support the massive interior dome, and transition to the square shape of the piers below. By using 40 windows around the base of the dome, the architects were able to diffuse natural light throughout the nave.

Interiors of the churches house the best remaining examples of Byzantine mosaic techniques. Small pieces of colored marble or glass were pressed into wet cement to create elaborate decorative scenes or designs.

The sparse Byzantine furniture pieces were usually simple and utilitarian. However, the rich had furniture elaborately inlaid with precious metals and ivory.

Romanesque, 800–1150

The Romanesque period is perhaps best known for stone structures featuring semicircular arches and horizontal lines. The period was influenced by Byzantine architecture, yet rough interpretations of Roman architecture were adapted, primarily to create churches, castles, monasteries, and fortresses.

FIGURE 2.19 The Church of Hagia Sophia (532–537) in Istanbul (formerly Constantinople) is the epitome of Byzantine architecture. The stone and brick structure has a heavy massive exterior that is contrasted by an interior open main vault richly decorated in mosaic tile patterns.
Courtesy of Murat Ildiz

The Romanesque period produced simple, heavy, and defendable buildings with thick walls, vaults, arches, and buttresses (Figure 2.20). Many of these massive structures survive today because of their solid construction. The Norman Conquest introduced large "great" halls, which were the centers of activity. Simple in decoration, the dark interiors had stone floors, small window openings, and fireplaces for cooking and heating.

The few pieces of furniture in these interiors were generally simple in construction and carved of wood. Some of the furniture was demountable. Rulers took it with them as they moved from castle to castle to control their territory.

Gothic, 1150–1500

As people congregated in towns built around castles, centers developed as trading places, creating the demand for more building activity. Churches became large, important architectural statements of power and wealth. The Gothic style emphasized the vertical line in design, architecture, furniture, and ornamentation. Trade routes carried the Gothic style throughout many lands, and each—Italy, Germany, England, and France—developed its own interpretation.

Gothic cathedrals are perhaps the greatest architectural achievements of these times (Figure 2.21). The pointed arch and vault made it possible to create towering interiors and tall expanses of glass windows. Stained-glass windows were surrounded by a skeletal stone cage, or lacelike ornamentation, known as tracery. Along with Gothic vaulting techniques, the flying buttress was used to transfer the load of the tall, pointed vaults to the ground.

The pointed arch forms were used throughout the interiors, appearing in window and door openings, moldings, and even furniture. Clerestory windows, gargoyles, and cubiform capitals on Gothic columns decorated these soaring spaces. The Gothic influence is still seen in modern buildings and interiors (Figure 2.22).

Gothic furniture was heavy and highly carved, echoing the vertical lines of the cathedrals (Figure 2.23). The massive horizontal chest was used universally for storage, a table, a seat, and even for sleeping. Chests were made of panel construction and carved with various motifs. Beds were constructed with massive carved canopies and draped curtains that could be drawn for warmth and privacy.

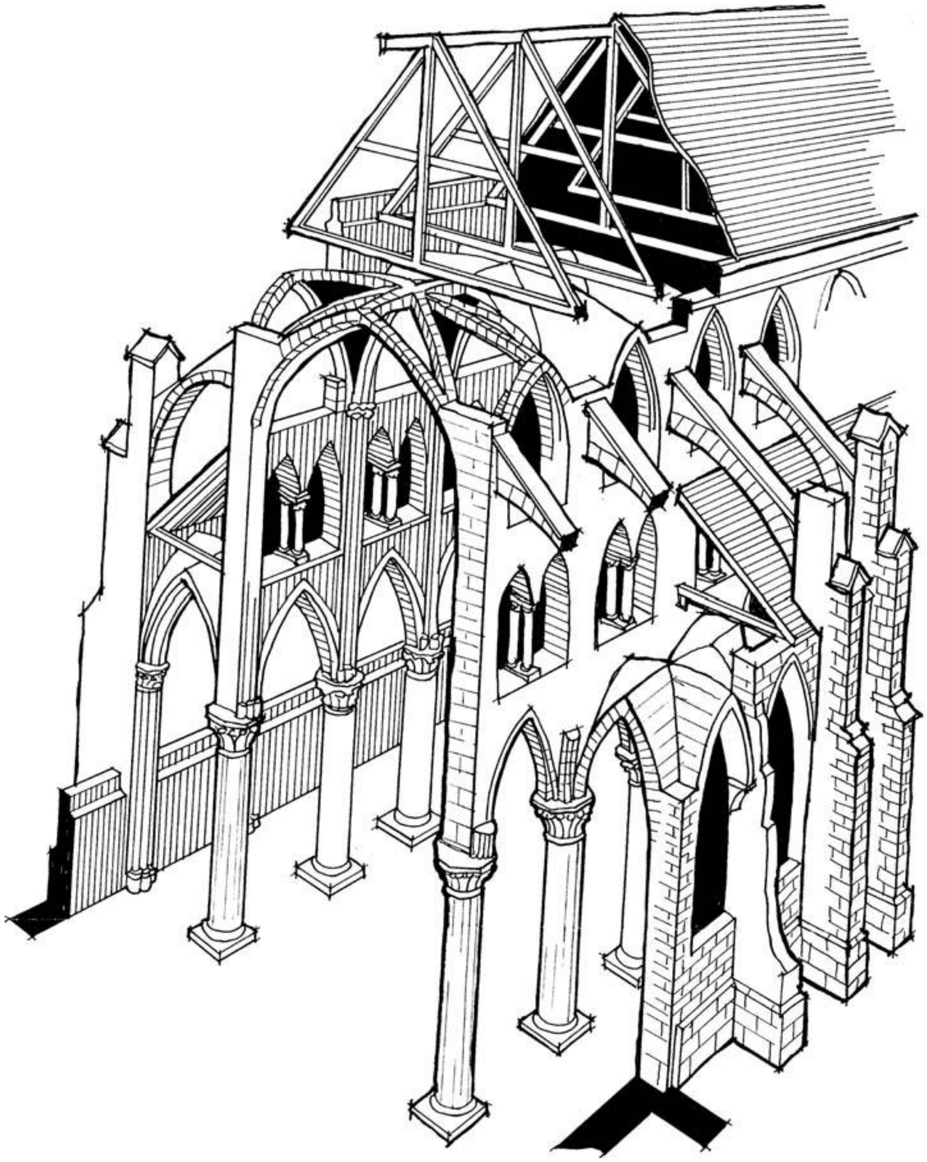


FIGURE 2.20 Sketch illustrating the functional character and structural support of ribbed vaulting and flying buttresses that counteract the horizontal thrust of the vertical arches.

The Renaissance, 1400–1700

The Renaissance, which literally means "rebirth," was characterized by a new way of life. Thinkers and artists saw expansion in all dimensions of human activity. The awareness of the individual and the study of nature gave inspiration for exploring new developments. Rediscovered classics preserved from ancient times kindled a new awareness and expansion of the arts, literature, and architecture.

Architecture flourished, combining the classical orders, entablatures, and arches with simple, geometrical buildings. Renaissance architecture sharply contrasted with the preceding towering Gothic forms. Elaborate interiors and furniture began to appear, echoing the former intellectual designs of the classic ages. The Renaissance encompassed several distinct stages and regional interpretations.

Italy, 1400–1580

The Renaissance began in Italy, where the remains of Roman civilization provided a stimulus. The medieval castle with its defense architecture gave way to new styles. The invention of the printing press allowed the rapid spread of new knowledge to other lands. A realistic art and sculpture developed, and linear perspective was introduced in painting.

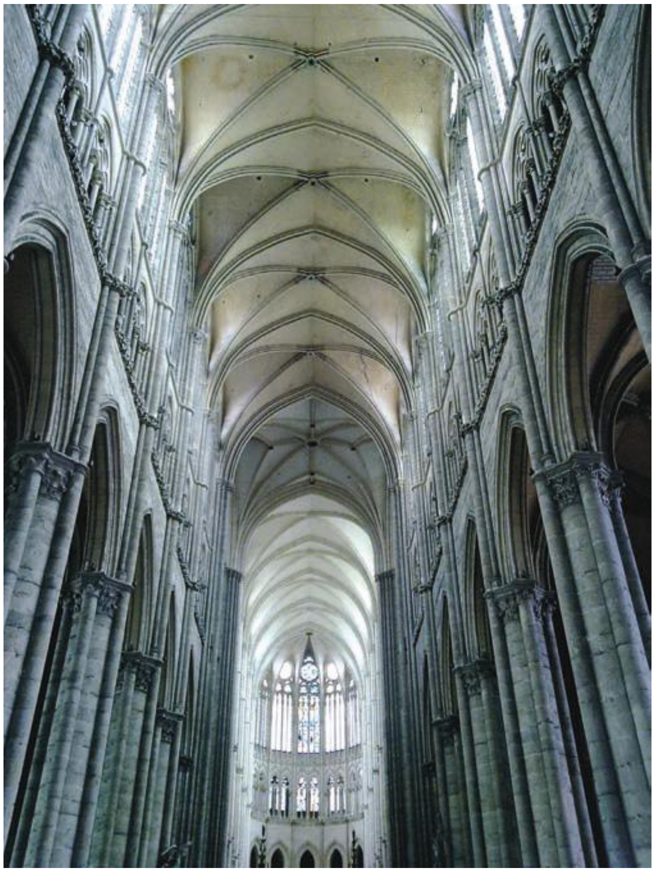


FIGURE 2.21 The Cathedral of Notre-Dame (1220–1269) at Amiens is an excellent example of French Gothic architecture. The towering interior ribbed vault is 140 feet (43 m) in height and 490 feet (150 m) long. It is the largest medieval interior in Western Europe.
© Ryan Luke Johns

FIGURE 2.22 The Pittsburgh Glass Building (1984) in Pennsylvania has characteristics of the Gothic influence. The architect, Phillip Johnson, translated the style into modern materials and construction.
PD-User: Derek Jensen

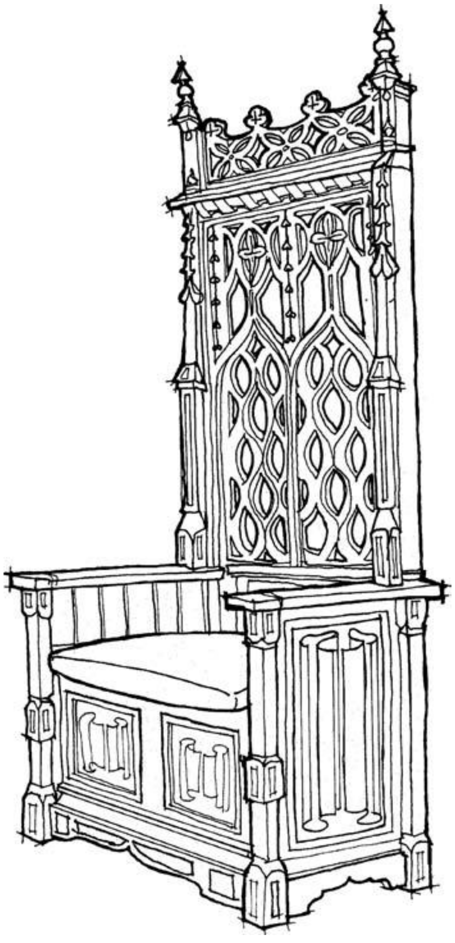


FIGURE 2.23 This chair exhibits characteristics of tracery, pointed arches, and buttresses similar to the Gothic architecture of that period.

FIGURE 2.24 Andrea Palladio's Villa Rotonda (1550) on a hill near Vicenza, Italy, has a central domed salon that is symmetrically flanked on four sides by identical projecting porticoes.
CC-BY-SA-2.5/Ivan Vighetto

Florence was the seat of the Italian Renaissance in architecture and design. The principles of formalized and symmetrical planning can be seen in its villas, public buildings, and town centers. Early Renaissance buildings exhibited an experimental and reserved use of classical elements, while High Renaissance styles developed sophisticated design theories derived from the classics. One person who systematically incorporated classical detail and orders into his architectural practice was Andrea Palladio (1508–1580) (Figure 2.24). His writings and designs, along with those of Leon Battista Alberti (1404–1472), served as sourcebooks for many architects who followed.

Renaissance interiors were painted, inlaid with wood, or finished in neutral tones and accented with bright draperies or accessories. A typical interior from this period can be seen in Figure 2.25. Coffered and flat ceilings, brightly painted, were used, as were flat, decorative columns, called pilasters. Floors were constructed with brick, tile, or marble laid in geometric patterns.

In the Early Renaissance, interiors were sparsely furnished with functional wood furniture that harmonized with the architectural designs. A variety of seating, such as stools, armchairs, and benches, was used for social interactions. In the Renaissance, wooden *cassone* chests, the *cassapanca* (Figure 2.26), and several variations of the X-shaped chair, such as the Savonarola, were introduced (Figure 2.27). The refectory table and the credenza storage unit were also characteristic of this period.

France, 1490–1650

French military campaigns into Italy brought the influence of the Italian Renaissance to the French nobility. However, French artisan guilds resisted the change from Gothic styles to the new Italian motifs, so the Early Renaissance saw a curious mixture of Renaissance ornamentation and the pointed, arched Gothic styles. Gothic exterior elements such as pointed roofs, towers, and dormers slowly gave way to Renaissance influences. Gradually, the French developed their unique style in the Renaissance, and it flourished later during the baroque period.

FIGURE 2.25 This master room in the Palazzo Davanzati at Florence, Italy, from during the fifteenth century, has tiled floors, richly painted walls, and a carved wood ceiling.
Courtesy of Carla Costa

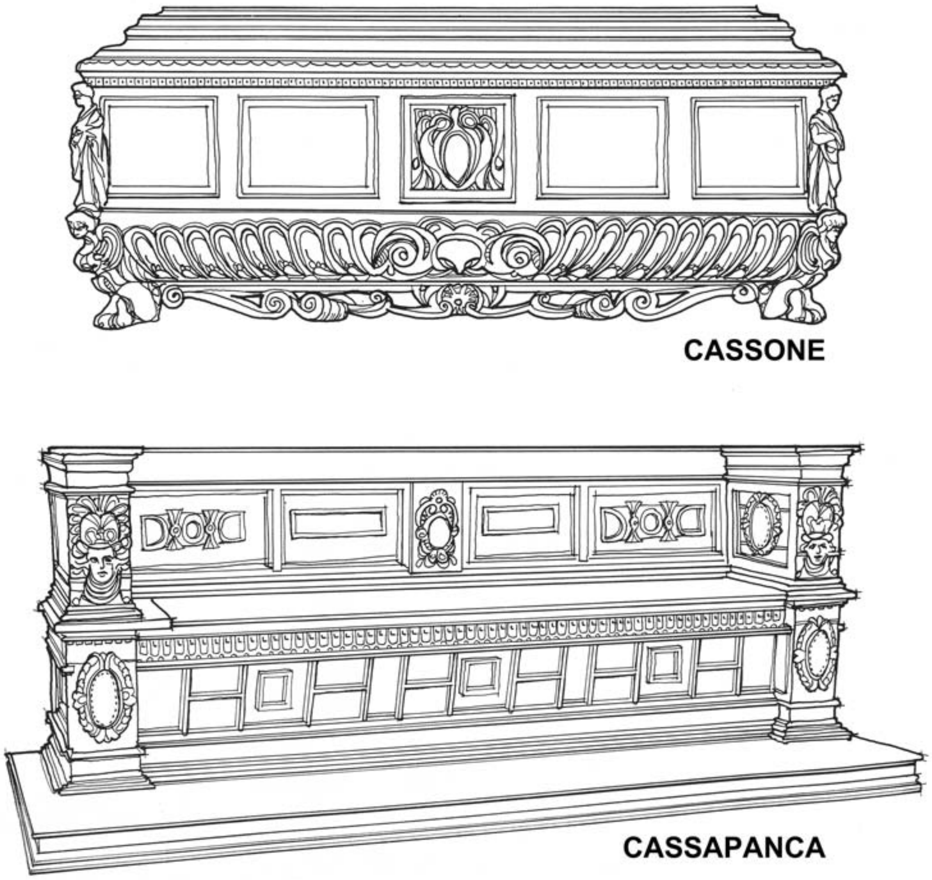


FIGURE 2.26 The large *cassone* storage chest and *cassapanca* seating/storage bench are examples of sixteenth-century Italian furniture.

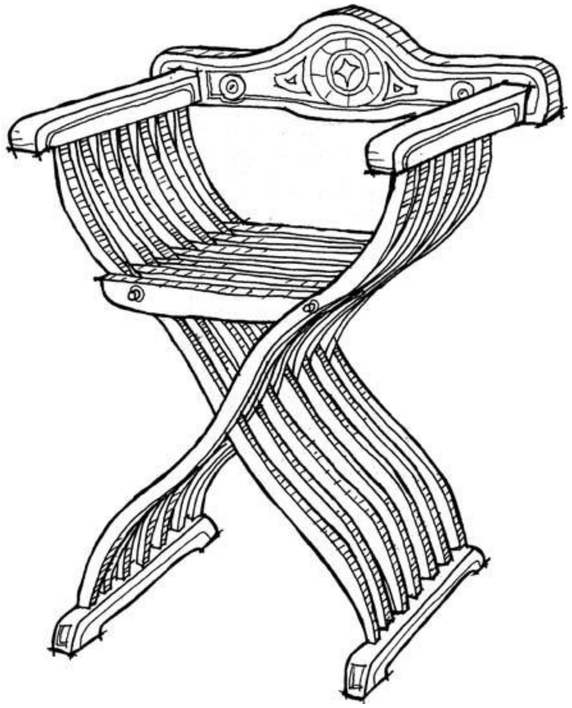


FIGURE 2.27 The Savonarola is a folding X-shaped chair derived from the folding stools of the Egyptians, Greeks, and Romans. This Italian example is from the fifteenth century and is constructed of beechwood.

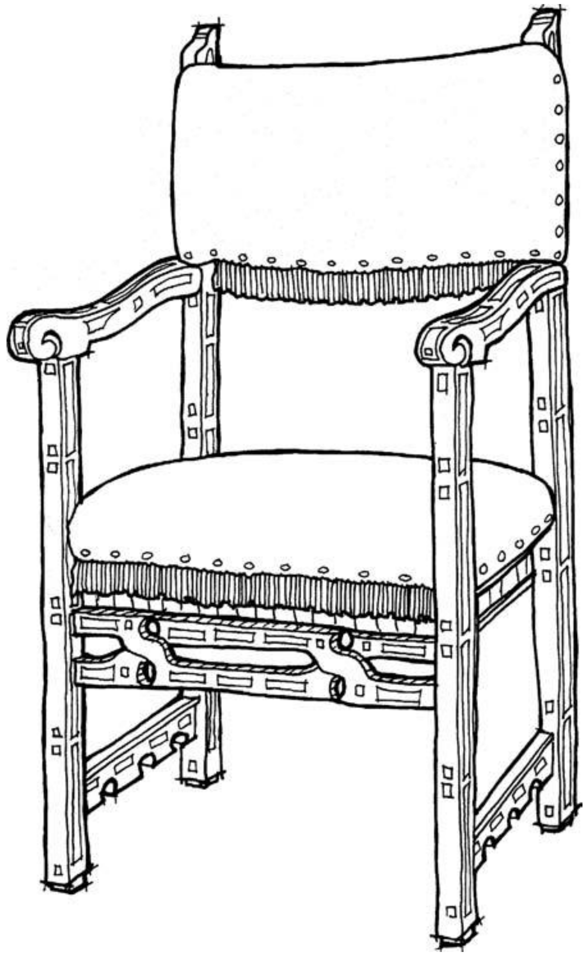


FIGURE 2.28 Monk's chair from the Spanish Renaissance, with a leather seat, back, and fretted front splat.

Little ornamentation was used in the interiors or on the furniture in the Early Renaissance period in France. Later, however, pieces were elaborately carved and inlaid with a variety of metals, marble, and shells. The French introduced the armoire, a clothing wardrobe piece still used extensively today. As the Renaissance advanced, furniture was crafted with ebony veneers and hidden construction joints. Fabric covering of furniture became popular, and marquetry (the inlaying of contrasting veneered materials) was developed.

Spain, 1400–1600

The Renaissance in Spain was influenced by the objects and art brought from Italy in political and military expeditions. Spain was strongly influenced during its Renaissance period by the tradition of Moorish decoration, since the Moors had been a strong force there for 800 years.

The Renaissance in Spain can be divided into several periods that vary in the degree of Italian influence. The most notable periods were the Early, or Plateresque (referring to the work of silversmiths), and the Desornamentado (unornamented), which adhered closely to the Italian style of austere simplicity.

The Moorish geometrical and decorative elements had a great impact on Spanish buildings. Interiors were simply plastered but detailed with mosaic-tile work, wood, wrought iron, and wood-paneled ceilings. Doors were generally of heavy wooden construction and recessed, like the windows, which were adorned with wooden shutters, iron grilles, and blinds. Floors were covered with rugs, and tooled leather pieces hung on the walls.

Spanish furniture, influenced by the Italians, was simple and was either placed along the wall or built in. Many chairs were covered with tooled leather, with Cordovan leather being much in demand. The sillon frailero, or monk's chair (Figure 2.28), is typical. The Spanish developed the varqueno writing cabinet (Figure 2.29), a chest of drawers with a hinged writing surface that, when open, revealed many cubbyholes, some of them secret compartments.

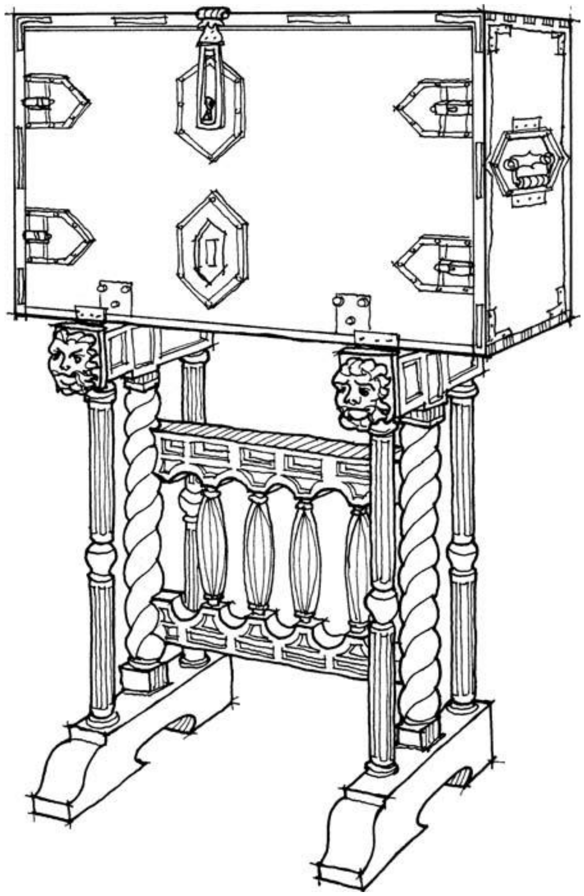


FIGURE 2.29 The Spanish Renaissance varqueno is a writing and storage desk made in wood with iron hinges and lock.

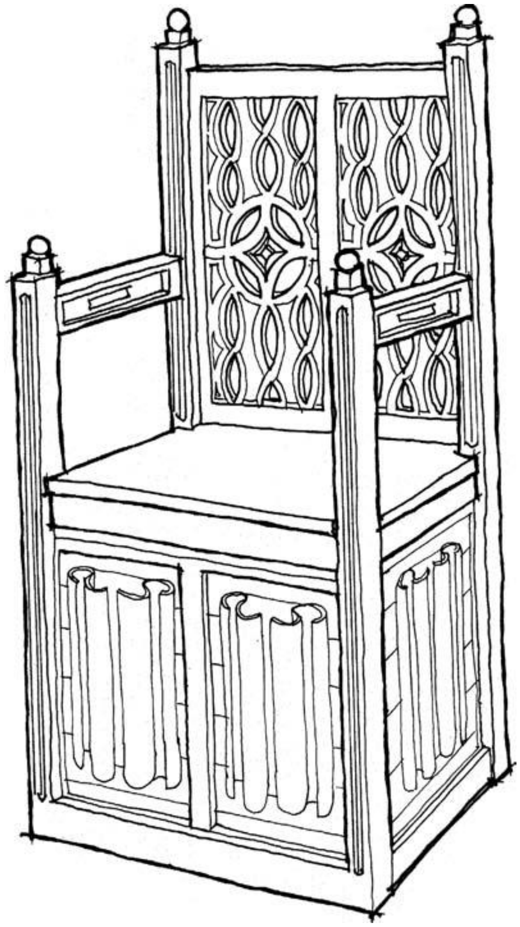


FIGURE 2.30 This Tudor chair is constructed in simple lines with a linenfold relief carving at the seat front, which resembles a folded sheet, and tracery carving on the seat back.

England, 1485–1689

The Renaissance seemed to come more slowly to England; however, growing trade, economic stability, and the throne pushed the country into new prosperity and introduced Renaissance principles throughout the region. The English Renaissance can be broadly divided into four periods: the Tudor, Elizabethan, Jacobean, and Restoration.

TUDOR PERIOD, 1485–1558 The Tudor period saw the slow ending of the feudal system and the development of towns. The Gothic style of architecture began to be modified with intricate patterns in an English style that used large, closely spaced windows and tracery. The Tudor Gothic style, which used a flatter arch, was introduced. Brick became preferred to stone.

In early times, English houses were constructed with an all-purpose space called the great hall, which had a central open hearth for cooking and heating. During the Tudor period, other smaller, more private, rooms were developed, and additional fireplaces were built into the walls. However, the main hall, in its long gallery form, still served as the primary activity center. The interiors were framed with beams, some exhibiting a fan-vaulted ceiling decorated with hanging pendants. Oak became the most popular building material and could be seen in wall paneling and furniture.

Furniture in the Tudor period was fairly sparse, large, and heavy. Pieces included chairs (Figure 2.30), benches, massive tables, canopied beds, and storage pieces, such as the cupboard, the food storage ambry, chests, and the press storage unit.

ELIZABETHAN PERIOD, 1558–1603 The Elizabethan period saw an increase in building activity, particularly in residential sectors. Houses were symmetrical in proportion, and in the interiors, plastered ceilings were developed

FIGURE 2.31 This massive Elizabethan bed from the sixteenth century has an assortment of intricately carved pedestals that support a wooden canopy. *©11C / age fotostock*

and stairways became focal points. Large estates were constructed for the wealthy, and the use of brick and stone increased. In turn, these materials inspired the use of additional classical features on exteriors.

Carved Elizabethan furniture was more refined and abundant. Although oak was still the most popular wood, others, such as walnut, were occasionally used. Chairs were still fairly straight and uncomfortable, since they were not proportioned to fit the human body. Some beds were monumental in size and construction (Figure 2.31), using various types of ornamented canopies and ornate carvings. Bulging "melon" shapes were often carved on furniture legs and other vertical members during this period.

JACOBEAN PERIOD, 1603–1649 The Jacobean period was named after the first of the Stuart monarchs, James I. The architecture of this time was influenced by the architect Inigo Jones (1573–1652), who had studied Italian architecture and executed many royal and public buildings. English architecture of this time saw an increase in the use of standardized bricks and Italian features.

Jacobean interiors were more regular in scale and comfort, with symmetry becoming more popular. The great hall's height decreased, and additional specialized rooms were developed. Ceilings were of decorative plaster, and more classical elements were used. The furniture, still fairly simple, was lighter and more comfortable. Panel-backed chairs were decorated, and ornamentation began taking on classical features. The gateleg table is one of the most notable furniture pieces of this time (Figure 2.32), and was especially useful in small rooms.

RESTORATION PERIOD, 1660–1702 The Restoration period began when Charles II took the throne (1660–1685) and introduced much of French style and architecture to England. This period overlapped the baroque and rococo periods, which are discussed later in this chapter. Symmetry was still dominant, and ornamentation with urns, pilasters, and finials was popular. Red brick and portland stone were a favorite combination of building materials.

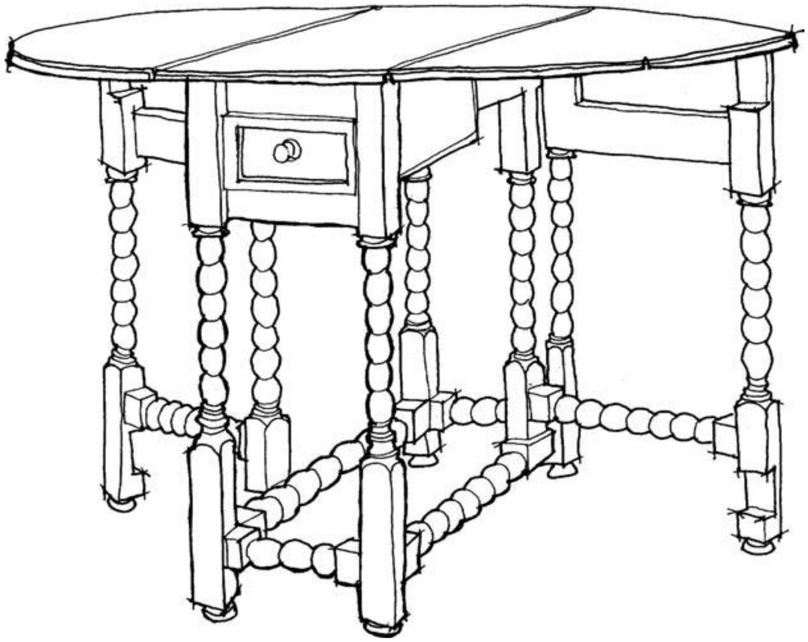


FIGURE 2.32 Jacobean gateleg table that can be folded out for additional table surface. This one is decorated with columnar legs and contains a storage drawer.

Interiors were symmetrical, with stairs, corridors, smaller fireplaces, and small rooms located around the great hall. Walls and carvings of oak or walnut and decorative plastered ceilings adorned the rooms. Floors were tile, marble, flagstone, and oak.

During the Restoration period, walnut became popular and was used in veneer, often inlaid with other woods. Skilled craftsmen constructed furniture that was curved and padded and thus more comfortable. The furniture became more decorative, influenced by French and Dutch styles. Beds, which continued to be one of the most important items of furniture, were quite large and canopied.

Baroque and Rococo, 1580–1760

The seventeenth century in Europe was a period of many conflicts, opposites, and irregularities characterized by a political stability imposed by a monarchy. Great wealth poured into Europe because of international trade, but only to a few rulers who gained power and dictated all aspects of life to their subjects.

Art and architecture expressed this age of power. The baroque originated in Italy as a style of religious expression, and then spread to France, where it emerged as a style of royalty and grandeur, particularly in public buildings, churches, and palaces. Its name was derived from *barocco*, a Portuguese term meaning imperfect pearl of irregular shape.

Italian Baroque, 1580–1750

The baroque style began in Rome and spread rapidly throughout the rest of Italy. A strong feeling of competition prevailed among European rulers to acquire the best artistic works available.

The architectural elements of Italian baroque, such as pilasters, pillars, entablatures, and round arches, evolved from classical Roman elements but were arranged in a new way to convey the feeling of dynamic movement. Pillars were frequently oriented diagonally, and architraves broke into pediments. Fireplaces were treated with elaborately carved details in high relief and often had the curvilinear contours of the period's doors and windows. The latter elements were generally elaborate structures, as high as the cornice of the ceiling, and dominated the entire room. Stairways were created as a visual and emotional experience, with pillars, pilasters, arches, and niches filled with oversized statues that often projected beyond the plane of the wall. Baroque ceilings were very high, containing dramatic effects, such as large figures. Although baroque interiors adhered to the classical orders, they were enlarged in scale and full of dynamic energy and movement.

Baroque furniture, mostly of walnut and very large, was designed for monumental and magnificent interior settings. Applied ornamentation consisted of figural silhouettes, swirling curves, deep undercutting of shapes, and three-dimensional projections. In some cases the decoration was so profuse that it could be difficult to identify the structure of the piece.

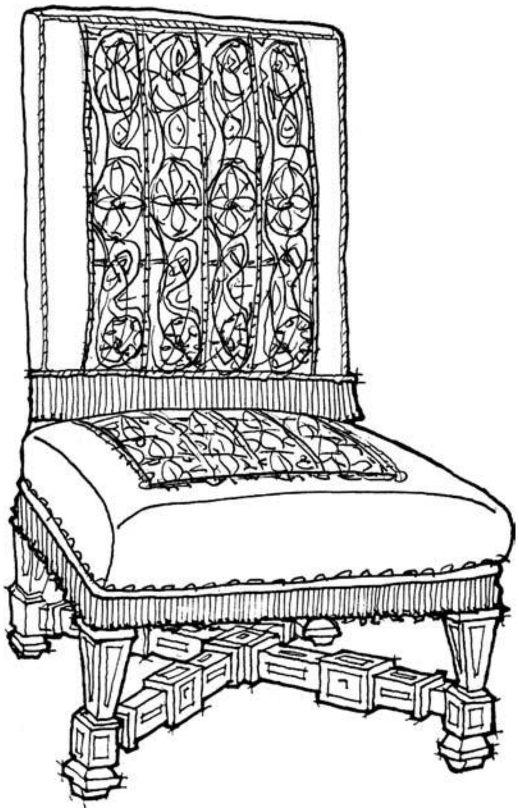


FIGURE 2.33 This baroque chair has an X-shaped stretcher, fringe trimming, and heavy, square, tapered legs. It represented a more formal style with a high rectangular and straight back.

Chairs had heavily carved gilded frames, with the arms constructed of scrolling curves extending to large scrolled feet with diagonal stretchers. Chairs were upholstered in velvets and silks, generally in a large pattern of strong, contrasting colors (Figure 2.33).

Classical-interpretation console tables set against the wall and supported by heavily carved bases, with dolphin, cherub, or mermaid motifs, were typical. The commode, or large chest of drawers, had an excessive amount of decoration and was used for storage as well as the display of art objects. Very large mirrors with heavily carved gilded frames became popular.

French Baroque, 1643–1715

Louis XIV (1638–1715) assumed the throne of France in 1661 and developed his court into an international leader in fashion and the arts. He saw the arts as a way to restore royal prestige and power. Under his rule, the finance minister, Jean Baptiste Colbert (1619–1683), established the Academies of Architecture, Fine Arts, and Music. Many factories that produced furniture, tapestries, and accessories were given royal encouragement by Colbert and supervised by Charles Le Brun (1619–1690), the art director of France. The French baroque style, which grew out of exaggerated Roman forms, was one of grandeur. It evolved as a national style, called *le grand siècle* ("the grand century"), and was associated with Louis XIV.

The French baroque was a monumental interior style of rooms and furnishings. Symmetrical, lavish ornamentation and rich color contrasts expressed the pomp and formality of court life during this period. Classical architectural details, such as columns, pilasters and entablatures; rectilinear outlines; and vast scale characterize the period. Cornices and deep-relief sculptural moldings, often with cherubs and foliage, were used around doors and windows.

The palace of Versailles was built for Louis XIV under the direction of Colbert, who assembled architects, artists, designers, and master craftsmen. Versailles covers more than 6,000 acres and was built to house 10,000 people. It has 67 stairways, more than 300 chimneys, and approximately 2,100 windows. Every room in the palace appeared to be a public space because of its enormous size and proportion, as well as its lavish decoration. Walls were generally constructed of wood and ornamented with gilded carvings and light-colored paint (Figure 2.34). Furniture was placed on the perimeter against the walls because pieces were designed for elegance rather than comfort and were generally too heavy to be moved. The motifs of the period ranged from foliate patterns and abstract swirls to shells, nymphs, and sphinxes.

FIGURE 2.34 The Chapel at Versailles (actually the fifth in the history of the palace) of 1689–1710 is two stories in height and lavishly decorated with an inlaid marble floor and carved white stone ornamentation.

Seating was designed as part of a ceremonial ritual, with a throne for the king, armchairs for princes, and stools and other chairs for nobility of lesser rank. Large chairs upholstered in velvet, silk, or tapestry had rectangular backs, heavily carved arms, and stretchers in flowing s-curves. In 1673, confessional chairs to be used by priests were designed with wings to hide a sitter's face. The sofa and chaise lounge were also developed during this period.

André Boulle (1642–1732) was appointed master cabinetmaker to Louis XIV in 1672. Boulle employed 20 cabinetmakers, along with his four sons, and made furniture for the king, other nobility, and foreign courts in his Louvre workshop. Boulle perfected the use of ormolu, an alloy of copper and zinc with the luster of gold, used for moldings and decorative motifs.

Storage pieces, such as the cupboard, bookcase, commode, and armoire, were very large, elaborate, and generally ornamented with Boulle marquetry. Tables with tops made of marble, stone mosaic, or wood were usually massive and gilded or inlaid. Tables for special purposes, such as the writing table or the bureau, began to appear at this time. The cabaret table was the first tea table.

French Rococo, Louis XV, 1715–1774

With the reign of the new king, Louis XV, social life began to shift from the grandeur of the court to luxury for the nobility and wealthy upper classes. Derived from the French word *rocaille*, meaning rockwork, the term "rococo" referred to the fanciful treatment of ornament. More important than the ornamentation, the rococo style developed a new approach to the planning of interior space.

Building facades became simplified, with less ornamentation. Much less emphasis was placed on classical pilasters, columns, and entablatures. Windows were larger, with simple moldings and delicate cornices. Interiors were planned for specific functions, and separate rooms varied in size and shape. Hollow interior walls constructed of light materials reduced the scale of individual rooms, replacing the heavy walls of marble and stone from the previous period. Walls were generally painted in pastel colors, with applied ornament in flowing curvilinear forms.

FIGURE 2.35 The fauteuil chair is designed with exposed carved wood framing, and open sides and cabriole legs. The wood was often gilded or painted.

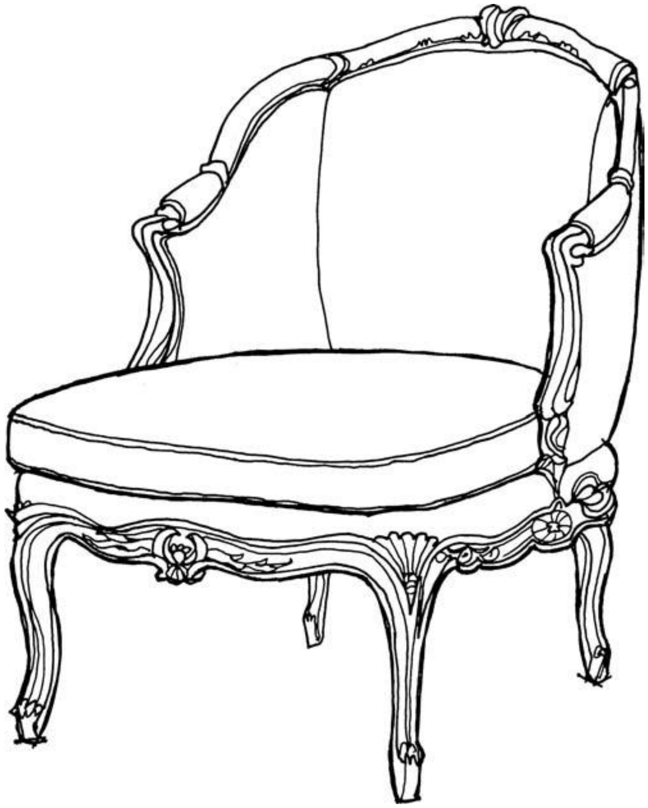


FIGURE 2.36 The bergère chair of the rococo period had an upholstered seat (sometimes a loose cushion) and enclosed sides beneath the arms.

The furniture of the rococo style was comfortable, light, graceful, and contoured to fit the human body. Soft, curved lines were predominant in chair backs and legs, commodes, and textile patterns. Chairs of this period generally had padded arms that were set back to accommodate women's clothing. Two important chairs of this period were the fauteuil (Figure 2.35) and the bergère (Figure 2.36). The fauteuil ("armchair" in French) had padded arms open underneath. The bergère was larger in scale and had enclosed sides. The emphasis on comfort and conversation also produced several sofas during this period.

English Baroque and Rococo, 1660–1760

When Charles II assumed the English throne in 1660, he sought to imitate the lavishness and extravagances of the French court under the rule of his first cousin Louis XIV. Echoing the turbulent politics of this period, architectural styles were also in conflict. In fact, the English baroque and rococo periods can be broken into distinct styles reflecting who occupied the throne.

Charles II was succeeded by his son, James II, who reigned from 1685 to 1688 and continued a policy of autocratic power. This provoked the nobility of England, and the crown was then offered to William of Orange, who was married to Mary, the daughter of James. This reign (1689–1702), known as the period of William and Mary, was characterized by simplicity, prosperity, and economy.

Queen Anne reigned from 1702 until 1714, and George I reigned from 1714 to 1727. In these periods England enjoyed an increase in trade and great wealth. New ways of thinking created an atmosphere of comfort and culture.

Social development continued under the leadership of George II and George III. The period from 1727 through 1760 is known as the Early Georgian Period.

Furniture historians disagree about whether the William and Mary style or the Queen Anne style is transitional between baroque and rococo. However, they almost always classify the early Georgian and Chippendale furniture

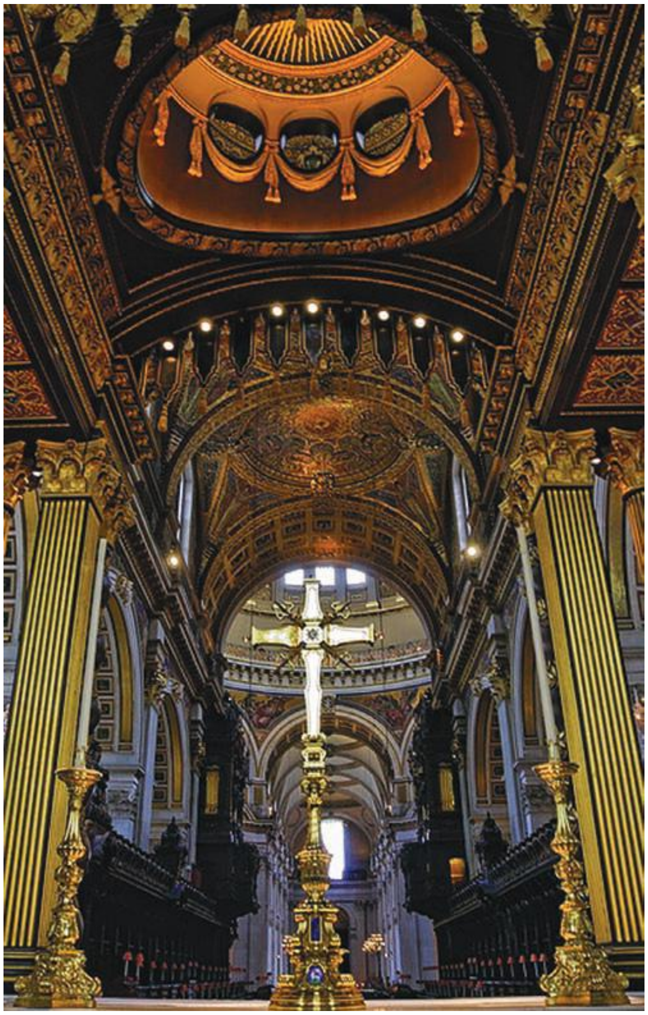


FIGURE 2.37 St. Paul's Cathedral (1675–1711) in London was designed by the noted architect Sir Christopher Wren. The classical features of the building attest to the baroque influence on architecture during this time.
Courtesy of fineartamerica.com/profiles/nigel-fletcherjones.html

styles as rococo, even though the exterior architectural design, as well as many interior architectural details, depicted the baroque and/or Palladian idiom.

Sir Christopher Wren (1632–1723) was an important architect who became a leader in the artistic life of the period. He was strongly influenced by the Italian architect Andrea Palladio and by French architects. Wren designed several churches, including St. Paul's Cathedral in London, in the baroque style (Figure 2.37). Generally, these English baroque exteriors were restrained in design and constructed of red brick with stone pilasters; they were large, simple rectangular shapes, with pitched roofs and dormer windows.

Interior walls were wood paneled to the ceiling, either of naturally finished oak or of painted white pine with gilt accents. Ceilings were generally elaborately painted, with illusionistic effects. Fireplaces and doors were carved and elaborately ornamented.

Another architectural style emerging during the Queen Anne period was the Anglo-Palladian, inspired by the architecture of Palladio and Inigo Jones. The Anglo-Palladian plan of Chiswick House (Figure 2.38), designed in 1725 by the Earl of Burlington, reveals a square, symmetrical shape with a circular hall in the center, reminiscent of the Villa Rotonda by Palladio. The influence of Jones can be seen in the richly decorated ceilings and fireplaces. Baroque elements, such as broken pediments over doors, rich ornament, and elaborate furniture, were still present. Even though English baroque interiors were large, sprawling, and ornate, they never displayed the dramatic effects of the baroque period in Italy or France.

Georgian interiors were elegant, refraining from lavish ornament. Wood paneling was painted white to blend with the plaster ceiling and simple moldings. Fireplaces continued to be framed with a broken pediment and other decorative details. French wallpaper featuring East Asian scenes and flocking (a textured surface used to imitate wall fabrics) sometimes adorned the walls. However, plain surfaces began to appear, as did an interest in balancing

FIGURE 2.38 The Chiswick House (1720–1725) in Middlesex was constructed by Lord Burlington and based on Palladio's studies of Roman baths. It combined classical motifs and had a highly decorated interior.
Courtesy of Paul Drougas

all elements of the interior. The furniture of the English baroque and rococo period also exhibited a variety of influences, as follows:

LATE STUART PERIOD, 1660–1668 The main characteristic of this period was deep carving of c- and s-curves in flowing, dynamic shapes. Spiral turnings were popular in tables and high-back chairs. Walnut replaced oak as the main wood for furniture. Two new forms of furniture were developed: elongated chairs, called daybeds, and chests of drawers on stands (Figure 2.39).

WILLIAM AND MARY, 1688–1702 In this period, furniture became smaller in scale and more comfortable. Wood veneers and marquetry with intricate, interlacing patterns became common. New types of case goods were introduced, including the writing desk, dressing table, and highboy, a chest of four or five drawers supported by a table (Figure 2.40).

QUEEN ANNE, 1702–1714 Comfort and elegance were considerations of the early 1700s. Queen Anne furniture was sturdy, with flowing, curved shapes, the cabriole leg, and very little applied ornament. China cabinets and small, low tables for serving tea were introduced, as was the fully upholstered wingback chair (Figure 2.41).

EARLY GEORGIAN, 1714–1760 Thomas Chippendale (1718–1779) was the leading furniture maker of the early Georgian period. His designs were created by combining the curves of the French baroque and rococo styles with Gothic influences, Chinese fretwork, and the gracefulness of the Queen Anne style. In 1754, he published *The Gentleman and Cabinet-Maker's Director*, which featured his designs and construction methods (Figure 2.42).

Early American Architecture and Interiors

The development of American architecture, interiors, and furniture was heavily influenced by English styles. As the colonies began to develop, colonists started to manufacture their own necessities, and their dependence on England began to diminish.

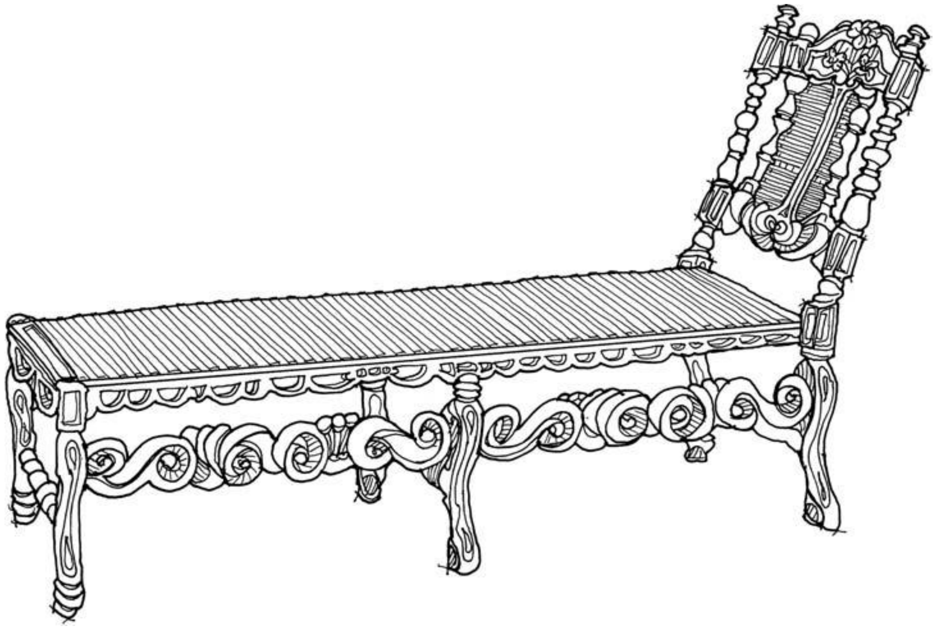


FIGURE 2.39 Example of a late Stuart period daybed.

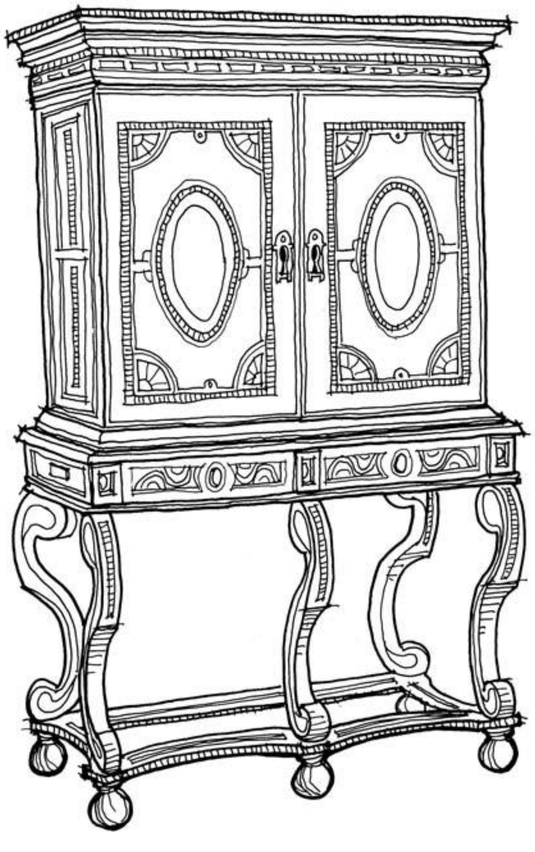


FIGURE 2.40 This walnut cabinet is indicative of the furniture styles during the William and Mary period (1688–1702). It is supported by broken-s-curved legs that rest on ball feet. The surface is overlaid with decorative marquetry.

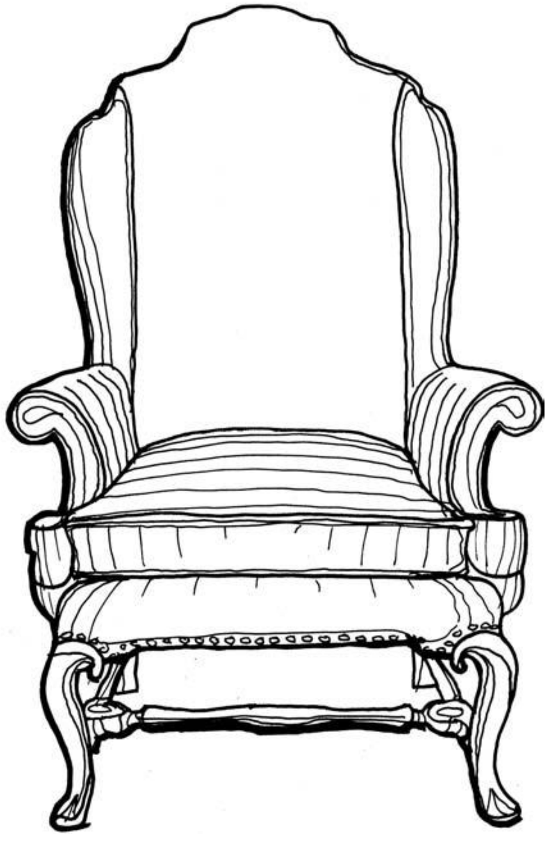


FIGURE 2.41 This upholstered walnut wing chair is from the Queen Anne period (1702–1714). Note the cabriole leg and curved shapes.

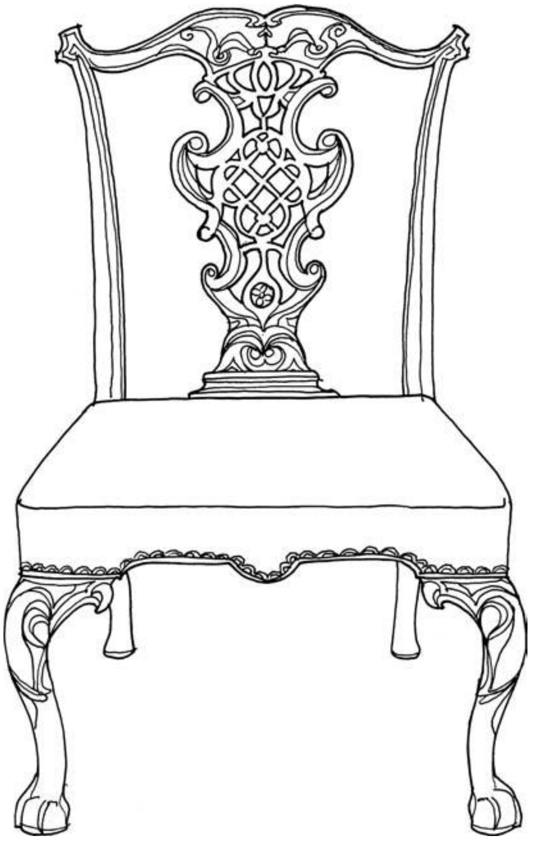


FIGURE 2.42 This mahogany side chair is typical of the style and strength of furniture made under Thomas Chippendale's direction.

Although the main stylistic influence came from England, other countries exerted some design influence. In the late sixteenth century, the Spaniards created thick-walled houses around open courtyards in Florida and the Southwest. French styles were evident in French settlements along the St. Lawrence River, the Great Lakes, and the Mississippi. As a result of various climatic conditions, regional American styles also began to appear. For example, because of the damp climate and dense underbrush, buildings in Louisiana were designed with raised ground floors and roofed outdoor galleries for protection from rain and heat. In the northern colonies, the Dutch constructed buildings with high-pitched roofs to shed snow. American architecture and furniture from the 1600s to the 1900s are generally divided into two distinct styles: the early colonial and the colonial Georgian.

Early Colonial, C. 1630–1720

Because the early colonists were faced with Indian battles, the elements, sickness, and accidents, there was not much time or energy to cultivate the arts. Agriculture was the basis of the economy, though gradually other trades and industries, such as fishing, lumbering, iron manufacturing, and shipbuilding, were developed. The colonists' rough dwellings had to be constructed quickly; indeed, sometimes they lived in caves or crude shelters of mud and branches. A typical house consisted of a simple, single room where all the basic activities took place. As the economy improved, a second room was added and sometimes a second story or loft area for additional sleeping space. The interior spaces were small and rectangular, with low ceilings. The main feature of each room was the thick-walled fireplace, used for heating and cooking (Figure 2.43). Beams and structural supports were left exposed and unpainted. The spaces between the supports were generally plastered and painted white.

The furniture of the early colonial period generally served multiple needs. Local craftsmen created their own interpretations of medieval, Elizabethan, and early Stuart styles. Influences from the Renaissance period were evident in architectural motifs, such as spindles and turned posts.

Chests were the most important pieces of furniture; they were used for storage, travel trunks, tables, or seating. Gradually, drawers were added, and the chest evolved into a chest of drawers on legs. The court cupboard of the seventeenth century was richly carved, with blocky proportions and "melon bulb" turnings on the legs, reminiscent of the English Elizabethan style. The storage and display cupboard evolved into the highboy, a high, one-piece chest on a waist-high stand (Figure 2.44).

FIGURE 2.43 A typical hall in an early colonial house built about 1684 shows how a single room was used for living, cooking, eating, and sleeping.
©11C / age fotostock

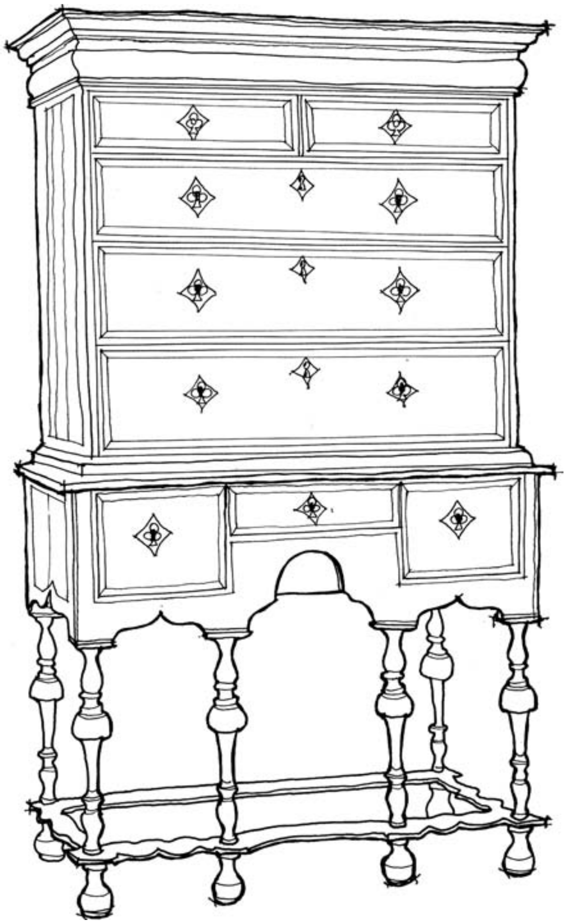


FIGURE 2.44 This early colonial highboy is made of veneered walnut and has William and Mary inverted-cup legs.

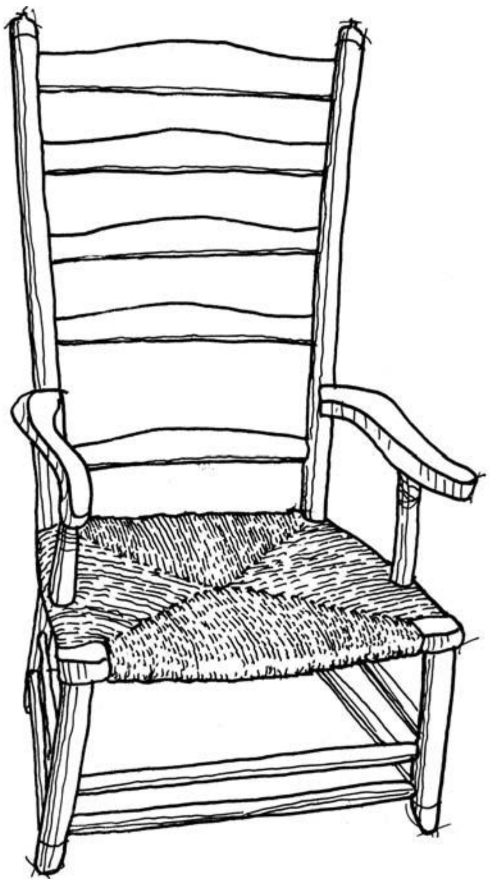


FIGURE 2.45 This Carver armchair is typical of the early colonial period, with a rush seat and a minimum of turned embellishments.

Chairs of the early colonial period were reminiscent of those made in Europe. They had stick backs, cane seats, and simple, turned cylindrical arms and legs, as exemplified in the Carver chair (Figure 2.45).

Since space was limited, furniture was designed for flexibility and convenience. The chair-table had a hinged top that could be lifted to form the back of an armchair. Tables with swinging gatelegs or butterfly supports had drop leaves that were extended for meals.

Colonial Georgian, C. 1720–1790

As America became more settled, increased trade brought closer contact with European styles. Colonial craftsmen depended heavily on the illustrated books on architecture and design published in England during the eighteenth century. Sir Christopher Wren and Palladio exerted strong architectural influences.

Although some regional differences existed in colonial America, from Maine to Florida the architecture was similar: symmetrical, with the front door in the center, generally flanked by pilasters and a pediment or a small porch (Figure 2.46); rectangular; and two or three stories in height. Rooflines were accentuated by projecting cornices that eventually became flatter and were topped by a balustrade.

Interior spaces consisted of four or five rooms with a fireplace in each and a large, central staircase. A spacious hallway ran from the front of the space to the rear. Large, tall rooms were based on the severe, classical Palladian and the Louis XV styles. Doors and windows were trimmed with classical architectural details, such as architrave moldings and triangular pediments. Walls were either paneled or papered. Wallpaper was first imported from China, but after 1786 it was produced in America.

By 1750, colonial furniture had become lighter in construction and had more curves. Craftsmen in Boston, New York, and Philadelphia produced distinctive furniture designs that could be identified with those population centers. Mahogany and walnut were the favored woods, and variations of Queen Anne and Windsor chairs were commonly used. Storage pieces included the lowboy, as a side table, and the highboy unit. Cabinets, chests, and large beds with fabric enclosures were used throughout the colonies.

Although colonial furnishings were basically copied from European predecessors and handbooks, American interpretations differed from the originals in ornamentation and proportions.

FIGURE 2.46 An example of a colonial Georgian dwelling showing strong symmetry with a central projecting entrance and triangular pediments. The hipped roof is topped with a balustrade and bracketed by two balanced end chimneys.

The Neoclassic Period and Other Revivals

As a reaction against the baroque and rococo styles, a movement called neoclassicism, or romantic classicism, began about 1750 and reached a peak in the middle of the nineteenth century. This age of rationalism, revolution, and industrialization revived the styles of the past. Not only were classical styles of architecture being imitated, but a new appreciation grew for the Gothic and other earlier styles from Europe, China, and the Near East.

Generally, the neoclassic style was simple and stable. It consisted primarily of straight lines and right angles. There were, however, distinct differences in various countries' early and late phases. Early neoclassicism was essentially an imitation of former styles characterized by dignity and restraint. In France it was the Louis XVI style; in England, a late Georgian or Adam style; and in America, the Federal style.

Late neoclassicism began about 1790 and was strongly influenced by Greek and Roman architecture and furniture. In France the style centered around Napoleon's empire. In England neoclassicism was called the Regency style; in America, the Greek revival or Empire style.

French Neoclassicism, 1750–1850

Louis XVI's name is associated with the early neoclassic style, which developed as a reaction to the rococo style. During his reign as emperor (1804–1815), Napoleon created the late neoclassic style in France.

LOUIS XVI STYLE, 1750–1792 The architecture of the period from 1750 to 1792 was restrained and devoid of ornament. The interiors again were large, with high ceilings and tall doors and windows. With the return of cornices, a distinction was made between the walls and the ceiling. Straight lines and right angles were emphasized, creating a dignified atmosphere (Figure 2.47). Wall paneling was generally painted white or off-white and framed by straight, thin gilded moldings.

This period also saw a dramatic reaction in its furniture. The furniture was produced in light and delicate proportions, but straight lines and rectangular silhouettes began to dominate. The distinguishing feature was the furniture supports. The cabriole leg began to straighten out, and by 1770, all pieces of furniture had straight and tapered legs, either round or square, and with vertical or spiral flutings. Mahogany was used more extensively because of the increased popularity of grained wood.

EMPIRE STYLE, 1804–1815 The Empire period illustrated the growing awareness of archaeological knowledge in the correctness of classical styles. Napoleon, who traveled to Egypt in 1798, was strongly influenced by ancient Egyptian

FIGURE 2.47 A room in the Hôtel de Tessé, Paris (1770), is an example of the dignified refinement of the French neoclassic style. White walls and doors are trimmed with gold leaf.

© The Metropolitan Museum of Art. Image Source: Art Resource, NY

designs, as well as by the monumental style of ancient Rome. The Empire style was characterized by its large scale and emphasis on flat planes. Walls featured flat pilasters and were generally painted in strong Pompeian colors, such as bright reds, yellows, greens, and deep blues. Walls and ceilings also featured painted decorations of stylized vegetable motifs in geometric patterns. Elaborate draperies covered the windows and sometimes extended across an entire wall.

Furniture designers of this period were more concerned with integrating antique design motifs—winged figures, sphinxes, eagles, and swans—than with human comfort. Pieces were heavy, solid; generally made of mahogany, ebony, and "ebonized" fruitwoods; and smothered with metal ornament. Case pieces and tables were strictly rectangular, but chairs and sofas combined gentle curves with straight lines. Beds and daybeds were treated in a monumental manner, with tent-like canopies, massive platforms, and elaborate scrolled headrests and footrests (Figure 2.48).

English Neoclassicism, 1760–1830

In England, the Anglo-Palladian movement had already separated itself from the baroque and rococo styles of France. The early neoclassic style, under the leadership of architect Robert Adam (1728–1792), interpreted classic architecture in a light and graceful manner until the 1790s. Then the late neoclassic period experienced a renewed interest in French styles, culminating in heavier proportions and literal interpretations of ancient styles.

LATE GEORGIAN, 1760–1800 The late Georgian period was largely influenced by Adam's strong contribution to interior design. He traveled extensively and was influenced by French and Italian architects and their theories of neoclassicism. The monuments of Rome and the excavated ruins at Pompeii and Herculaneum made great impressions on his designs. He created his distinctive styles based on what he saw on his travels, as well as on current books on Greek and Roman architecture.

The most notable feature of this period was that it was the first time a conscious effort was made to unify all elements within a single space or room. Adam designed not only the walls and ceiling of a room but every piece of equipment, including furniture, light fixtures, floor coverings, textiles, silver, pottery, and metalwork. Architectural effects were created by his monumental treatment of classical columns, pilasters, entablatures, arch forms, domes, and panels ornamented with classical motifs. Roman prototypes could be seen in many of his rooms through the use of semicircular, segmental, or octagonal end walls treated with architectural orders. Adam preferred pastel plaster walls to emphasize the finely molded white stucco relief. Fireplace mantels and doors became smaller in scale, and interest in ceiling decoration increased.

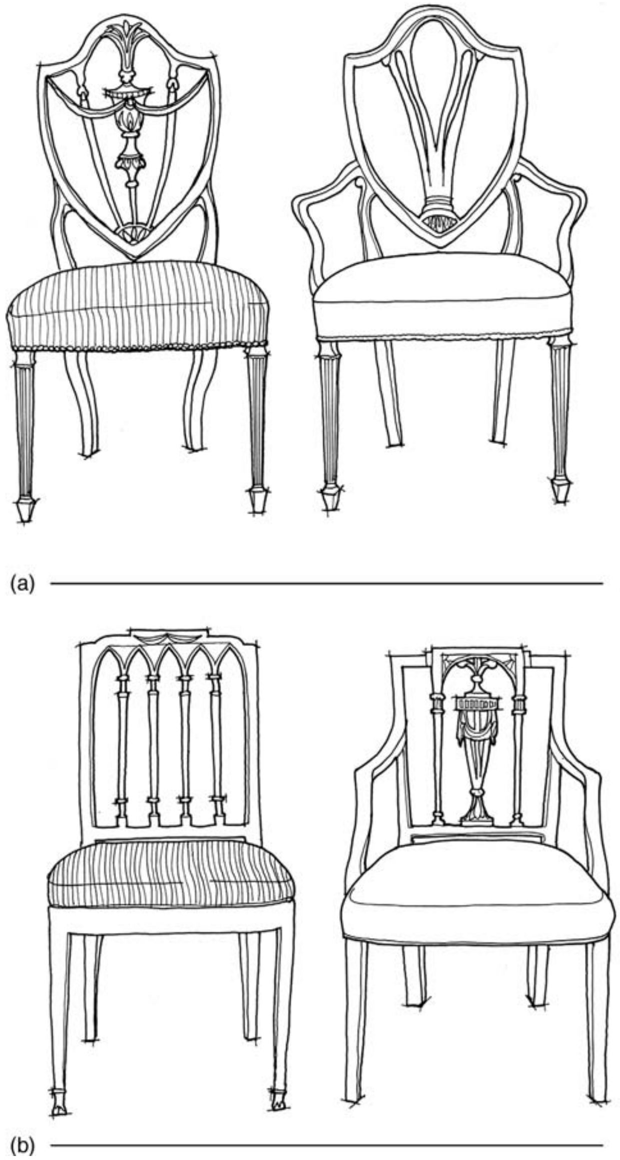
FIGURE 2.48 Reminiscent of the furnishings of the Greeks, Romans, and ancient Egyptians, this bedroom in the Chateau Malmaison, near Paris, was refurnished for the Empress Josephine in 1810.
CC-BY-SA-3.0/Moonik

Adam's emphasis on the unity of his interiors led him to design furniture that would also be complementary in scale and decoration. His interior motifs reappeared in his furniture. He was particularly noted for the development of the English sideboard, as we know it today, as well as his side tables, settees, cabinets, and bookcases. His sideboard is characterized by its bow front and satinwood frieze across the top, with urns, acanthus, and a plaque showing griffins on either side of a portrait medallion (Figure 2.49).

Two of Adam's followers were George Hepplewhite (d. 1786) and Thomas Sheraton (1751–1806) (Figure 2.50). Hepplewhite is best known for his chair designs featuring straight legs of round or square sections that tapered toward a thimble or spade foot, with heart-, oval-, and shield-shape backs. Hepplewhite gained an international reputation after his widow published a book of his furniture designs in 1788. Thomas Sheraton's *The Cabinet-Maker and Upholsterer's Drawing Book and Cabinet Dictionary* established his reputation. He was influenced by Hepplewhite's use of straight legs, slender forms, moderate scale, and marquetry or painted decoration. Sheraton,

FIGURE 2.49 This bow-front commode was designed as one of a pair by Adam in 1733. It features decorative motifs inlaid in various woods.
V&A Images / Alamy

FIGURE 2.50 Two designs for Hepplewhite's shield-back chairs (a) resemble the delicate Adam style. Thomas Sheraton's side- and armchairs (b) illustrate his use of the straight line, right angle, and short simple curves.



however, refined the use of the straight line, right angle, and short, simple curves. These elements are best expressed in his chair backs, which exhibit a great deal more surface detail than Hepplewhite's. Sheraton also is credited with the development of the tambour desk, writing desk, and kneehole desk.

REGENCY STYLE, C. 1800–1837 Architecture drew little interest during the English Regency period, in part because of the Industrial Revolution and the increase of wealth available to the middle class, which was not interested in cultivating new artistic styles. Interiors were generally open, incorporating large folding doors to separate rooms. To extend the interior space, bow and bay windows were used. Interiors as a whole became plainer, with less emphasis on rich ornamentation and more on flat surfaces. Ceilings were white plaster; walls were generally painted in strong colors with contrasting white pilasters or gilded fixtures. Fireplaces, which became less important, were framed with simple white or black marble mantels.

Regency furniture was very large in scale, severe, and simple in design. It imitated Chinese, Greek, Roman, Gothic, and Egyptian forms and ornaments. X-shaped supports, as well as animal forms, such as lions, sphinxes, and chimeras, were used for chairs and stools. Case goods generally were very heavy and used architectural supports and moldings. One of the most important pieces of furniture of the Regency period was the adaptation of the "Grecian" sofa with scroll-shaped head and footrest (Figure 2.51).

Thomas Hope (1769–1831) was one of the most important designers of the Regency period. He traveled extensively and in 1807 published a book of his designs entitled *Household Furniture and Interior Decoration* (1807).

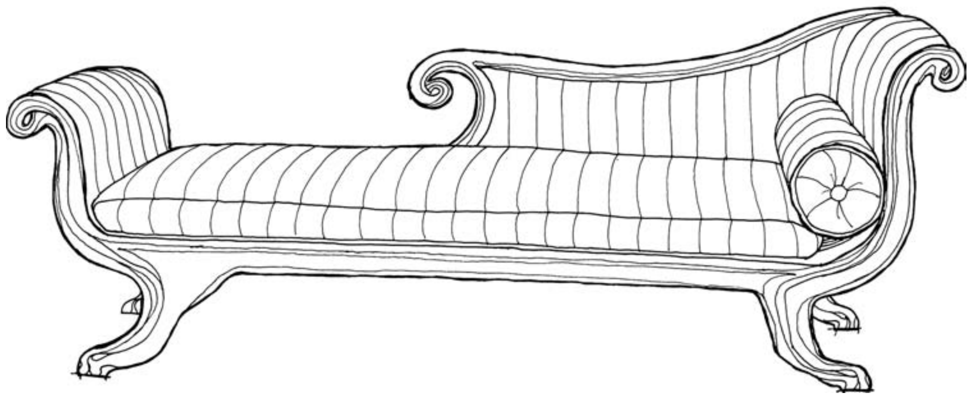


FIGURE 2.51 An example of "Grecian" sofa illustrates the influence of Greek, Roman, and Egyptian forms in its splayed legs with lion feet and scroll-shaped head- and footrest.

American Neoclassicism, 1790–1860

Neoclassicism in the United States began about 1790, when ancient Roman buildings and contemporary French and English neoclassic buildings were used as models for American architecture and interiors. The Federal style—the early phase of American neoclassicism—was characterized by formal public buildings that were based on Roman, Renaissance, and contemporary European models. However, domestic interiors and furniture relied on the restrained neoclassicism of Adam and his followers.

The late neoclassic period began after 1820, when the architectural style turned from Roman to Greek models. In America this period is referred to as the Greek Revival or Empire style, because it was strongly influenced by the French Empire and English Regency styles.

FEDERAL, 1790–1820 Independence and patriotism in America developed during the Federal era, which included the American Revolution, the War of 1812, and westward expansion.

Architecture during this time was rooted in classicism and symmetry. Thomas Jefferson, on his return from Europe, remodeled Monticello, his home, and produced designs for the University of Virginia in the new Federal style. That style, with its symmetry and attention to detail, soon became the most popular for new buildings across the land. Entries were often pedimented, flanked by columns, and placed symmetrically on the façade. Chimneys were moved to the ends of the building, and roofs were flat or hipped, topped with a balustrade (Figure 2.52).

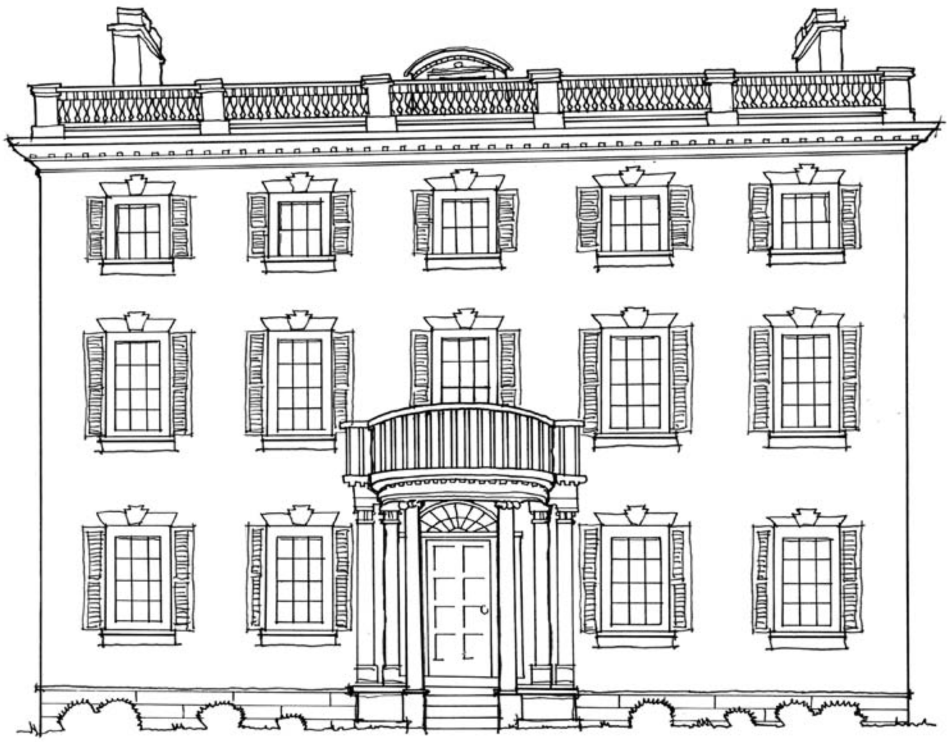


FIGURE 2.52 The Federal style produced a refinement of classical taste in American architecture. Symmetry, an entry portico, classical elements, and a roof topped by a balustrade are typical of this style.

FIGURE 2.53 An example of Duncan Phyfe's earlier work can be seen in this striped sofa in the Green Room of the White House, as President Barack Obama looks at a mirror. The elegant simplicity of the square-back chairs is reminiscent of the Sheraton style.
PD-User: Pete Souza

Generally, residences had simple rectangular rooms, but some were combined with circular, octagonal, or oval spaces and ornamented with delicate surface embellishments. Walls were plastered and painted in white or pastels with classical motifs around center chandeliers hanging from the high ceilings. Floors were crafted in various woods and often covered by large carpets. Doors and windows were tall. Fireplaces were constructed of marble and flanked by pilasters.

Federal furniture styles came to America primarily through the influence of pattern books and can be classified as early (Sheraton, Hepplewhite, and Duncan Phyfe) and late (Empire). Hepplewhite's sideboard and shield-back chair were popular. Furniture in the early period had simple legs and feet. Proportions were small in scale.

Duncan Phyfe (1768–1854), a New York furniture designer, varied the Sheraton style in producing furniture bearing his unique stamp of individualism and style (Figure 2.53).

The late Federal style of furniture exhibited French and English influence. These pieces were of heavy proportions, primarily made from dark mahogany, and highly ornamented with a variety of motifs. Wardrobes were monumental; chair legs were embellished with motifs of animal feet in both wood and metals.

GREEK REVIVAL OR EMPIRE STYLE, 1820–1860 About 1820, architects returned to earlier periods, to the monumental classics of Greek and Gothic structures, for models to copy. It was a time of using historic styles in a variety of design movements. *Eclecticism* reigned, incorporating historical pieces and parts of classic buildings—rather than the entire composition—into new buildings.

The Greek style became popular in America for architectural motifs. Large commercial buildings, as well as private homes, incorporated pediments, porticoes, columns, and various details from the classic structures of the past. Sympathy for the Greek wars of independence and the urging of American statesmen for federal buildings in classic styles caused architectural designers to produce this revival. Temple-style buildings using Greek orders began to appear everywhere, particularly in the large mansions of the South.

Empire-style homes were spacious in their interiors and filled with large proportioned furniture. Geometric designs and vivid colors, especially in carpets, curtains, and upholstery, added richness to the American Empire interiors.

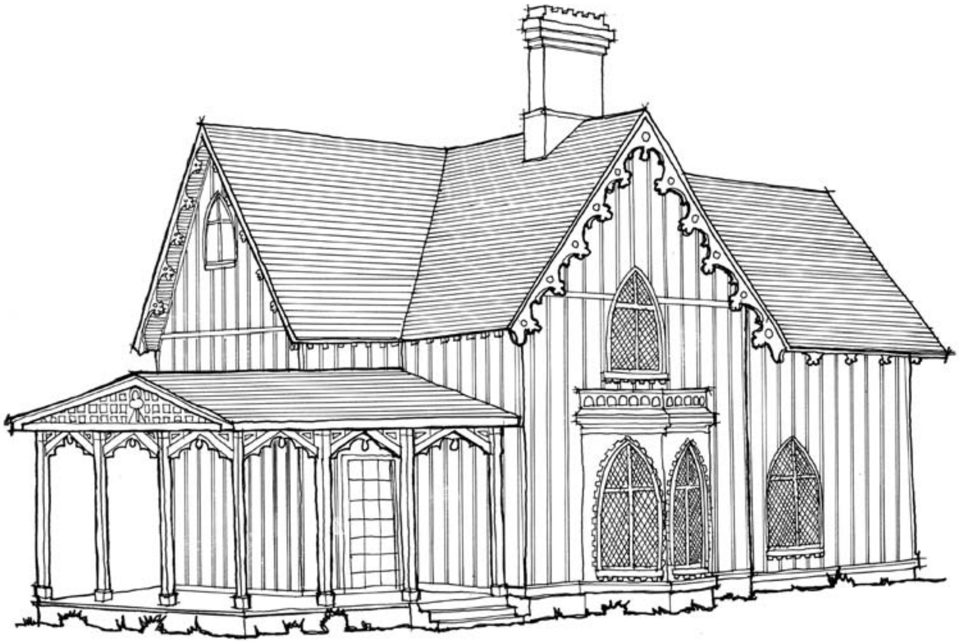


FIGURE 2.54 In this Carpenter Gothic–style cottage, the windows are tall and arched. Adding to this vertical effect are pointed gables with a scalloped verge board.

The Victorian Era, 1830–1901

The Victorian era is generally identified with the reign of Queen Victoria. Many architectural, interior, and furniture styles of the past were adopted, including the Greek, Gothic, and subsequent movements. The period produced heavily decorated and stylistic varieties in the architecture, interiors, and furniture.

Society developed into middle- and upper-class stratifications, each demanding more social functions. Inventions flourished, the automobile appeared, and immigrants flowed into America. All this variety and industrialization produced some interiors that were not orderly in their arrangement and used unrelated carvings and patterned surfaces excessively.

The Gothic revival style overlapped the Greek style and was inspired by the Gothic designs still being produced in London. Although the Gothic revival did not produce exact copies of existing buildings, the style was seen as proper for churches, as a testament to Christianity.

The Victorian era also produced an abundance of residential varieties. These wood interpretations of earlier styles each had its own characteristics. Soon, however, residences began to be interpreted in the Gothic style. A series of cottage dwellings by Andrew Jackson (1815–1852) and A. J. Davis (1803–1892), as seen in Figure 2.54, exemplify the Carpenter Gothic, or gingerbread, style. Its machine-cut scrollwork on gables became a popular motif. Gothic interiors of carved, arched wooden panels and corresponding furniture were given contemporary proportions, in many cases resulting in awkward appearances.

After the Gothic style came the Italian villa, mansard, Victorian eclectic, and Queen Anne styles. Machine saws capable of intricate carving produced a variety of shapes in trimwork, shingles, posts, and windows.

A pivotal event in the Victorian era was the Great Exhibition, held in London in 1851. Art, crafts, and machines were exhibited in the Crystal Palace (Figure 2.55), a structure of prefabricated iron and glass components that could be assembled and dismantled at the site. This was the beginning of an age of new materials and advanced technology. Interestingly, as the industrial and machine age progressed, turning out better materials and methods of mass production, the designs of the time remained deeply rooted in historical copies. For example, an outdoor garden seat, formerly produced in wood, could be made in the new malleable cast-iron material, but it continued to be molded in the old naturalistic vine pattern, with grapes and leaves. This contrast of new materials and old designs continued until the twentieth century, when finally architects and designers began to explore the integrity, meaning, and functional aspects of new materials and processes. This direction was to produce distinct styles that had no predecessors.

FIGURE 2.55 The Crystal Palace, designed by Joseph Paxton, was a prefabricated iron-and-glass structure that housed the first World Fair, the Great Exhibition of 1851. It was over 1,848 feet (564 meters) long, and 454 feet (138 meters) wide.
PD-User: J. McNeven

NON-EUROPEAN ARCHITECTURE AND INTERIORS

There have been non-European influences, direct and indirect, on Western architecture and interiors since ancient times. Only the most important of these contributions can be discussed here, but the reader is encouraged to consult books from the bibliography and other sources for more details of these cultures and their influence on design. As we become more global in our culture, it is important for the interior designer to understand the beginnings and current traditions of these peoples and their lands.

Africa—Prehistory to the Present

The huge continent of Africa occupies almost one-fifth of the Earth's land masses and is very diverse in geography, climate, and peoples. It has been found to be among the oldest sites of the beginnings of the human race. However, tracing the history of African architecture can be difficult. It is limited by the lack of physical evidence—not much of the ancient designs and structures remain for us to see. Many artifacts were made of wood, which has not survived well in the heat, humidity, and insects of the land. Also, it seems that preservation was not a priority of ancient Africans; many structures were simply replaced with new ones as the old ones succumbed to time and the elements.

As in many other countries, African architecture was shaped by many external influences and made of a variety of materials and methods, such as stick/wood, thatch, stone, mud brick, and rammed earth—depending on each region's preference of materials and methods. In general, African architecture is often categorized by the regions of the continent, such as north, east, west, central, and south—each area's architecture reflecting the local geography, materials, climate, and type of coastline. Many non-African civilizations also made physical incursions into the continent and left their influences on the people, culture, and architecture of Africa. European explorers and colonials also brought many of the architectural and art forms from their countries, sometimes adapting them to the local region. These included medieval European fortresses, castles, and richly embellished homes for the wealthy.

FIGURE 2.56 The mud mosque of Djenné is the largest mud brick building in the world and one of the most famous landmarks in Africa.
CC-BY-SA-3.0/Ruud Zwart

As mentioned earlier in the chapter, Egypt in northern Africa was widely known as one of the earliest established civilizations and produced monumental architecture such as the pyramids. The architecture and art of this region was heavily influenced by Islam and Christianity—for example, the mud mosque of Djenné (Fig. 2.56). With the arrival of Muslim traders in the eighth century, West African architecture exhibits indigenous materials from designs originating in the Middle East. In South Africa, some of the oldest examples of human designs have been found in painted caves. And south of the Sahara, the complex stone arrangements of the Great Zimbabwe (Fig. 2.57) are the best known examples of monumentally scaled architecture. This structure (termed "stone enclosure or large houses of stone") was encircled by high stone walls laid without mortar, for a protective enclosure for the ruling class.

For everyday living, African homes are often based on extended families living together under a family elder. They share common spaces such as kitchens and living (social) spaces, with private spaces connected by doorways or curtains (Figure 2.58).

Contemporary architecture in Africa is composed of a rich variety of cultures, religions, and regionalism in materials and methods. As in past centuries, much of the modern architecture was influence by external design philosophies and movements across the globe. Yet, some of the most successful architectural examples tend to meld the climates and peoples' needs to become more responsive to a true African style of architecture.

Islamic Design—622 to the Present

Islamic architecture has existed from the seventh century, when the religion of Islam was formulated. Islamic design is not associated with a specific geographical location, as it has evolved in different regions of the Islamic world, and its influence can be seen in many parts of the world. Although its roots are in the Middle East, it spread to North Africa, Europe, and Asia. Islamic design covers many aspects of life, including buildings, interiors, and decorative elements designed for secular use. It is the product of the culture of people who, in general, profess the Islamic faith.

Islamic architecture encompasses a wide range of both secular and religious styles from the foundation of Islam to the present day. The most prominent types of Islamic architecture are religious buildings such as the mosque, the tomb, and the religious school called a *madrasa.* Secular buildings include the palace, the citadel, the bazaar, and the hospital.

FIGURE 2.57 The ruins of the Great Zimbabwe stone complex are some of the largest and oldest structures in South Africa. The enclosure was started around the eleventh century.

PD-User: Ulamm

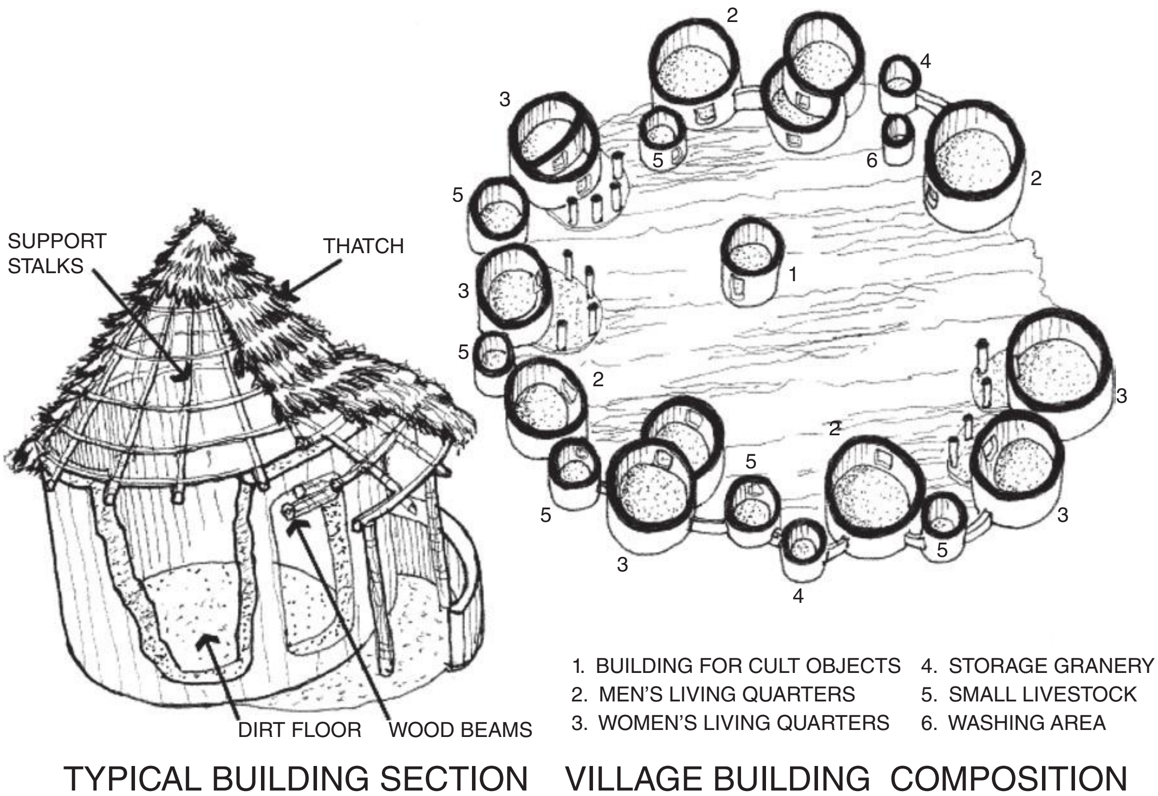


FIGURE 2.58 These sketches depict a typical dwelling unit of wood and clay, and a collective arrangement of the types of structures mingled together for a group of people.

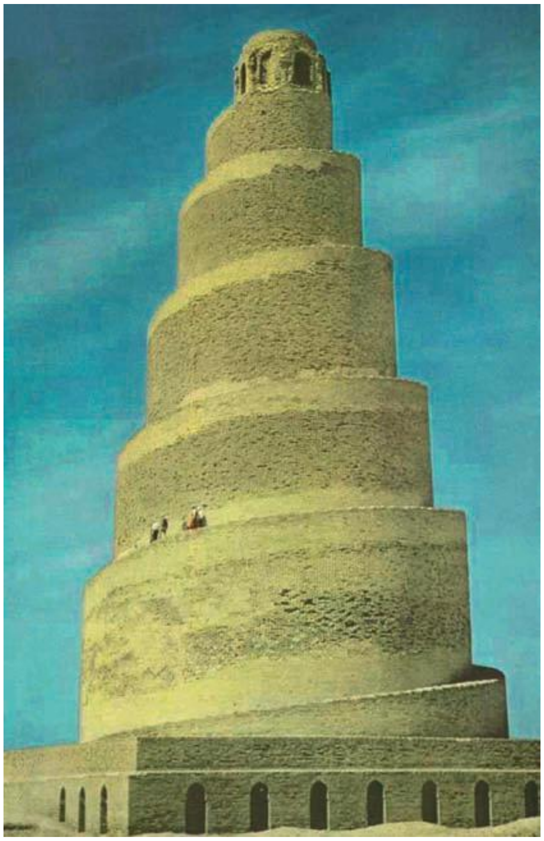


FIGURE 2.59 The Great Mosque at Samarra was started in the ninth century and was one of the largest mosques at that time.
CC-BY-SA-3.0/Izzedine

FIGURE 2.60 The complex arabesque inlays on the entry to this structure are a good example of the complexity of the ornamentation.
CC-BY-SA-3.0/Hans A. Rosbach

The mosque is a building for public worship, built in many forms and sizes, and it generally includes a minaret, a slender tower attached to it, or standing nearby. The Great Mosque at Samarra (Figure 2.59) was the largest in the Islamic world at the time, built in the ninth century, north of Baghdad. The mosque was 1,440 feet (444 m) long and had a spiral minaret 163 feet (50 m) high.

Other architectural elements within the mosque include the *mihrab*, a prayer niche that served to point toward the direction of Mecca, for praying. Another important element is the *minbar*, which is located next to the mihrab with a water basin nearby for the faithful to perform a ritual washing before they pray. The mihrab and the minbar are traditionally the most highly decorated elements within the mosque.

Islamic motifs were generally geometric shapes, such as squares, rectangles, hexagons, octagons, and stars. A highly stylized plant life was also represented in much Islamic art. Animal forms appeared every now and then, and human forms rarely appeared at all. Arabic calligraphy is another motif used to enhance the interior of a building by providing quotations from the Koran, the sacred book of Islam.

A common ornament is the arabesque, a composition of interlacing plant life combined with spirals, knots, or medallions, as seen in Figure 2.60.

Islamic interiors were very lavish in their wall treatments. Motifs such as the arabesque and other geometric patterns were applied to the walls in plaster and stucco, woodwork, and tile. The *muqarna* is an example of plasterwork that consists of tiers of concave shapes, reminiscent of a great network of adjacent pendentives (Figure 2.61).

Although ornamental woodwork was important in Islamic architecture and interiors, wood was somewhat scarce and only used for door panels, wall panels, tie beams, and other smaller decorative objects. One important element that wood was used for is the *mashrabiya*, which is a window grille (Figure 2.62). It is generally made of turned-wood grillwork and is used as a privacy screen for the women's quarters, to allow them to observe the outside world, while preventing them from being seen.

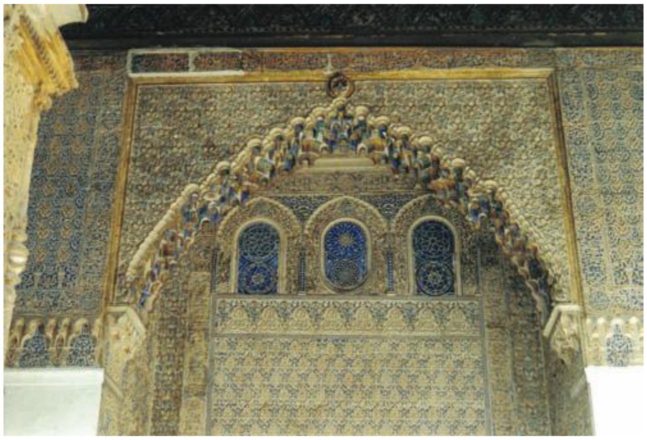


FIGURE 2.61 The *muqarna* is a type of decorative corbel structure that is used in Islamic architecture. This ornamentation is somewhat reminiscent of stalactites.

CC-BY-SA-3.0/EmDee

FIGURE 2.62 A carved wooden window grille, called a *mashrabiya*, can sometimes be found on a projecting second-floor window.

CC-BY-SA-3.0/Rémih

Islamic design also includes an abundance of glazed ceramic tile used on the walls and floors. Tile designs as well as intricate mosaics were used on both the interiors and exteriors of buildings.

Islamic furniture was minimal and usually consisted of only a few traditional seating pieces, such as long, low benches. Generally, luxurious carpets and cushions were used for seating, because wood was scarce in many Islamic regions.

China—4000 BC to AD 1912

Chinese architecture and interiors developed over a long period and involve the art of creating space, as well as the unique use of materials and construction techniques. The architecture was a traditional, homogeneous blend of buildings that originated more than 4,000 years ago and was repeated throughout the centuries. Construction and designs varied with the dynasties and regions of the country.

Chinese buildings and towns were based on cosmos imagery and a careful ordering of space. Designs emphasized a regularity of structure and modular proportions. These formulas are evident in both simple, small buildings and grandiose ones because similar materials and methods were used for both. Structures were usually wooden frameworks of beams and columns placed on a platform (Figure 2.63). Non-load-bearing latticework and screens were placed between the columns for privacy and space separation, while permitting air circulation. Stone and brick were used mostly in fortifications, tombs, bridges, and pagodas, where more durability was required.

Many Chinese houses were designed with an integral landscaped garden that provided a scenic walk or place for meditation. The gabled, tile-covered roof of the house often was steeply pitched, curving upward. Wide overhangs were supported by multiple brackets, often complex in their design. This roof construction evolved over the centuries, producing well-crafted geometric forms that interlocked into tight joints, eliminating the need for nails or bolts (Figure 2.64).

FIGURE 2.63 The Chinese timber technology can be seen in the Teipei Confucius Temple located in Taiwan. The temple was built in 1854, destroyed in 1895, and rebuilt in 1925.

Buildings were designed as primary rectangular spaces that were increased by the addition of lesser bays and lower roofs, creating a pavilion style. Most arrangements were laid in axes of primary and secondary spaces.

Chinese furniture was scarce or at a minimum, as most functions took place on or near the floor, with perhaps a mat. In more affluent households, chairs were made, as armchairs and armless versions (Figure 2.65).

Influences of Chinese architecture can be seen throughout the world, particularly in the Victorian era, when many Chinese buildings and stylistic forms were copied in new construction.

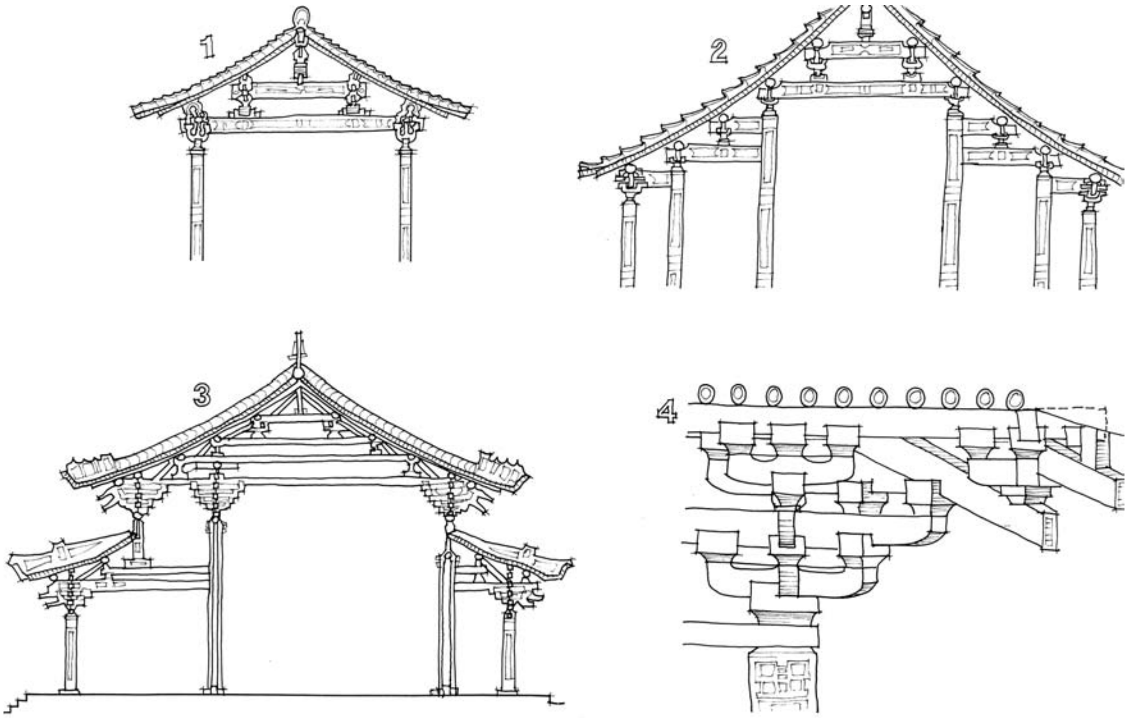


FIGURE 2.64 The evolution of Chinese roof construction shows that the early designs consisted of (1) narrow eaves and span. To increase the size of a building, more pillars are added (2), which caused the interior to become cluttered. A system of brackets (3) was then developed that would reinforce the structure and open up the interior space. Beginning in the eighth century, cantilevers were designed to fit within the brackets that supported more brackets (4).

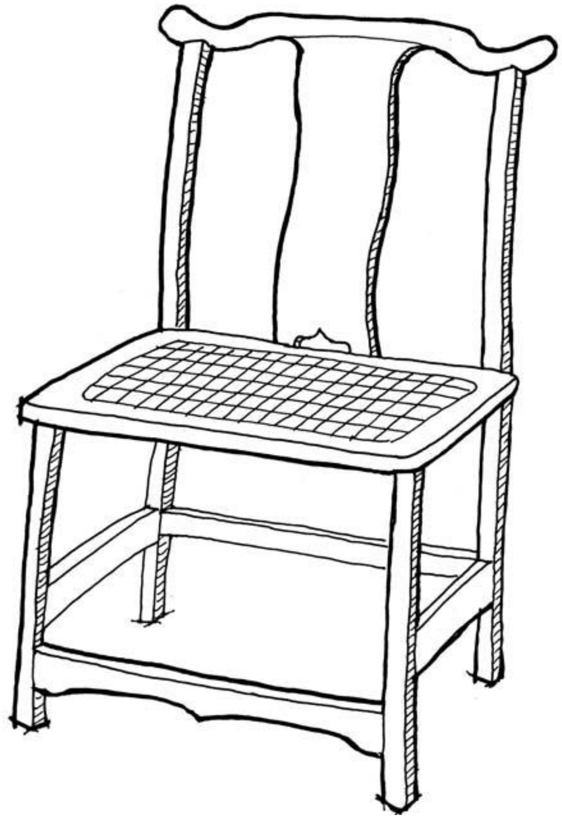


FIGURE 2.65 This early Chinese chair exhibits the common characteristics of a yoked back with splat and a high front stretcher to raise one's feet off a cold, damp floor.

FIGURE 2.66 The most notable and influential building that characterizes Japanese form is the Katsura Imperial Palace, built about 1620. The palace is a group of buildings with entrance gates and teahouses surrounded by gardens and lakes.

Japan—Prehistory to the Present

Japanese architecture and interiors were strongly influenced by the Chinese techniques that reached Japan primarily through Buddhism and through temple building, by way of Korea. However, Japan has its own distinct style of architecture.

In Japan dissymmetry, as contrasted to the Chinese symmetrical patterns, was introduced. Traditional Japanese architecture relies on wood as the primary building material and uses horizontal wooden frameworks, set upon a platform and infilled with windows, doors, and sliding partitions (Figure 2.66) that are often made of wood frame and paper. Hipped roofs are tiled and curved upward on complicated bracket forms.

Japanese architecture is closely connected with the environment, with walls and spaces opening onto the exterior, providing a strong tie between external and internal spaces. This sense of harmony and relationships and of open internal space had an influence on the residential buildings and interiors of modern Western architecture.

Japanese houses are often designed on a modular *tatami* floor mat system (Figure 2.67). Traditional tatami mats were made from rice straw and vary in size in different regions in Japan, but are today generally 2 inches (5 cm) thick and a little larger than 3 feet wide by 6 feet (1 by 2 meters) long. Room dimensions were established in the tatami proportions, and *shoji* (translucent screens) panels were placed between columns for light and view control.

India—2500 BC to the Nineteenth Century

Much ancient Indian architecture has been lost because the structures' wood construction has not survived. Most that do remain are temples that were constructed of brick and stone (Figure 2.68).

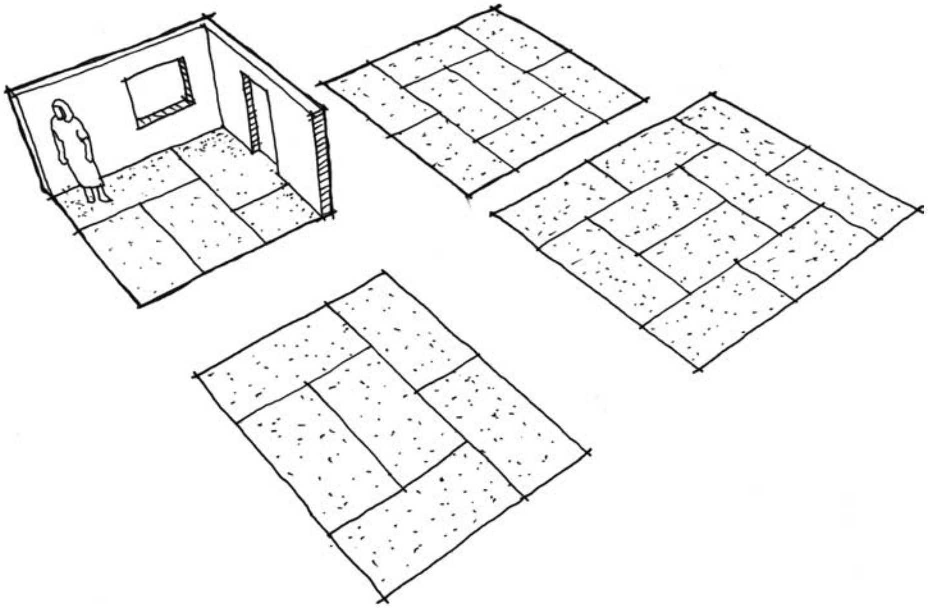


FIGURE 2.67 Room arrangements based on the modular tatami floor mat system. Mat layouts avoid intersecting lines and can range from a small 4½-mat system to a system with 6, 8, 10, or even larger numbers of mats.

Indian craftsmen were very adept at rock-carving techniques, hollowing out niches, forms, elaborate carvings, and entire buildings from the stone. Large Buddhist monasteries and temples were carved from the rock faces of cliffs, creating an exciting sculptural form of space and structure.

Some of the best-known architectural monuments are the Taj Mahal and the Fatehpur Sikri, both located in Agra, Uttar Pradesh, India.

Pre-Columbian Era—300 BC to AD 1570

Although the name "pre-Columbian" generally refers to the time periods preceding Christopher Columbus's voyages of 1492, it is used to denote the history of the American indigenous peoples before the arrival and influence of the Europeans. The people and architecture of pre-Columbian, sometimes called pre-Hispanic, America, were established throughout South, Central, and North America and related regions. The rich complexity of the cultures in those areas produced many Mayan cities and Incan fortresses throughout the region. Many of the structures were in the form of pyramids, markets, ball courts, and other building groupings.

Although most of these structures are gone or overgrown with vegetation, those that do remain exhibit distinct style, ornamentation, and construction methods (Figure 2.69). Mexican and Southwestern American design motifs often are based on these previous civilizations and their buildings.

FIGURE 2.68 The Hindu Temple Lingaraj in Bhubaneswar, Orissa, India, dating around the beginning of the ninth century, epitomizes the form and exceptional carvings in medieval Indian architecture.
CC-BY-SA-3.0/G.-U. Tolkiehn

FIGURE 2.69 The Temple of the Sun, Palenque, Chiapas, Mexico, was built at the end of the seventh century and belongs to a group of buildings that included the Temple of the Cross and the Temple of the Leafed Cross. The architecture of these buildings is very subtle and appears simple, yet they contain, especially on the interior, numerous decorative elements.

NOTE

1. David B. Guralnik, Editor-in-Chief, *Webster's New World Dictionary of the American Language*, 2nd College Edition. New York: Simon and Schuster, 1984, p. 382.

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3

The Evolution of Modern Design

The evolution of modern architecture and design was characterized by the rapid transformation of Western civilization beginning in the late eighteenth century. One of the most important developments was the Industrial Revolution, which changed the old order of society. New technology in transportation and communication (telephone, radio, movies) made people more aware of each other, important events, and the availability of commercial products. Living and working conditions for all people improved because furniture and other items could be mass-produced rather than handmade. This development permitted the growing middle class, rather than just the wealthier upper class, to become consumers of the products of industry.

Further, theories of evolution and relativity, along with other scientific discoveries, made people question basic concepts of humanity and of the world around them.

NEW TECHNOLOGY AND INNOVATIVE DESIGN

The Industrial Revolution and the introduction of new materials and technology caused architecture and interior design gradually to emerge from mere imitation of styles of the past. A new style of architecture emphasizing iron, wood, and glass appeared. Another important innovation was the development of new structural members made of iron that allowed greater spans between cast-iron columns. The use of freestanding columns supporting iron girders and timber roofs created flexible, open spaces that allowed a fluid interpenetration of spaces, as opposed to the rigidity of the typical closed-box arrangement.

The tremendous space the iron frame could span was exhibited by the Crystal Palace at the London Exposition in 1851 (Figure 2.55). This structure demonstrated that a frame could be self-sustaining and that nonstructural materials, such as glass, could be used as exterior surfaces for admitting natural light. The same structural iron large-span construction was also used for department stores, libraries, railroad stations, exhibition halls, and other specialized public and commercial buildings.

For decades, there was a definite division between art and technology. New technology and materials challenged a few innovative designers, but the majority of these designers were content to draw inspiration from historical styles.

Michael Thonet, 1796–1871

Michael Thonet was an innovative Austrian designer who designed and produced in the 1830s what is considered to be the first modern furniture. He invented a process for steaming and bending hardwood by machine that is still used. The result was gently curved shapes that could be used for sturdy, lightweight, and relatively inexpensive furniture. His furniture was shown internationally at the London Exhibition and was accepted immediately at all social and economic levels. It became widely popular in Europe and the United States both for home and public use, notably in cafés and ice cream parlors (Figure 3.1). Thonet also created the bentwood rocker (Figure 3.2), whose rounded arms and swirling curves seem to imitate the chair's swaying motion.

Shaker Furniture, 1747–c.1860

The Shakers were members of a communal religious sect who came to the United States from England in the second half of the eighteenth century. Their belief in order and utilitarian objects produced plain furniture devoid of carved ornament, moldings, or veneers. It was generally delicate in its proportions, though sturdy, and exhibited only the essentials of form to achieve maximum efficiency. This concept that true beauty rests on the suitability of the article to its purpose, that form should follow function, is one of the most important founding principles of modern design.

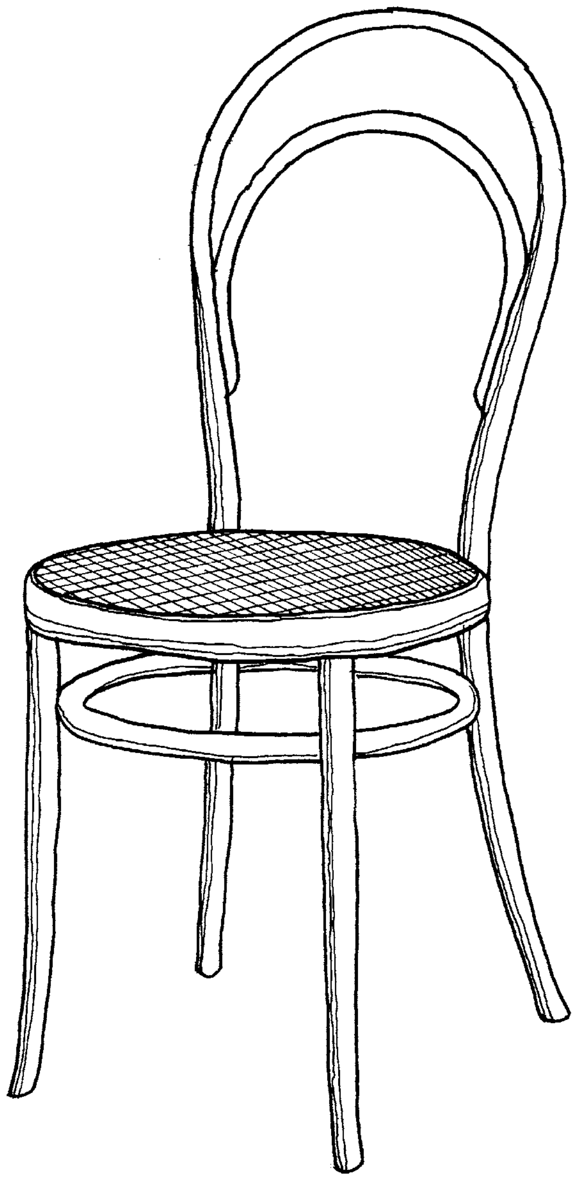

FIGURE 3.1 The Vienna café chair (1876) was mass-produced by Michael Thonet. The back and legs are formed from a continuous section of bent wood. This style of chair is still in production today.

FIGURE 3.2 In 1860, Michael Thonet and his sons produced Rocking Chair No. 1, using the new bentwood technique. They produced a chair of flowing lines and thin structural elements of wood.

PD-User: FA2010

FIGURE 3.3 Shaker interiors and furniture were primarily utilitarian in function and style, lacking an abundance of ornamentation.

The interiors of Shaker houses consisted predominantly of built-in cupboards, chests, and drawers, each designed for a specific storage purpose. Shaker furniture became popular around 1860 and remains so because of its simple, sparse lines and functional quality that can be successfully combined with a variety of other styles (Figure 3.3).

The Arts and Crafts Movement, 1860–1900

The early part of the nineteenth century produced attempts to imitate handmade products with machine methods. However, most mass-produced objects exhibited poor quality in design and construction. A conscious revolt against machine-made objects was begun in England as early as the 1840s by John Ruskin (1819–1900), a writer who condemned machine-made objects and the use of one material to simulate another. In his book *The Seven Lamps of Architecture* (1849), Ruskin urged a return to honest craftsmanship, particularly that of the Gothic period. A.W.N. Pugin (1812–1852) expressed similar feelings when he wrote in *Contrasts* (1836) that true beauty of design was attained if the design fit the purpose for which it was intended. This reaction against machine-made products was called the Arts and Crafts movement and was headed by William Morris (1834–1896), a writer, artist, and designer who advocated a return to basic honesty and simplicity in handmade furniture.

Morris and his company produced wallpaper, textiles, and furnishings (Figure 3.4) exhibiting repeating patterns inspired from nature. However, the firm's handcrafted products were more expensive than the mass-produced products of industry, and thus the movement failed to spread to all levels of society.

The Arts and Crafts movement attracted a number of followers, including artists, architects, designers, and critics, who continued Morris's ideas, although they moved away from the heavy, medieval influences he favored.

In the 1890s, Charles F. A. Voysey (1857–1941), one of Morris's most important successors, designed houses featuring honest, uncluttered interiors, as well as his own wallpaper, textiles, and furniture. Voysey's furniture showed a Japanese influence in its light, simple design.

Henry Hobson Richardson (1838–1886) was an American architect who revolted against the Gothic revival and turned to the heavy massing and round-arched Romanesque style. His work has been termed "Richardson Romanesque," and Richardson is one of the few architects with a style named after him (Figure 3.5). His personal style also featured exteriors of local stone or weathered wooden shingles, and towers that harmonized with the natural setting. Richardson's interior space was laid out in an asymmetrical plan with a generous amount of space flowing around the entrance hall and stairway (Figure 3.6). The use of interior space, rather than a concern for exterior symmetry and regularity, also dictated the size and placement of windows. Richardson's interiors emphasized his concern for expertly crafted woodwork and built-in furniture. His interpenetration of spaces was an influence on the work of Frank Lloyd Wright.

In California, the Greene brothers, Charles Sumner (1868–1954), and Henry Mather (1870–1957), integrated the arts and crafts techniques with shingle-style architecture and Japanese emphasis on structure and detailing (Figure 3.7). They emphasized the connection details of the joints, pegs, and wood structure of the building, instead of hiding these with decoration. The craftsmanship of Greene and Greene's interiors and furnishings

FIGURE 3.4 The Green Dining Room (1867) of the South Kensington (now the Victoria and Albert) Museum in London was designed by William Morris and Philip Webb. It is now called the Morris Room.
V&A Images, London/Art Resource, NY

emphasized perfectly integrated woodwork in every detail. Julia Morgan (1872–1957, the first woman architect registered in California, also worked in this integrated tradition of paneled woodwork and furnishings. She is most known for her work at Hearst Castle in San Simeon, California. But she also designed many commercial buildings and residences.

Art Nouveau, 1890–1905

The art nouveau movement appeared during the 1890s throughout Europe and the United States almost simultaneously. This movement opposed excessive overloading of interiors with unnecessary applied ornament and furnishings. It was believed that the beauty of an object was derived from natural forms, simplicity, and good craftsmanship. Artists of this period tried to create a new style based on leaves, flowers, branches, and sweeping curves. Art nouveau is characterized by sinuous, organic lines ending in a whiplash curve like the bud of a plant. Art nouveau was the first truly original style since the French rococo (1715–1774).

FIGURE 3.5 Trinity Church in Boston, Massachusetts, is one of the most acclaimed examples of Richardson's Romanesque style of architecture.
CC-BY-SA-3.0/Daderot

Art nouveau was popularized in Europe by many designers from the early 1880s until about 1900. Victor Horta (1861–1947), a Belgian architect, fully developed the art nouveau style through the use of meandering ribbon patterns that appeared molded in the iron handrails of stairways, painted on walls, and inlaid in floor mosaics. An example of his work is the Hotel Tassel in Brussels (1892–1893) (Figure 3.8). Before Horta, exposed iron was used mostly for bridges and engineering works, not as an interior material.

In France, the architect Hector Guimard (1867–1942) was noted for carrying the art nouveau style mainly into his interiors. He designed furniture, fixtures, lamps, doorknobs, and even special nailheads with long, sensuous lines that were included as part of a totally unified interior.

Unaware of what was being done in Brussels and France, Antonio Gaudi (1852–1926) worked in Barcelona, Spain, and was one of the most creative and inventive architects in the art nouveau movement. Gaudi's sculptural forms seem to be in constant motion (see Figure 4.6). His interior spaces appear to have been pulled askew, leaving strange, organically shaped windows that seem hollowed out by the wind. The same sensuous, fluid shapes appear in his furniture and fixtures.

Charles Rennie Mackintosh (1868–1928), a Scotsman, was the only inventive architect working in the art nouveau style in Great Britain. Mackintosh's designs consisted mainly of rectilinear shapes with delicate swirls of linear patterns. His furniture was formal and elegant and featured tall (some were more than six feet high), straight backs with slender vertical elements (Figure 3.9).

In the United States, there were only two major art nouveau designers: Louis Sullivan (1856–1924) and L. C. Tiffany (1848–1933). Sullivan was a Chicago architect who designed commercial buildings, applying a stylized, flowing floral design to the exteriors (Figure 3.10). Tiffany, who developed new techniques of working with glass and metal, is best known for the swirling decorative patterns and vivid colors in the flowers and trees of his stained-glass windows and lampshades.

FIGURE 3.6 Henry H. Richardson designed this interior, in the R. T. Paine house (1884–1886) in Massachusetts, with an abundant use of wood structure throughout.
CC-BY-SA-3.0/Daderot

FIGURE 3.7 The Gamble House by Greene and Greene in Pasadena, California. The structure emphasized the craftsmanship style with its exposed framing and carefully constructed connection details.
CC-BY-SA-3.0/Mr. Exuberance

FIGURE 3.8 Victor Horta designed this dynamic, flowing staircase in the Tassel House, Brussels, Belgium (1893).
PD-User:Henry Townsend

FIGURE 3.9 The tall-back chair designs by Mackintosh can be seen in the Willow Tearoom (c. 1903).
CC-BY-SA-2.5/Dave Souza

FIGURE 3.10 Louis Sullivan designed the tracery around the street-level windows of the Carson, Pirie, Scott and Company Store (now the Sullivan Center) in Chicago (1901–1904). His designs reflected the art nouveau influence of nature-based motifs. Look closely and you will find his initials in the design.

The Vienna Secession Movement, 1897–1911

At the turn of the century, the Vienna secession movement was led by protesting groups of young designers and artists, including architects Otto Wagner (1841–1918), Adolf Loos (1870–1933), and Josef Hoffmann (1870–1956). This movement was the Viennese parallel to the arts and crafts reform movement and protested design approaches, such as art nouveau, that focused only on surface ornamentation and visual effects. In 1903, Hoffmann and Koloman Moser (1868–1918) formed the Wiener Werkstätte (Vienna Workshop) to produce utilitarian objects handcrafted by fine artists. Their goals were to produce functional art that would be viewed as aesthetically significant and would link the public, designer, and worker through objects of everyday use. Hoffmann, the most brilliant of the Viennese decorative arts modernists, is best known for the design and furnishings of the Palais Stoclet, a lavish residence in Brussels. It is an example of the unique Viennese total work of art, integrated inside and out with luxurious materials and elaborate decorative objects, paintings, mosaics, and furnishings. Later, Hoffmann and Wagner became known in the United States for their furniture designs, which are still manufactured today.

Although the Vienna secession movement had no strongly identifiable design effects on American interior design, it did contribute to the foundations of the Modern design movement.

THE TWENTIETH CENTURY

In the twentieth century several important designers pioneered in the development of the Modern style of architecture and design. When they began their innovative practices, American and European designers and architects were still using historical or eclectic styles, and architects who attended the French Ecole des Beaux-Arts were "borrowing" pseudoclassical elements for their building vocabularies.

Pioneers of Modernism

Louis Sullivan was an important architect not only as a pioneer in the development of modernism but also as mentor to Frank Lloyd Wright. Sullivan adopted the phrase "form follows function" as the principle defining the way in which architectural and design elements expressed their structure, rather than concealing it with eclectic ornamentation.

Frank Lloyd Wright (1867–1959) developed the theory of "organic" architecture, which states that a building should grow from the inside out, blending into the landscape. Wright believed architecture should be uplifting, going beyond the needs of comfort and shelter. In his home designs, he used the open-plan concept, breaking away from many boxlike, closed interior spaces. Wright developed the "prairie style" house (Figure 3.11),

FIGURE 3.11 Frank Lloyd Wright's design for the Robie house (1909) in Chicago exhibits long horizontal flowing forms extended from a central fireplace core.
Library of Congress

FIGURE 3.12 Wright employed rich materials that helped to define shape and direction, spatially linking major areas within the interiors, as seen in Taliesin East (1925), Spring Green, Wisconsin.
Photographer: Chicago History Museum

which expressed his concern for the freedom of movement available in the wide open spaces of the American Midwest.

Wright had firm design control over all his buildings, including the interiors and the furniture (Figure 3.12). He used natural tones in the plaster work and natural finishes on wood. His interiors abounded with geometrical designs, diagonal motifs, stained-glass inserts, and asymmetrical arrangements.

Wright's seating designs were geometric and fairly uncomfortable, because he felt sitting was an unnatural body position, and standing and reclining were natural. Many items were built in and were integrated with the architecture.

One of Wright's most stunning creations that expressed his organic theory of design is the Kaufmann residence Fallingwater (Figure 3.13) at Mill Run, Pennsylvania (1934–37). He used primarily concrete and limestone for the construction materials. The color palette was also based on his unified theories, limiting it to light ochre on the concrete, natural limestone, and Cherokee red for the steel.

Le Corbusier (1887–1965), a Swiss architect and designer whose given name was Charles-Edouard Jeanneret-Gris, was an early French Modernist who used simple, cubist-style designs. He believed that a house was a "machine for living," whereas Wright's concept held that house and landscape were one. Le Corbusier's designs, which exhibit geometrical abstractions, were founded on principles of mathematical, orderly modules. His best statement of Modernism in architecture is the simple, boxlike Villa Savoye, built in 1929 in the Paris suburb of Poissy (Figure 3.14).

Le Corbusier worked with furniture designer Charlotte Ferriand and designed tables, chairs, and built-in storage units. His chromium-plated tubular steel chairs were designed for comfort, conversation, or reclining.

Later in Le Corbusier's career, he abandoned many of his simple, geometrical shapes, creating a more sculptural form of architecture with concrete and plaster, as exemplified in the church at Ronchamp in 1950 (Figure 3.15).

FIGURE 3.13 Wright designed Fallingwater to sit over a stream and waterfall. It is composed of a series of cantilevered terraces and balconies with concrete as the horizontal elements and limestone for the vertical ones.
Carol M. Highsmith's America, Library of Congress, Prints and Photographs Division.

FIGURE 3.14 Le Corbusier, with Pierre Jeanneret, designed the Villa Savoye (1929–1930) in Poissy, France (near Paris), in the simple, geometric forms of the Modern style. The main living area of the house is raised above the ground-level garage and entry foyer. The roof is provided with a patio and protected by a windscreen.
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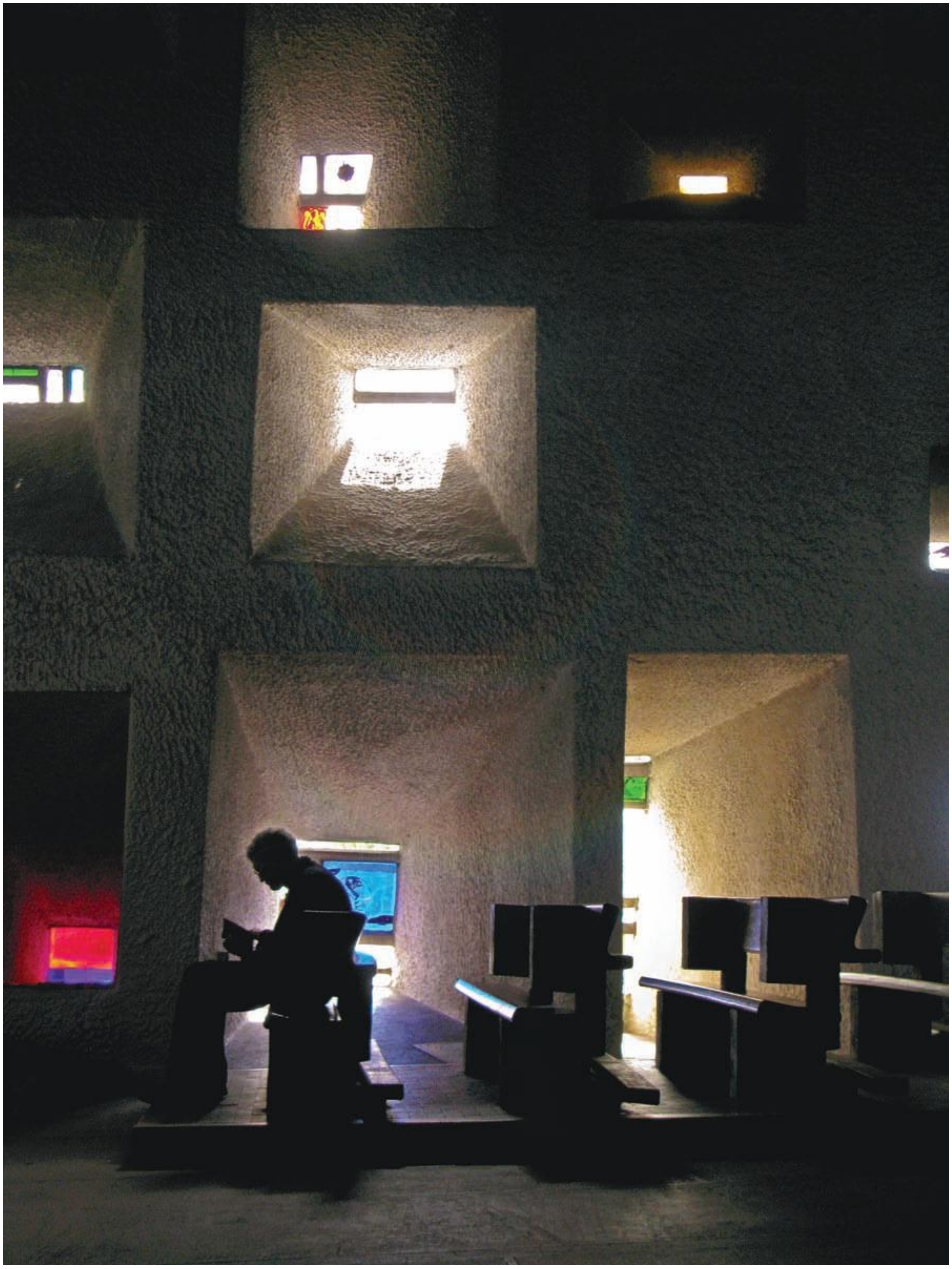

FIGURE 3.15 The Chapel at Ronchamp (1950–1954) in southern France, by Le Corbusier, is an expressionistic free-form sculptural building. The interior sloping walls were heavily stuccoed and penetrated by a variety of sized and patterned windows.

Courtesy of Eduardo Ponce

FIGURE 3.16 Gerrit Rietveld's "Red and Blue Chair" (c. 1918) represented a major break from traditional furniture design. The seat is painted blue, the back red, and the other parts black with yellow accents on the ends.
CC-BY-SA-3.0/Ellywa

de Stijl, 1917–1931

A group of artists and architects in Holland originated the de Stijl ("the Style) movement, which favored geometrical and abstract designs. Although some historians also call this movement constructivism, that was an art movement originating in Russia in the 1920s. Painters, such as Piet Mondrian (1872–1944); sculptors; architects; and designers, such as Gerrit Rietveld (1888–1965), used basic elements to compose their works. Mondrian restricted his paintings to abstract geometric lines and shapes, in primary colors with black and white. In turn, architects and designers turned to flat planes, geometry, and simple forms to echo the de Stijl principles.

Perhaps the most noted design of the movement was Rietveld's Red-Blue Chair (Figure 3.16). The handling of the flat planes, simple joinery, natural woods hidden with paint, and sharp edges all allude to the aesthetics and precision cutting of machine manufacturing, as opposed to the crafted furniture of earlier eras.

Bauhaus, 1919–1933

One of the most influential movements in modern architecture and design came from the Bauhaus, a German school of design, under the initial direction of Walter Gropius (1883–1969).

The Bauhaus philosophy was to simplify the design of objects so that functionalism, material usage, and construction techniques were evident in the finished piece. Ornamentation was seen as surface decoration, not part of the integrity of the design; hence it was banned. The Bauhaus celebrated prefabricated and standardized parts in designs stemming from the age of machine manufacturing.

Gropius, a German architect, studied in Berlin. With Adolf Meyer (1881–1929) he designed some of the first modern buildings of his time, including the Fagus factory at Alfeld (1911–1913) and the Deutsche Werkbund Pavilion at the Cologne Exposition (1914). He became the first director of the Bauhaus School and designed its new facilities in Dessau, one of the most important examples of modern architecture (Figure 3.17). In 1928, Gropius retired as the Bauhaus leader; the school closed in 1932. Gropius then worked in Europe and America, becoming the head of the architecture department at Harvard University in 1937.

The German architect Ludwig Mies van der Rohe (1886–1969) succeeded Gropius as the director of the Bauhaus and was one of the most influential pioneers of the machine-design styles. His German Pavilion for the International Exposition in Barcelona, Spain, in 1929 (Figure 3.18) is considered a masterpiece of design. He used free-flowing

FIGURE 3.17 The Bauhaus School of Design (1925–26) is a prime example of the emerging Modernist style at that time. The building design is functional, utilitarian, and devoid of ornamentation.
Courtesy of Mark Brack

FIGURE 3.18 Ludwig Mies van der Rohe provided free-flowing spaces in the Barcelona Pavilion with wall planes and designed chairs, tables, and other furniture that have become classics.
CC-BY-SA-3.0/MartinD

space, planes for walls, and thin steel columns under a low, flat roof. As part of the exhibition, he also designed the classic Barcelona chair (see Figure 16.5), which has become one of the most significant chair designs in history.

Mies van der Rohe coined the phrase "less is more," which reduces design to its most elemental essentials, then refines the details to near perfection. He moved to the United States to head the Illinois Institute of Technology architectural school in 1938 and influenced many of the steel-and-glass enclosed high-rise buildings of the 1950s and 1960s.

Another member of the Bauhaus was the architect Marcel Breuer (1902–1981), who designed several important modular-unit furniture pieces in the machine style. His tubular steel chair of 1925 (Figure 3.19) and the Cesca Chair of 1928 (Figure 3.20) are copied today and have become international classics. Breuer also became world famous for his architectural works, such as the UNESCO Secretariat building (1957–1958) in Paris and the Whitney Museum (1966) in New York.

International Style

In 1932, Philip Johnson (1906–2005) and Henry Russell Hitchcock (1903–1987) organized an International Exhibition of Modern Architecture and coined the term "International style." This style used ferroconcrete and glass in an unadorned and modular form to produce stark, simple structures. The International style emphasized free-flowing interior spaces, as opposed to structure as a mass, and decoration was eliminated to create sleek lines, regularity, asymmetry, and volumes defined by light. Many of the buildings were white, exhibiting a stark contrast to the landscape—glorifying the building as a machine-made entity.

FIGURE 3.19 Marcel Breuer designed this chrome-plated tubular steel armchair with leather slings (1927–1928) and named it the Wassily chair, after artist Wassily Kandinsky, who also taught at the Bauhaus. His classic design continues to be produced and is used in many contemporary settings today.

Courtesy of Knoll, Inc./Joshua McHugh

FIGURE 3.20 Marcel Breuer's "Cesca Chair" of 1928 is made in simple lines of chromed tubular steel with a caned back and seat. It is still manufactured today.

Digital Image © The Museum of Modern Art/Licensed by SCALA/Art Resource, NY

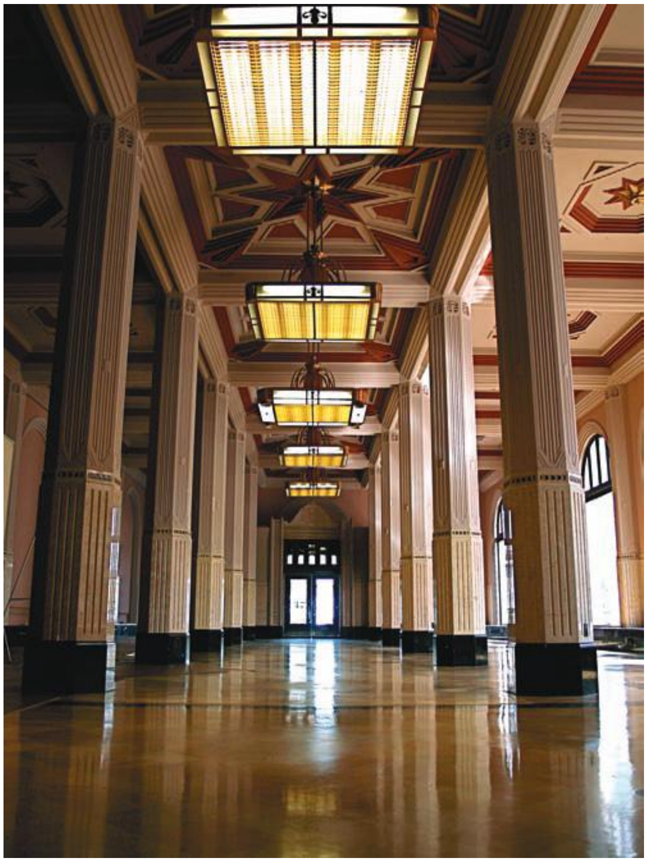

FIGURE 3.21 The art deco style can be seen in this Oklahoma Natural Gas Company lobby with motifs of sunbursts, zigzag patterns, and use of hard materials throughout.
CC-BY-SA-3.0/Pfox7

Art Deco, 1925–1940

Modern design spawned the art deco style in the late 1920s and 1930s. It was named after the 1925 Paris Exposition of Decorative Arts, which exhibited design styles fashioned after machine productions. Its linear style and boldness were a contrast to the former art nouveau movement of flowing, organic forms. Art deco used aluminum, shiny metals, plastic, mirrors, and glass walls. Geometric shapes and bold colors were used freely in contrasting patterns and surfaces (Figure 3.21). Images such as lightning bolts, zigzags, sunbursts, and triangles were used in dynamic patterns.

Art deco quickly spread to America through the many department store buyers who had attended the 1925 Exhibition, bringing back various products crafted in the innovative style. Later in the period, buildings and furniture were designed with straight, machinelike exactness, and the emphasis on streamlining was seen in aircraft, trains, automobiles, and many consumer products. The style expressed streamlining and speed, and often is termed Streamline Modern.

Influenced by the Paris Exposition, Eileen Gray (1879–1976) exemplified the art deco style with her highly decorative interiors. However, she later became interested in the Modern movement, as seen in her use of glass and tubular steel, and she abandoned the art deco style.

MODERNISM

The influences of Mies, Le Corbusier, and Gropius led modernism and the International style into the forefront of design. The development in the 1930s of Plexiglas®, thermosetting plastics, plastic laminates, nylon, and fluorescent lighting added to the clean, functional look of Modern styling.

Although there are some typical characteristics of modernism, there is also variety within it. Generally, however, Modern style is functional, is simple in form, and lacks ornamentation.

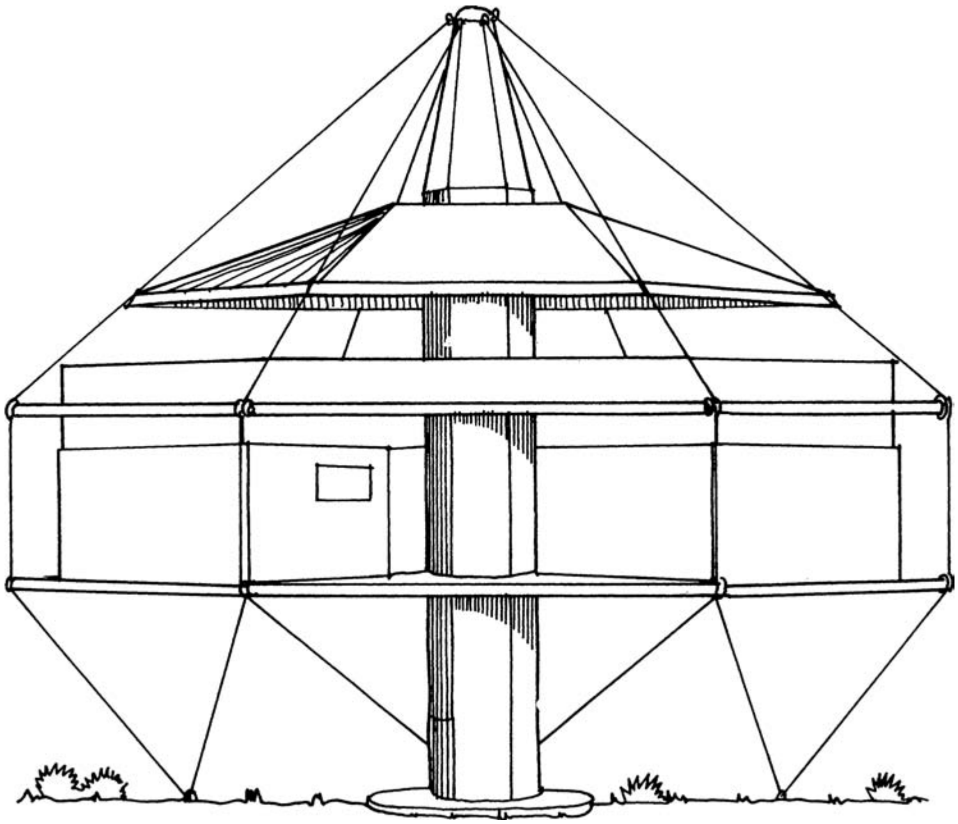

FIGURE 3.22 Buckminster Fuller's Dymaxion House (1927) applied technological features such as a hexagonal enclosure of plastic and metal suspended from a central mechanical core.

Early Modernism, 1930–1950

By the 1930s, modernism had spread throughout America. Although it is difficult to list all the key people who contributed to the development of modernism, we will mention major contributors to this style in architecture, interiors, and furniture.

Buckminster Fuller (1895–1983) was the architect, engineer, inventor, and futurist who developed the Dymaxion House in 1927 (Figure 3.22). Although Fuller is not considered a true Modern stylist, his work with both machine fabrication of materials and functionalism places him as a modernist. He invented geodesic domes (see Figure 4.2), which have been built throughout the world.

Alvar Aalto (1898–1976), a Finnish architect, was an international designer of buildings and furniture. Aalto's concerns for acoustics and lighting produced some distinctive interiors. His innovative stacking chairs are widely copied today and exhibit the machine-made simplicity of the modernists—although, unlike most modernists, he worked primarily in plywood, utilizing laminating and bending techniques (Figure 3.23), rather than metals.

Charles Eames (1907–1978) was an innovative furniture and interior designer whose impact is still seen in today's products. The leg splint he designed of molded plywood for the navy in the 1940s led the way to the development of his famous plywood chair (Figure 3.24) of 1946. He also designed a molded plastic chair with Eero Saarinen (1910–1961) and one of polished aluminum, both of which are considered classics.

Eames and his wife, Ray (1912–1988), started designing furniture for the Herman Miller Company in 1946, producing a series of noteworthy pieces still being copied. Eames not only designed furniture but also was involved in architectural design and movie making. His own house, a forerunner of the use of factory-made components, was constructed in 1949 of lightweight steel (Figure 3.25).

Eliel Saarinen (1873–1950), a Finnish architect who settled in America, in 1932 became director of the Cranbrook Academy of Art, which educated many design leaders of the 1950s and 1960s. Although Saarinen is not considered a pure modernist in his architectural designs, his influence through the Cranbrook education system had great impact on Modern designers. Examples include designs such as the Diamond chair (Figure 3.26) by Harry Bertoia (1915–1978), architecture by Harry Weese (1915–1998), and works by textile designer Jack Lenor Larsen (1927–).

FIGURE 3.23 Alvar Aalto's Paimio Chair (1931–1932) is typical of his designs using laminated and bent birch plywood. These contrasted with the modern-style tubular steel furniture of the same period.

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FIGURE 3.24 Molded plywood chair (1946) by Charles Eames and Ray Eames. These production chairs were cut from sheets of plywood and formed into various structural, flowing forms.

Image Courtesy of Herman Miller, Inc.

FIGURE 3.25 Charles Eames built his own home (1949) near Los Angeles of modular lightweight steel framing members. These systems allowed a great flexibility in placement of windows, walls, and other components.

© Jim Sugar/Corbis

FIGURE 3.26 Harry Bertoia designed the Diamond chair in 1952 with a framework of welded steel rods that could be furnished with a seat cushion attached. These classic chairs, as seen to the right, are still produced today.
Courtesy of Knoll, Inc./Frank Oudeman

Eero Saarinen (1910–1961), the son of Eliel, was an architect who worked with Eames designing innovative furniture. Saarinen designed the Womb chair (Figure 3.27) in 1946 and a pedestal chair in 1958. Later, he produced many major works of architecture, including the Trans World Airlines building at Kennedy Airport (Figure 3.28) and St. Louis's Gateway Arch (see Figure 14.6), one of the most innovative examples of contemporary architecture and a unique interior space.

Richard Neutra (1892–1970) was a Viennese architect who established himself in California and worked with Wright. In 1929 he designed the Lovell House, which utilized steel and glass in large grid patterns. This house became the prototype for all-glass residential structures, such as the classic Kaufman House (Figure 3.29) in 1946. His houses were linked with nature and often had dramatic cantilevers. Neutra also was known to have spent much time defining his clients' needs with detailed questionnaires, which was in contrast with the way many architects designed at that time.

Hans Knoll (1914–1955) in 1938 started Knoll Furniture, which set the standards for modern, durable furniture. He and his wife, architect Florence Schust Knoll (1917–), produced pieces by several noted designers, such as Eero Saarinen and Pierre Jeanneret from France. Knoll Furniture is still a leader in modern furniture products.

George Nelson (1908–1986), an architect and author, worked for the Herman Miller Company and in 1947 set up his own industrial design office. Nelson designed the L-shaped desk (Figure 3.30) in 1949 and the slat bench in 1948.

Philip Johnson graduated from Harvard and studied architecture under Gropius and Breuer. In the Miesian style, Johnson designed himself a transparent glass and steel house in New Canaan, Connecticut, that brought him into the limelight (Figure 3.31). Although he worked originally in the International style, his later works are primarily

FIGURE 3.27 Eero Saarinen created his famous Womb chair designs in 1948. They were constructed of molded fiberglass-reinforced shells.
Courtesy of Knoll, Inc./Photographer: Eric Laign.

FIGURE 3.28 Eero Saarinen's TWA terminal at JFK International Airport (1962) is one of the most sculptural buildings constructed. Structure, interior space, and materials all flow integrally throughout the building.
PD-User: Mnw2000

FIGURE 3.29 The Kaufman House (1946) in Palm Springs, California, was designed by Richard Neutra. It is a prime example of modernism.
Hemis/Alamy

FIGURE 3.30 L-shaped desk (1949–1950) from the Executive Office Group by George Nelson for Herman Miller
Image Courtesy of Herman Miller, Inc.

FIGURE 3.31 Johnson's Glass House (1949) in New Canaan, Connecticut, is a masterpiece of modern design using transparency, geometry, minimal materials, and controlled proportions.
Carol M. Highsmith's America, Library of Congress, Prints and Photographs Division

Postmodern. Johnson continued to produce award-winning designs, such as the AT&T Building (1978) in New York (see Figure 3.40) and the Republic Bank building in Houston.

Middle Modernism, 1950–1970

The 1950s brought a wave of technological advances, such as air-conditioning, low-cost furniture, improved plastics, suspended ceiling assemblies, and synthetic fibers. Master architects—Mies, Wright, Johnson, Eero Saarinen, and Neutra—continued to refine style as an expression of honesty in materials and construction. An example of this functionalist expression, characterized by exposing the mechanical system in the ceiling, is seen in the United Nations General Assembly building (1952) in New York City.

In this period, large, sleek skyscrapers abounded, and corporate clients required multiple large floors of interior planning and design. Several firms, such as Skidmore, Owings & Merrill (SOM) (which started in 1936), have provided comprehensive design services for the architecture, interiors, and engineering of many of the major buildings constructed in this era and today (Figure 3.32).

Bruce Goff (1904–1982) was not a true modernist in architectural style, but his influence and designs are significant. Primarily working in Kansas and Oklahoma, he produced two well-known houses in Oklahoma: the 1950 Bavinger House in Norman and the 1956 Price House in Bartlesville. Goff explored free-flowing interior spaces and used a variety of materials, styles, and techniques bordering on eclecticism.

Alexander Girard (1907–1993) was an architect noted in the late 1940s for his restaurant and cafeteria designs, which were popular far into the 1950s. Girard's Modern style used simple materials and colors to express his vision of unadorned interiors as honest statements. He and his wife, Susan, collected primitive and folk art that influenced many of his design ideas. Today, these artifacts reside in the International Museum of Folk Art at Santa Fe, which was established in 1953 and houses over 100,000 pieces of their collection.

FIGURE 3.32 SOM designed the Lever House (1951) in New York City as a 24-story sleek structure in the Modern style, using glass and steel. *CC-BY-SA-3.0/David Shankbone*

Brutalism

Brutalism, developed primarily in Europe, is an architectural and design style that contrasted with the International style. The term was coined in 1953 from the French *béton brut*, meaning "raw concrete." Brutalism exhibited a monumental style of large mass, rough textures, and bold colors. Sculptural exteriors were punctured with openings to allow light to shoot into the interiors, much like cannons, as Le Corbusier explained and demonstrated in his works.

Paul Rudolph (1918–1997) was an architect who studied under Gropius and produced noteworthy residential structures in Florida. His interiors were simply furnished in the Modern style. In 1963, Rudolph finished the controversial Yale University Art and Architecture Building (Figure 3.33), which used a bush-hammered ribbed concrete texture outside and throughout the interiors. This innovative brutalist building integrated structure, space, and the mechanical systems in inventive ways. However, the people who used the spaces complained about the lighting and various functional problems. In 1969 a fire destroyed the upper three floors of the building, and in the mid-1970s the interiors were almost totally remodeled into new spaces.

Louis Kahn (1901–1974) was influenced by ancient ruins and created architecture and interiors with a sculptural handling of materials and space. Kahn designed a series of monolithic buildings primarily in concrete or brick that exhibited a new richness and understanding of these earthy materials. Among his most famous buildings are the Richards Medical Center in Philadelphia and the Kimbell Art Museum in Fort Worth, Texas (Figure 3.34).

The Minimal Style

Ward Bennett (1917–2003) began to design furnishings and interiors in the 1950s, gaining international prominence in commercial work for the headquarters of the Chase Manhattan Bank. He became a major influence with his furniture and textile designs, particularly for the Brickel Corporation between 1963 and 1988. He and other designers, such as Nicos Zographos and Benjamin Baldwin, became caught up in the "minimalistic style" for their interiors, reducing spaces to elemental necessities and using plain surfaces, sparseness, no ornamentation, and minimal furniture.

Other important designers producing significant works during the 1960s were Angelo Donghia (1935–1985), Barbara D'Arcy, Edward Zajac, Peter Andes, and Richard Callahan. Although these designers were not producing

FIGURE 3.33 The Yale Art and Architecture Building (1963) by Paul Rudolph is one of the best known examples of American Brutalism design.
CC-BY-SA-2.5/Sage Ross

FIGURE 3.34 The Kimbell Art Museum in Fort Worth is one of the best known buildings by the architect Louis Kahn.
PD-User: Andreas Praefcke

FIGURE 3.35 The Solomon R. Guggenheim Museum (1956–1959) in New York by Frank Lloyd Wright. This fluid, reinforced concrete structure is dominated by the creation of the large central spiral ramp.

pure Modern-style interiors, their projects influenced many other designers and the general public. Later, in the 1970s, Joseph Paul D'Urso continued the minimalistic movement.

Reaction to Modernism

The 1950s and 1960s saw the emergence of buildings and interiors with more sculptural qualities than the geometric structures of Mies and Gropius. Concrete and plaster were molded into shapes representing the plasticity of the materials. Wright's Guggenheim Museum (Figure 3.35); Oscar Niemeyer's (1907–) parabolas in Brasilia, Brazil; Le Corbusier's Chapel at Ronchamp; and Saarinen's TWA terminal represent Modern architects' explorations beyond the rectilinear forms of the International style.

In the 1960s, criticisms arose that the pure functionalism and austere appearances of Modernists' buildings and interiors lacked sensitivity to the users and the general public. At this time, several designers rebelled against the styles of pure Modernism and embraced ornamentation and the historicism of earlier styles.

Robert Venturi (1925–) is a leading architect who has worked for Eero Saarinen and Louis Kahn. Venturi expressed the contradictions, ambiguity, and duality of contemporary life in his book *Complexity and Contradiction in Architecture* (1966). He set the wheels in motion for other architects and designers to throw off the purity of Modern styles and look back to history. Venturi's work used classical forms, such as the Palladian arched window, in a rather whimsical fashion. He did not copy them exactly or put them in their proper classical composition, but juxtaposed elements almost playfully to demonstrate contradictions in form (Figure 3.36). His floor plans and interiors broke the rectangular patterns of the Modern style with diagonals, to reflect human movement. Venturi's award-winning firm, Venturi, Ranch, and Scott-Brown, includes his talented wife, architect Denise Scott-Brown (1931–).

Venturi's philosophy stated that, since the world is complex and contradictory, there is no "good" or "bad" design. He coauthored *Learning from Las Vegas*, in which he expounded the idea that the "ugly and the ordinary" are an integral part of modern society. He applauded Las Vegas, Nevada, with the mobility, diversity, and visual delights

FIGURE 3.36 Venturi designed the Vanna Venturi House (1962) in Philadelphia for his mother. He manipulated various classical architectural elements such as a broken pediment entry.
PD-User: Smallbones

this city represents, as an example of the symbolism of our times. Venturi's ideas were radical when the book was published in 1972, but many designers emulated his ideas about the representation of societal patterns and historical references. Venturi coined the phrase "less is a bore," contradicting the modernist design principles as quoted by Mies van der Rohe "less is more." Thus, the seeds of the rejection of modernism, or what is now termed postmodernism, were planted.

Charles Moore (1925–1993) received his doctorate from Princeton University under Louis Kahn and began both a teaching career and an architectural practice. Like Venturi, Moore began to rock the established Modernists by playfully interjecting ornamentation and historicism in his works. He is most noted for his Piazza d'Italia design of a public plaza in a subdivision in New Orleans (Figure 3.41) that was considered to be a masterpiece of Post-Modern design. However, it began to deteriorate quickly, as the surrounding developments were never completed. His 1962 house in Orinda, California (Figure 3.37), was a simple rectangular plan with a different facade on each elevation and four large interior columns. The furnishings were typical of the new design movement—they were personal pieces representing historical memories of his travels and associations with the past. By the late 1960s, this concern with historical context and a desire for urban renewal set the stage for the next steps in design. The preservation and restoration movement began to save and celebrate old buildings. The recycling of architecture and interiors, such as the Ghirardelli chocolate factory in San Francisco, sparked a new interest in and reuse of those treasured old buildings.

Late Modernism and Postmodernism, 1970–1990

In the 1970s, the United States went through a period of slow building activity and high inflation. The energy crisis in 1973–1974 curtailed new construction and initiated energy conservation measures in building design. Preservation, conservation, recycling, and solar design came to the forefront in design during this decade.

As the nation and designers looked to the historicism of buildings, architects developed the concept of contextualism (Chapter 2): the idea that new and old buildings were an integral part of history, that location and adjacency to other buildings were important factors when considering a building site. Designers looked to historical examples for those meanings that the Modern or International style had lost.

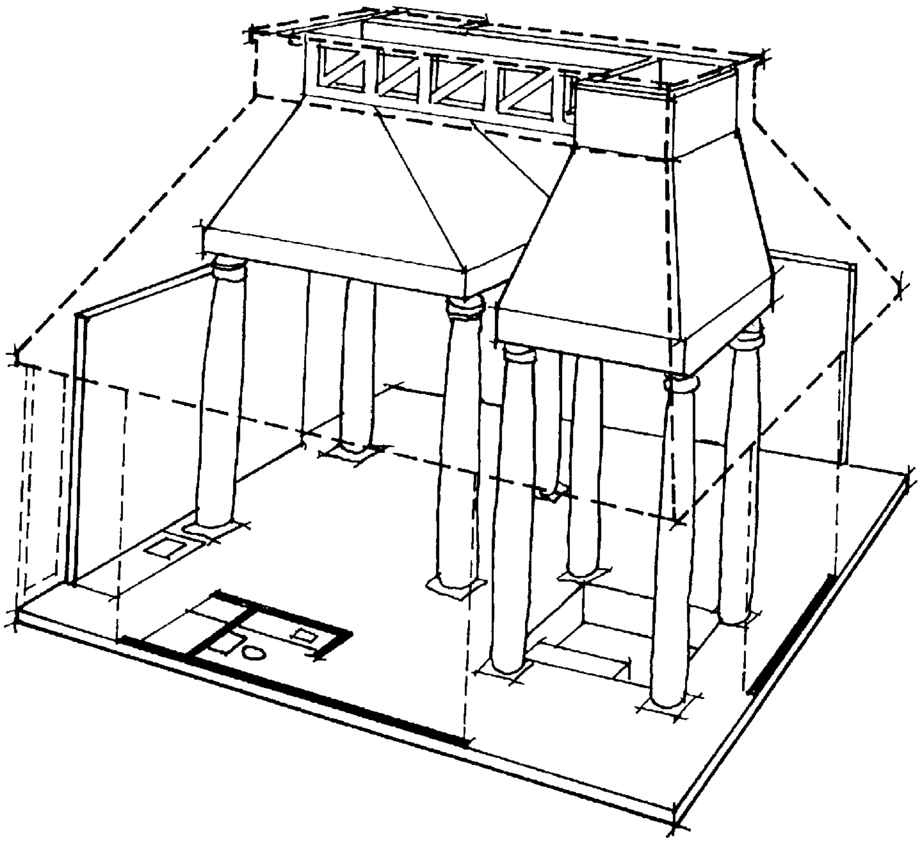

FIGURE 3.37 Moore designed his own tiny house in 1962, composing it of two simple space-defining structures and a steel truss at the roof. It recalls the form enclosures of historical structures such as the Mayan or Hindu temples.

In the mid-1970s, a group of architects began to label this new movement postmodernism and attacked modernism's principles with a fury. Perhaps one of the most prominent architects identified with this movement is Robert Stern (1938–), who studied history at Columbia University and architecture at Yale University, establishing his own practice in 1969. He designed a series of residences in the 1970s that brought back the familiar Palladian details, gables, shingles, and other applied ornamentation. Both his exteriors and his interiors embraced historicism, particularly from the classical periods. His architectural work continues to explore the concepts of postmodernism (Figure 3.38).

Michael Graves (1934–) studied architecture at the University of Cincinnati and at Harvard. He later spent time in Europe drawing and making studies in the Ecole des Beaux-Arts traditions. By the late 1970s, he had produced many houses, galleries, and museums in the postmodern style. Graves's use of color relates to what he calls the "cultural references" of nature, such as blue for the sky, yellow for sunlight, and green for plants (Figure 3.39).

Postmodernism caught up many established architects into new ways of thinking about design, as evidenced by Johnson's AT&T skyscraper (Figure 3.40) and Moore's Piazza d'Italia in New Orleans in 1978 (Figure 3.41), which featured classical Roman details crafted in modern metals.

The postmodern style can be seen in many illusionistic buildings that reflect historicism and contextualism, such as Johnson's skyscrapers and Charles Pfister's (1939–1990) interiors. We see examples of designers seeking to outdo one another with stylistic adaptations. Graves continues to explore the movement in his various building designs throughout the land (Figure 3.42).

High-Tech

Not all interior design and architecture since the 1970s has been primarily a reaction against modernism. For example, the Pompidou Centre in Paris (Figure 3.43), executed in 1997 by architects Richard Rogers (1933–) and Renzo Piano (1937–), is a prime example of the high-tech movement. The structural, mechanical, and other service parts of the building are exposed on the exterior, attesting to the machine-age beauty of support systems. High-tech emphasizes and displays materials and principles used in science, machines, and other technological advances. In interior design, the high-tech movement is exemplified by Joseph Paul D'Urso (1943–), who used metal fencing and stainless steel sinks as prime interior elements within his apartment and other buildings.

FIGURE 3.38 Classical elements are apparent throughout a number of buildings in the Boardwalk, Orlando, Florida, as designed by Robert Stern.

PD-User: WDWbuff

FIGURE 3.39 The Walt Disney Swan Hotel in Lake Buena Vista, Florida, exhibits Michael Graves's use of color and form in the postmodern style.

CC-BY-SA-3.0/Traveler100

FIGURE 3.40 The 1978 AT&T Building in New York, by Johnson and Burges, is said to be loosely derived from the design of Chippendale's highboy furniture piece.

FIGURE 3.41 The 1978 Piazza d'Italia in New Orleans by Charles Moore is criticized for its seemingly classical Roman allusions. The piazza was designed to provide the small Italian-American population of New Orleans a place to hold its annual feast and celebration of St. Joseph.

FIGURE 3.42 Michael Graves incorporated many postmodern forms in the Denver Public Library, 1990.
CC-BY-SA-2.5/KM Newnham

FIGURE 3.43 The Pompidou Centre in Paris is a prime example of high-tech style. It exposed and color-coded many of the building systems such as structure, mechanical, and escalators rather than hide them behind facades.
CC-BY-SA-3.0/ © Jorge Royan

FIGURE 3.44 The Memphis style employed bright colors and simplistic forms, often in contrasting shapes.
CC-BY-SA-3.0/Zanone

Memphis Style

In the 1970s, modern Italian design was challenged by several avant-garde designers, such as Joe Columbo (1930–1971), who began rejecting modernism style. In 1981, the Italian design and architecture collaboration Memphis Group exhibited at the Milan Furniture Fair. They employed brightly colored, vibrant style pieces and an abundance of plastic laminates (Figure 3.44). The products are often in unconventional shapes, with shocking contrasts, and are based on mass-culture appeal. The Memphis style had major influences on many products and interiors, particularly fast-food restaurants and upscale retail shops.

Deconstructivism and Deconstructionism

In 1988, the Deconstructivist Architecture show was held at New York's Museum of Modern Art. This controversial exhibition gave a public viewing of what is called deconstructivism and deconstructionism. The two terms are often used interchangeably; however, there are some differences.

Deconstructionism can be traced to the theories of literary criticism of European philosophers who teach that opposing ideals are equally important and that the taking apart, or deconstruction, of ideas will lead to new theories.

Deconstructivism in architecture is often said to be derived from the literary movement. The designs of a number of individuals represent the variety found in deconstructivism. In architecture and interior design, these movements take apart the elements and reassemble them in a totally different manner, attempting to alter perception and instill physical dislocation—often by the use of jagged edges (Figure 3.45). The results tend to go against the principles of design aesthetics, often producing what has been looked upon as a disturbing composition. Deconstructivist structures do not necessarily reflect specific universal or social ideas, such as universality of form, and they do not reflect the belief that "form follows function." The designs of SITE Projects, Inc., Peter Eisenman (1932–), and Eric Moss (1943–) are representative of this movement (Figure 3.46).

Design Trends in the Millennium

By the middle of the 1990s, architectural design was becoming more pragmatic, focusing on the human experience and how we perceive or understand the built environment in relation to the natural environment through the use of space, materials, light, color, and shadow (Figure 3.47). There was a strong interest during this time in

FIGURE 3.45 For his own home design in Santa Monica, California (1978), Frank Gehry clustered his architectural composition around corrugated metal, wood, and chain-link fencing.
CC-BY-SA-2.0/IK's World Trip

FIGURE 3.46 Peter Eisenman's City of Culture of Galicia in Spain resembles rolling hills with high degrees of contouring and many individually shaped windows.
galitseligmann/Alamy

FIGURE 3.47 Santiago Calatrava designed the Reiman Pedestrian Bridge (a cable-stayed structure) in 2001, connecting the Milwaukee Art Museum on the lakeshore to the downtown's central business district Milwaukee Art Museum.
CC-BY-SA-2.0/Michael Hicks (Mulad)

regionalism and an emphasis on the impact of environmental issues, such as global warming, ecological sustainability, conservation, and recycling.

Neomodernism

During the late 1990s a second phase of minimalist design emerged, expressing simplicity, whereby projects focused on the most basic building systems and elements, representing a more pragmatic approach to architecture. This movement saw design as a return to the purist forms of modern architectural vocabulary, moving away from the postmodern era. Neomodern architecture shares many of the basic characteristics of modernism, as both rejected the postmodern ornamentation and its deliberate attempts to imitate or reinterpret the past. Neomodern buildings were designed to be largely functional and monolithic. They are often found in large projects such as shopping centers, office towers, and condominiums such as those seen in Figure 3.48.

New Urbanism

New urbanism is a design movement that focuses on contextual relationships of architecture and how buildings are integrated into cities and urban areas. It focuses on people, social characteristics, economics, politics, and proximity in geography, as well as the effects on the built environment. The idea introduces and promotes neighborhoods that contain a mix of commercial, housing, and other facility types within walkable distances, lessening the dependence on motor vehicles and more responsive to "livability."

Urbanism supports open space, with context-appropriate planning and architecture, seeking a balance in the developments for all people and activities. This movement is promoted as a design strategy that can reduce traffic congestion, control urban sprawl, and increase the relationships with desirable elements that people need, want, and aspire to.

One example of New Urbanism is the 5,000-acre (20-km^2) town development of the city of Celebration, Florida, in June 1996 by the Walt Disney Company (Figure 3.49). It is a mixture of residential and commercial properties. It is a prime example of a community showcase and has become a popular tourist destination.

Another example of New Urbanism can be seen in the development of I'On in Mt. Pleasant, South Carolina (Figure 3.50). It is a mixed-use community that includes shared public green spaces, extensive sidewalks, trails, parks, lakes, and other common areas.

FIGURE 3.48 The Bay Adelaide Centre in Toronto is a 51-story monolithic tower of steel and glass. It also achieved a Gold LEED rating.

CC-BY-SA-2.0/upstateknitter

FIGURE 3.49 A view of downtown Market Street, Celebration, Florida, the city designed and planned by The Walt Disney Company

CC-BY-SA-2.5/Bobak Ha'Eri

FIGURE 3.50 A concert in the amphitheater in I'On community
CC-BY-SA-3.0/William Hamilton

The Green Movement

The resurgence of environmental concerns (first seen in the 1960s and 1970s) again called for the demand of efficient use of energy, and began to promote more use of clean energy. This has been one of the strongest influences that the design profession has experienced since the beginning of the twenty-first century. As mentioned, concerns for the environment came to the forefront during the 1960s, but progress for change was extremely slow in developing. However, many governments, particularly in America and Europe, initiated and pushed forth a series of ordinance and code reforms that began to change the practice of design and construction.

As concerns for the environment were reemerging in the 1990s, many architects, landscape architects, designers, and planners moved to the forefront of what has been called *the Green movement*, or sometimes *sustainable design*. The architect, William McDonough (1951–) has been one of the strongest advocates of ecological issues, and his approach to sustainability is labeled "cradle-to-cradle." His approach is a strategy of connecting production, consumption, and reuse. This principle is illustrated in his strategy of "waste equals food." In 2002, McDonough co-authored a best-selling book with the chemist Michael Braungart, titled *Cradle-to-Cradle: Remaking the Way We Make Things.* The authors strive for a creative application of technology to create a functional link between natural and built environments.

McDonough developed a list of best practice principles dealing with earth, air, water, energy, and the human spirit. He implements these principles in his many designs for industrial objects, buildings, and master plans. An example of McDonough's designs is the Adam Joseph Lewis Center for Environmental Studies at Oberlin College (Figure 3.51), which was built in 2001. The building is an integration of natural energy and the building's energy needs. It draws much of its energy from the sun, uses geothermal systems for heating and cooling, and filters wastewater through a greenhouse-enclosed "living machine" of wetlands for reuse in toilets and landscape. In 2006, the building became a net energy exporter to other buildings on campus. McDonough's own office building was a leader in the Green movement (Figure 3.52).

FIGURE 3.51 The Adam Joseph Lewis Center for Environmental Studies, located on the campus of Oberlin College, is one of the most advanced examples of Green building in the United States. The project's lead architect was William McDonough.
PD-User: Daderot

FIGURE 3.52 William McDonough + Partners' office building (2008) in San Bruno, California, was awarded the U.S. Green Building Council's Leadership in Energy and Environmental Design Platinum rating.
CC-BY-SA-3.0/Coolcaesar

FUTURE DEVELOPMENTS

From these chapters on the development of design throughout time, we can see that no style tends to remain as the perfect solution or theme for all times. In the past, styles have been named and cataloged by historians as they defined what constituted their essence and contribution to architectural and design history. Design movements or trends tend to develop over time as our tastes and society change and evolve. No doubt we will continue to see movements and styles that come, evolve, and lead into new directions, and possibly new styles that will remain as a "snapshot" in history.

As we move into the design stages past postmodernism, we are seeing a lot of change and variety in architecture and interior design. It is an ongoing process, as designers respond to situations in the built environment. As has occurred in many periods and styles before our time, new directions and references to the past will create other design movements. Each will seek to impel design in a new direction until a new major stylistic form representing our societal patterns emerges.

Globalization

Design has become more globalized and interlinked through communications and sharing among various peoples and cultures throughout the world. Designers will continue to become more accustomed to working in a number of other countries and cultures as they undertake projects on a global scale (Figure 3.53).

The computer's abilities to collect and transmit massive amounts of information—including drawings and virtual spatial creations that can be shared across the globe—will no doubt create a new form of global architecture and design awareness.

FIGURE 3.53 Designed by American architectural firm Kohn Pedersen Fox, the Shanghai World Financial Center (left) and adjacent Jin Mao Tower are some of the tallest buildings in China.
CC-BY-SA-3.0/Ferox Seneca

FIGURE 3.54 Frank O. Gehry designed the Walt Disney Concert Hall for the home of the Los Angeles Philharmonic utilizing CATIA (computer-aided three-dimensional interactive application) for the complex shapes and construction.
Photographs in the Carol M. Highsmith Archive, Library of Congress, Prints and Photographs Division.

Interactive Design

The Internet and computer computational power have allowed us to create virtual environments and test them by scientific modeling of the subsystems, to see what impact and support they can offer once realized. These modeling techniques produce simulations, both visual and physical, that can be accurately measured for conceptual analysis and to determine what will occur when the project is finally constructed and occupied (Figure 3.54).

Environmental Responsibility in Design

Practicing sustainable design (sometimes referred to as green design), conserving nonrenewable resources, and creating buildings that have minimum impact on the environment will affect society as a whole. Designers have an obligation to seek new strategies to reduce the negative impacts of their designs on our environments (Figure 3.55). Architects and designers must continue to rethink the way they build exterior and interior environments to reduce the carbon footprint by acquiring materials locally and designing structures that help reduce the need for artificial energy sources and delivery systems. These measures will foster an appreciation of our environment and all the interlaced activities, peoples, and lands that are dependent upon one another. Nature, humankind, and technology will continue to become more harmonized.

In its earliest studies, sustainable design looked at nature and its intricacies to understand how it works, and what impact we have on it. This led to the field of *biomimicry*, which is the study of the forms and systems in nature to find inspiration in order to solve human problems. Some of the earliest historical examples are the study of birds in order to understand their flight, and apply these principles to human devices, such as Leonardo da Vinci's "flying machine" designs. Today, we find interest in such devices as *biowalls*, primarily made of plants and supporting materials, such as water, soils, and lighting. These are introduced into buildings to use the natural properties of plants to clean indoor air and provide other qualities such as cooling and humidity control (Figure 3.56).

FIGURE 3.55 The building 30 St Mary Axe, London (2003), was designed to use half the power of a similar skyscraper, utilizing natural ventilation and other energy-saving techniques.
Courtesy of Steve Cadman

In conjunction with this, the concept of *biophilia* was developed by the social psychologist Erich Fromm in 1965. The term means "love of life or living systems" and refers to the basic desire of human beings to appreciate the life forms of nature. This idea proposes that there is an instinctive and natural bond between human beings and other living organisms. Direct correlations are seen in healthcare facilities, where patients have been found to recover faster when they are offered an interaction with nature. Perhaps it will continue to be an integral part of design that seeks naturalistic solutions to human problems and needs.

FIGURE 3.56 This biowall uses plants to clean the indoor air through a filtering process. It also adds closeness to nature, by introducing it into the architecture of the building.
CC-BY-SA-3.0/Ronald Lu & Partners

Sustainable principles, such as energy conservation and efficiency, recycled or sustainably produced materials, indoor environmental quality, and establishing the standards for the quality and durability of products that last longer are only a few of the strategies that we will see continue in the future of design.

More for Less

Our constructed spaces will become smaller, as population densities increase, and the demand for better use of resources, and increased manufacturing costs will become more of a design issue in the future. Designers will seek to create more with fewer materials and manufacturing processes, and envision smaller spaces, which will pay homage to the phrase "less is more," coined by Mies van der Rohe. This approach is also a derivative of Buckminster Fuller's theory of "Doing more with less," which dealt more with engineering than design aesthetics. Both principles seem to support the theories of minimalism, although now it is a more comprehensive than an approach just to buildings and their elements. This will become apparent in cities, buildings, and their interiors—where people live, work, and play (Figure 3.57).

Social Responsibility

Social responsibility, in many forms, has been a persistent issue in design for many years. In the 1970s, designers were encouraged to "abandon design for profit" and accept a more compassionate approach. Every design project, whether large or small, affects our society, and designers are becoming more concerned with social responsibility in their works. As more natural disasters have occurred in the last few years, architects and designers have responded to the need for temporary shelters for people. There's nothing people want more than the bare necessities and a roof over their heads after a natural disaster takes place.

FIGURE 3.57 This compact house utilizes vertical stacking and has as many spaces and features as most larger houses. *Courtesy of Andersen Windows.*

FIGURE 3.58 The Katrina Cottages are small residential structures that are now designed and marketed across the United States, as interest in small dwellings becomes more prevalent.

One such project is the Katrina Cottage, which is a small, sturdy, dignified house that arose as a solution for post-disaster housing after Hurricane Katrina in 2005. Several architects designed a series of small houses and made their plans available to the people of Louisiana and Mississippi (Figure 3.58).

User Participation

User participation will continue to become more an integral part of the design process, as designers seek to be more responsive to people's needs and wants in the built environment. User participation as a design tool began in the 1960s and is discussed more in Chapter 6. It refers to the people who actually use a building (or will use a new or renovated building), and solicits their direct input during the design phase of a project. In the past, redevelopment work and urban renewal projects in city districts relied on user design inputs. Some of these early participatory sessions were conducted "live" before television cameras or in front of meeting hall assemblies of concerned people. In these instances, the users had direct input and influence on the design decisions.

As far back as 1988, the AIA (American Institute of Architects) report *Vision 2000: Trends Shaping Architecture's Future* called for more awareness and participation by the general public in shaping our built environment. This public, or user-generated, architecture has been called "process design" by Charles Moore and William Turnbull (1935–1997). Process design involves the people, soliciting their hands-on involvement not only in the design stages but in the construction phase as well. This idea is particularly important in the works of Christopher Alexander (1936–), as explained in his book *A Pattern Language*, and several others.

Improved user participation is a direction architects and designers now take and will seek to follow more in the future as they create viable solutions for our built environment. Computer connections and personal digital devices have made the input, collection, and organization of direct user interaction more available than in the past and will continue to evolve as design tools.

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4

The Basic Theories of Design Composition

Design theories and applications are as numerous as designers, projects, and historical examples. Although at first glance they may seem quite different, design theories do have some commonalities and basic premises. Theories are underlying principles, guiding forces, speculations, or ideas that people share about how things exist or operate. For example, believing that the earth was flat once was a theory. The Bauhaus movement (Chapter 3) was a theory about how resources, technology, art, and society should interact that set the parameters for the work of many artists, designers, and technicians. Design theories are developed to enable designers to formulate, apply, and evaluate essential design elements and principles to meet human needs and fulfill human aspirations. Design composition is traditionally taught as a theoretical base for constructing, viewing, and judging the interrelationships of objects, space, and materials. These compositional theories primarily address the physical arrangement of elements in the environment as perceived by human beings when they interact with them. Design theories should also take into account human psychology and behavior, correlating people's needs and desires as they interact with one another and the environment.

This chapter will explain the basic theories of design composition. Counterpart concepts for addressing human behavior and the needs for security, comfort, stimulation, variety, and complexity will be discussed in Chapters 6 through 9. The issues of privacy, community, and territory are detailed in Chapter 7.

DESIGN APPROACHES

All professional fields of design, such as architecture and industrial, graphic, fashion, and interior design, utilize theories of design composition. Particular design theories can be fairly simple, yet complex at the same time. It can be difficult to separate all the concepts of design into specific components, because there is no limit to the flexibility, relationships, and application of the ways design is carried out.

In Chapters 2 and 3, we discussed the origins and development of design through the ages and looked at various examples of how it was applied.

We shall now discuss several common design approaches, purposes, and applications (Figure 4.1). Examples will be given of the ways various designers express them, and how people view or evaluate them. Although most people consider structural and decorative design to be the basic approaches, other types can also be major influences. Many combinations of all these approaches, discussed in the following sections, are evident in design theory.

Structural Design

Structural design is the underlying framework, or structural component, and is usually expressed in the final visual form. The design is not an embellishment added to the form, but rather an integral part—such as the ancient

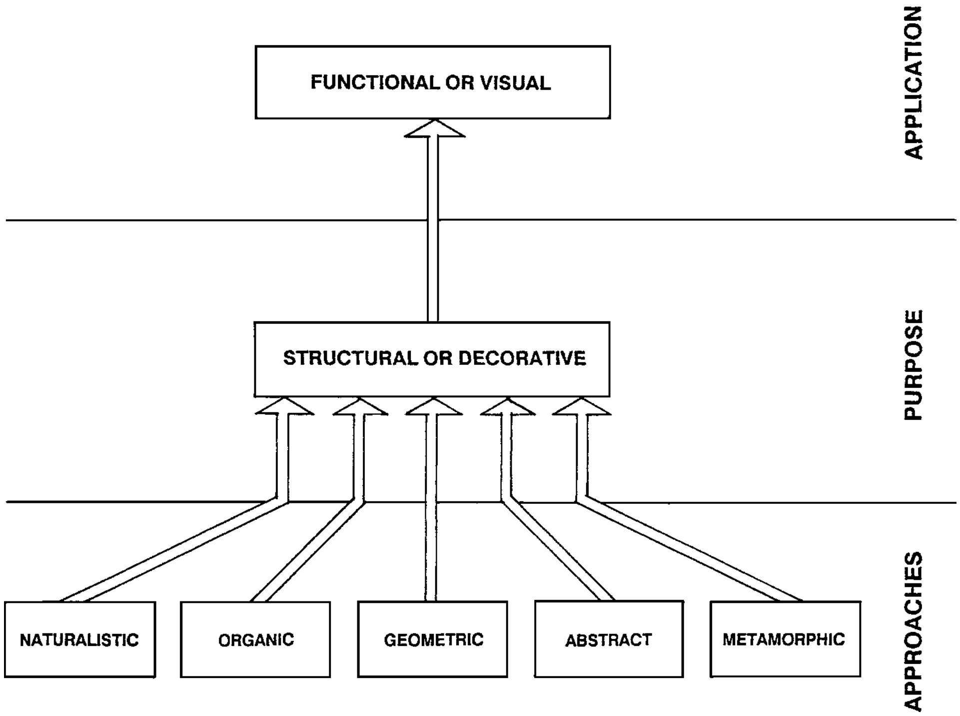

FIGURE 4.1 Several design approaches designers commonly use

pyramids in Egypt (Figure 1.6) with their stacked and exposed stonework as the structural support, and Buckminster Fuller's geodesic domes (Figure 4.2). Looking at nature, we find the design of a beehive, the shape and composition of the bones in a bird's wing, or those of a spider's web to be structural in form. Structural design in furniture can be seen in modern designs that use tubular steel, such as Marcel Breuer's chair of 1925 (Figure 3.19). Simplicity is one of the characteristics of most structural design.

Decorative or Applied Design

Decorative design implies that ornamentation is applied to structure. Patterns printed on wallpaper or fabrics are not intrinsic to the structural makeup of the material and are referred to as applied design. The Victorian era saw much of this type of ornamentation in architectural design and in furniture. One of the important furniture designers of the Victorian era was John Henry Belter (1804–1863), who made chairs, sofas, and case pieces with elaborate openwork designs and fruit, flower, and foliage carvings applied to the structural forms (Figure 4.3). In Victorian interiors, elaborate carvings, cornices, and moldings were added to the basic structural components of the walls and ceilings.

A fascinating example of decorative design applied to structural design can be seen in the evolution of the automobile. The early models consisted of the basic functional elements of engine, chassis, wheels, and passenger compartment. Later development has seen decorative additions to the body, using chrome, brass, colors, and custom features or gadgets. Even the basic body shapes have been streamlined to imply speed, as seen in Figure 4.4.

Decorative design should be applied logically and sensitively, because it makes a powerful and personal design statement. Applied decoration can harmonize with an object's form, function, and materials or become a contrast.

Naturalistic Design

Naturalistic design utilizes shapes found in our natural environment, such as rocks, hills, ocean waves, and clouds, instead of artificial or manufactured objects (Figure 4.5). Living organisms, such as plants and animals, are, of course, also found in nature, but these are referred to as organic designs. It is feasible, however, to include both living and nonliving things in naturalistic design and in organic design. Can we say, for example, that the ocean is not "alive" in composition or its movements?

FIGURE 4.2 The framework of Buckminster Fuller's geodesic domes is established by mathematical proportions and structural analysis. This is a good example of the structural design approach.

Organic Design

An approach related to, or derived from, living things (such as a person, an animal, or a plant) is organic. Organic design is not based on precise geometric form, but rather on flowing, undulating curves and forms. Organic design in architecture is closely linked to the work of Antonio Gaudi (Figure 4.6). His organic structures illustrate solutions to the problem of linking a geometric structure to organic forms. Organic design, like naturalistic design, reflects our existence as an integral part of our natural environment and the universe.

FIGURE 4.3 This sofa (c. 1850) by John Belter exhibits an elaborate imagery of leaves, vines, fruit, and acorns in the fabric and carving of the rosewood. (Virginia Museum of Fine Arts, Richmond. Gift of Mrs. Hamilton Farnham.)

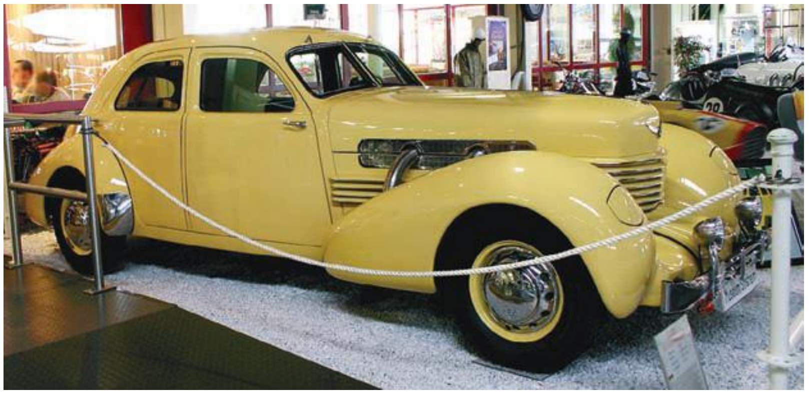

FIGURE 4.4 Streamlining was an applied design for the bodies of early automobiles to give them the appearance of speed and sleekness.

Geometric Design

Geometric design is related to straight lines, circles, squares, triangles, rectangles, cubes, spheres, and other mathematically precise shapes. The Greeks often are credited with perfecting the geometric approach to design in both their architecture and their ornamental motifs (Figure 2.13). Geometric forms were also characteristic of the early periods of contemporary architecture and design. In the de Stijl movement (1917–1930), several Dutch artists restricted design to the basic elements, primary colors, and arrangements of lines and two-dimensional geometric shapes on a flat surface. Gerrit Rietveld, a furniture designer and architect, translated these principles into three-dimensional forms, as seen in his Red-Blue Chair (Figure 3.16) in 1917. Geometric design can be found in wall coverings, floor coverings, furniture, and upholstery fabrics (Figure 4.7).

FIGURE 4.5 An example of naturalistic design can be found in Frank Lloyd Wright's Fallingwater, a private residence designed to be a nature retreat for its owners. The house is well known for its connection to the natural site. The fireplace hearth in the living room integrates boulders found on the premises.

FIGURE 4.6 The fantastic architecture of Antoni Gaudi is based on organic principles. He believed that straight lines do not exist in nature and that building designs should reflect nature's organic patterns.
CC-BY-SA-2.0/Jaume Meneses

FIGURE 4.7 The interior features and furniture of this waiting area are based on geometrical design principles.
Courtesy of Kimball Office

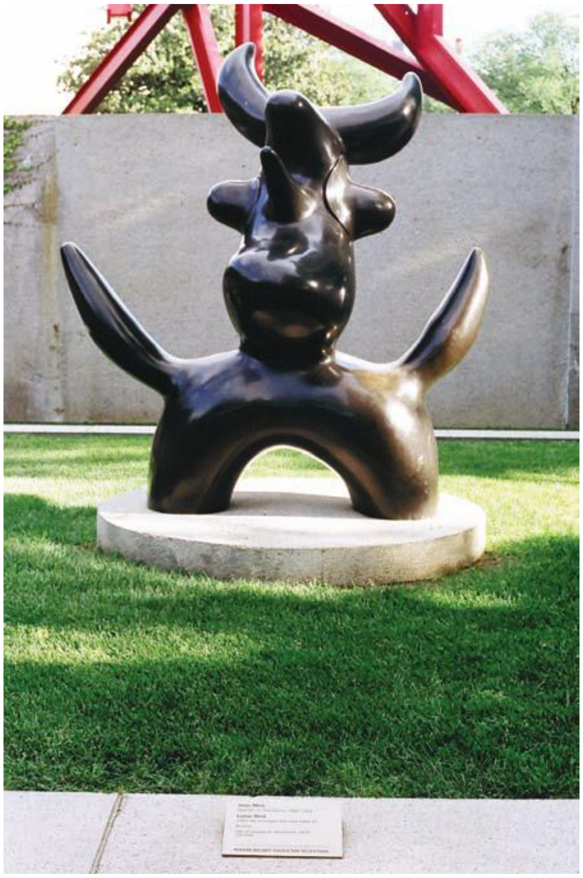

FIGURE 4.8 The *Lunar Bird* by Joan Miró is an abstraction based on the bird form.

CC-BY-SA-2.0/Ben Javelina

FIGURE 4.9 *Roger* is a self-portrait of Roger de La Fresnaye, who demonstrates an individual response to cubism. He was influenced by Georges Braque and Pablo Picasso.

PD-User: The Yorck Project

FIGURE 4.10 This quilt art exhibits some metamorphic design qualities as the images appear to evolve into different shapes and directions.

Designed and made by Jen Kingweld

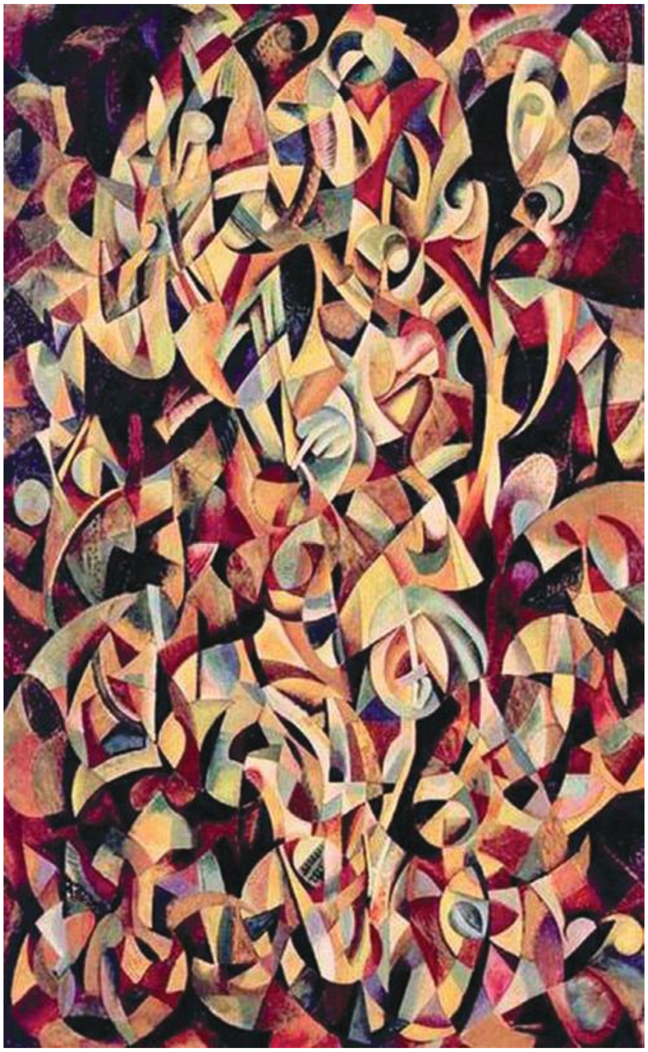

FIGURE 4.11 The painting *Dance*, by Alexander Rodchenko (1915), seems to be constantly changing in form, composition, and point of view.
PD-US

Abstract Design

Abstract design can be derived from natural, organic, or geometrical shapes, but it distorts or stylizes them to create a new meaning or essence. The original object is transformed into something different and may or may not be recognizable (Figure 4.8). This type of design, frequently characterized by simplification of form, can be seen in the work of Pablo Picasso (1881–1973) and other artists, such as Roger de La Fresnaye (1885–1925), who often reinterpreted shapes into Cubist abstract motifs, as seen in Figure 4.9.

Metamorphic Design

Metamorphic design refers to the changing, varying forms or shapes within a design. It is an alteration of the design's basic premises, evolving as it progresses. In nature, the changing of a caterpillar into a butterfly is a good example of a metamorphosis. Some wall coverings and fabrics whose patterns seem to change and evolve from a basic form exhibit metamorphic design (Figure 4.10). In drawing, examples of work by M. C. Escher (1898–1970) exhibit changing, metamorphic designs that delight the eye. Abstract works by other artists also exhibit this moving, changing theme (Figure 4.11).

THE ELEMENTS OF DESIGN

As traditionally taught in schools, theory of design composition has been defined under the generic term *basic design*, which in turn is divided into two major areas: elements and principles (Figure 4.12). The seven elements can be thought of as the vocabulary in design language, and the eight principles can be likened to the grammar, or rules for applying those elements.

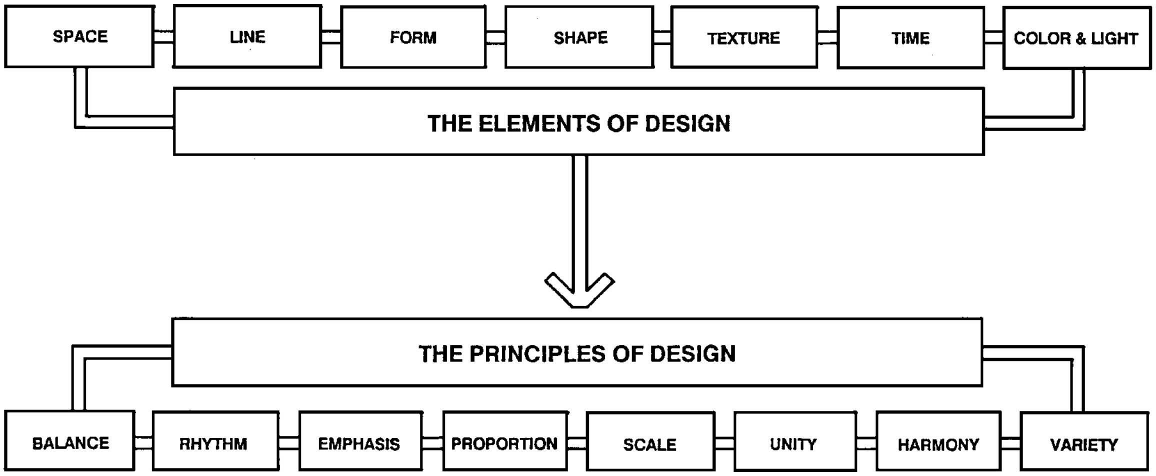

FIGURE 4.12 Basic design compositional theory is traditionally divided into the elements and principles of design.

The "Elements of Design" are space, line, form, shape, texture, and time, which are discussed in the following sections, and color and light, discussed in Chapter 5. Although some textbooks do not include time as a basic element, the authors will illustrate how it is an integral part of the other elements. The "Principles of Design" utilize the seven elements and consist of balance, rhythm, emphasis, proportion, scale, unity, harmony, and variety. The principles can be thought of as a funnel that directs or focuses the elements to achieve a particular effect or solution.

The elements and principles of design are the foundation and vital tools that a designer manipulates to create a strong solution to a given problem. A good grasp of basic design theory is essential no matter whether an individual plans to become a professional interior designer; to work in related fields of architecture, graphic design, product design, or fine art; or simply to use the knowledge to enhance day-to-day living.

The elements and principles of design should not be thought of as fixed rules and formulas, but rather as guidelines to encourage the creation of successful designs. Different combinations of elements and principles can produce different results or characteristics in the final design. By understanding these basics of design theory, the designer can set up certain criteria to evaluate what we commonly refer to as *good design*.

Space

Space is perhaps the most important and complex of the basic elements in design theory and application. It can be thought of as an endless vacuum relating to our universe, or "outer" space. Space can also be expressed as a complex relationship between our feelings and impressions, for example, as we view a painting that represents objects and the space around or through them—all in the same cubist drawing, as illustrated in Figure 4.9. To the interior designer and the architect, space is the essence of what our natural and man-made environments are all about. Space has physical, visual, emotional, psychological, implied, functional, planned, and aesthetic connotations (Figure 4.13). Various theories analyze the essence of space and how it affects us or, conversely, how we affect it. Such an integral relationship exists between human beings and the spatial environment that it is difficult to define the line between the two.

Space is spoken of in relationships—to people, their occupancies, and the time period in which they exist. Webster's dictionary defines space not only as an area where things exist and move, but also as a period of time. The "sub-elements" of space are physical objects, nonobjects, movement in three dimensions, and time. The fabric that holds these together is the human unit and its interaction with them all. When we discuss space as a basic element of design, we are more appropriately talking about "spatial" concepts and relationships than about "space" as a distinct entity. We shall use the word *space* interchangeably with *spatial* in the following discussions.

Time-Space Perception

To the interior designer, the boundaries of floors, walls, and ceilings of a room seem physically to mold, define, and articulate space in that environment. People and objects within the space also influence the way space exists

FIGURE 4.13 This cantilevered office provides an enclosed space in the atrium, as well as allowing visual space to flow around and through it.
© Skidmore, Owings & Merrill LLP I © Jimmy Cohrssen

and how we perceive it. Space is not static but invites people to change it as they move through it bodily, visually, or psychologically. Although we cannot walk into space, our sight and other senses can experience it, and our minds can interpret its impact on us. The phenomena of time and movement play an important part in our perception and use of space, because unless the environment is very small, we cannot perceive all of it at once. We must take time and move through it little by little, gradually accumulating impressions until a sense of the whole and its relationships has been assembled.

As we move through an interior environment, its space(s) become a sort of space/time continuum, and often our impressions change from our initial perceptions. The key here is that space is indeed perceived and changed by how we move through it, thus giving space a sense of "kinetics" or nonstatic existence. If we stand still in the environment, our movement of vision (focusing and refocusing on objects or the space) will create changing relationships, both physical and psychological. So space is not static, although the structure forming it or the fixed viewpoint of the observer appears to be. Examples of the kinetic aspects of space can be seen in the architectural sculptures found in parks, plazas, shopping malls, and museums. People can walk around, under, through, and perhaps even on space, as illustrated in Figure 4.14.

We speak of space being divided into "positive space and negative space." Positive space refers to the area that is filled or occupied by mass, forms, or objects. The empty space that surrounds these areas or that is surrounded by the objects is called negative space. The two are directly related and can be balanced or contrasted, depending on the design aspects. Despite what its name might imply, negative space is of equal importance to positive space, and sometimes is even more significant.

Look closely in this book at the photographs of environments and the spaces they present. A designer should ask, "Can I go beyond the fixed viewpoint of the camera and experience the space? Can I see myself in it, moving through it, seeing it from different viewpoints? Will these experiences change my initial impressions of the space?"

FIGURE 4.14 The interiors of the Fukui Dinosaur Museum in Japan offer an abundant variety of views, objects, and stimuli as one moves through the space.
CC-BY-SA-3.0/Douggers

It is important to begin looking beyond the fixed view of the photograph—which was also fixed in time—and try to see what the designer was creating and how people will experience the space. Designers are constantly using our perceptions of space, such as color or texture, to modify a space or heighten its impact on us. A designer should put himself or herself in the space and move around in it—even while creating it.

Spatial Relationships

The understanding and effective use of space and its many relationships have a major effect on successful design, because space forms the basis of architecture and interior design. The success of an environment is often determined by the function and quality of the space, because it is after the use and the form of the spatial environment have been established that the material, surface, color, and texture of the objects are considered.

To create form or to define boundaries of spaces, physical and nonphysical spatial concepts must be organized to achieve particular results. The overall relevance of space becomes clearer if space is considered unlimited until the architect or interior designer defines it by erecting walls, floors, and ceilings or adding other shapes.

Building structures and interiors generally consist of a number of spaces that are related by function, location, or circulation. These relationships are defined as spatial concepts. Spaces flow into one another vertically, horizontally, and in many other ways to create coherent shapes and patterns that meet specific needs and make aesthetic statements. Some important basic concepts of spatial relationships, shown in Figure 4.15, are described as follows:

ENVELOPED SPACES "Enveloping" refers to smaller spaces that are contained within a larger volume of space. The smaller and the larger spaces generally have their own identities, thus promoting a distinct relationship between the two. The smaller space may reflect the shape of the enveloping space, emphasizing their similar forms, or it may contrast with the larger space for emphasis on form or function (Figure 4.16). Also, the spaces might be similar in form yet oriented differently to create distinctive shapes.

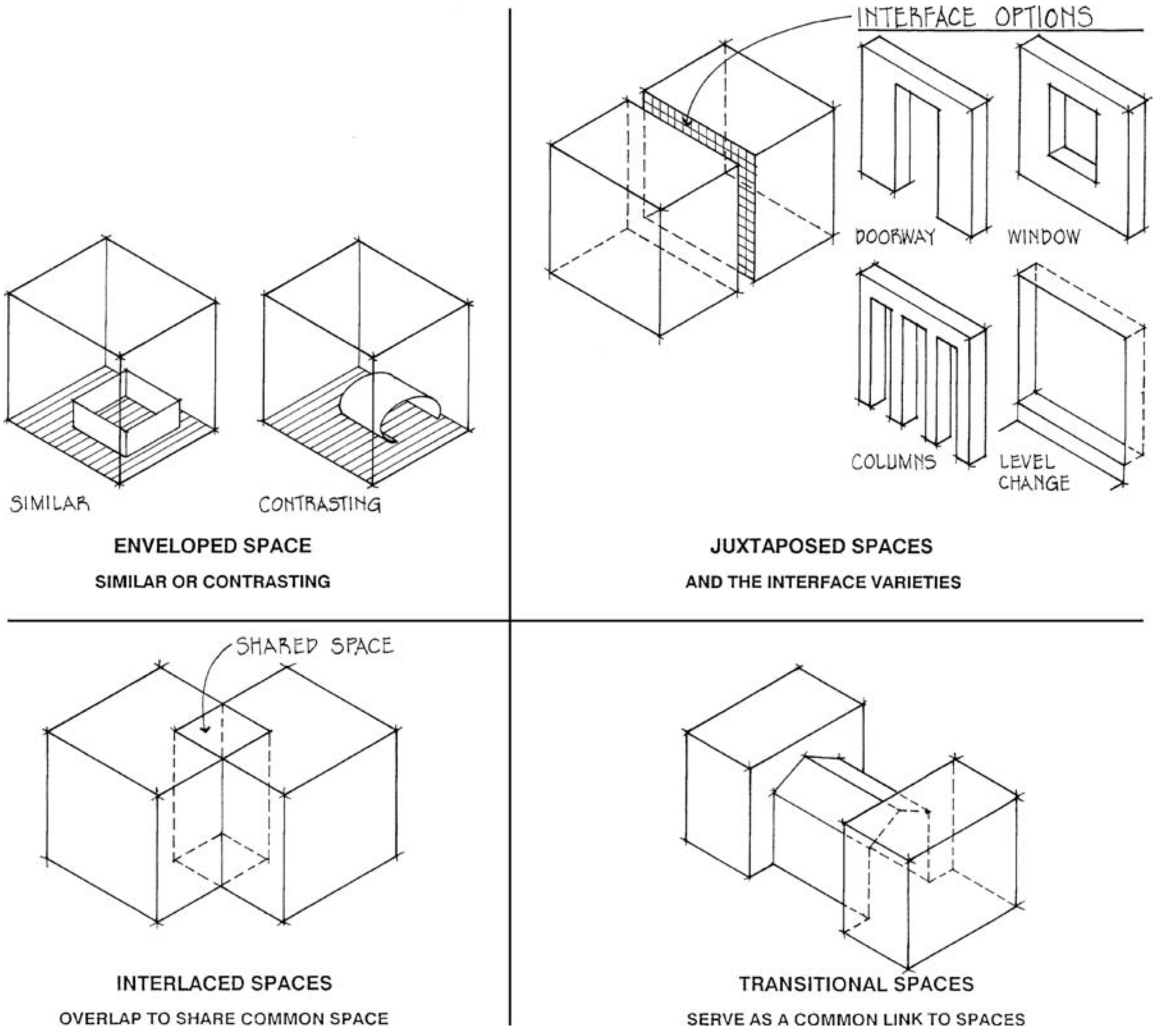

FIGURE 4.15 Basic spatial relationships can be defined as enveloped, juxtaposed, transitional, and interlaced.

JUXTAPOSED SPACES A common type of spatial relationship is juxtaposition, or comparing spaces side by side (adjacent spaces). Each space is defined in its own unique form, which is related to its functional, symbolic, or structural requirements. The juxtaposed spaces might be similar, exactly the same, or contrasting—the degree of relationship depends on the interface (and resulting plane/penetration) between the two. The separation element between the spaces then might (1) restrict physical and visual access between them (a door), (2) be a distinct element between them (columns or freestanding wall), (3) restrict physical but not visual access (window or opening), or (4) be implied through change of levels (ceiling- or floor-level changes), color, or surface textures (Figure 4.17).

TRANSITIONAL SPACES A common or intermediate space linking other spaces is called transitional. This intermediate space, such as a hallway, mudroom, exterior portico, or breezeway, can link other, sometimes more important, spaces. The transitional space can also become an important space in itself, and even be the dominant space, such as a center atrium or courtyard linking other spaces. Transitional space can be similar in size, form, and orientation to the spaces it links, or it can differ from them. Transitional spaces are often used to heighten people's senses in anticipation of moving into another space (Figure 4.18). For example, after being confined to the tighter, smaller space of a low, long entry to a large auditorium, people tend to perceive the auditorium as larger than it really is. Frank Lloyd Wright often used smaller and lowered ceilings in his designs of transitional spaces that linked larger spaces.

INTERLACED SPACES A space created by two spaces that connect so that the form or shape of one affects the other in a zoned or shared configuration are termed *interlaced space.* Interlaced space can be seen as part of one of the spaces, or it can gain its own distinct identity as a link for the original spaces (Figure 4.19). The overlapping of these spaces and the resulting shared form can be physical or implied.

FIGURE 4.16 The circular glass staircase at the Apple Store in New York is an example of a contrasting enveloped space within a rectangular space. Yet it is similar in treatment of glass and steel materials.

FIGURE 4.17 Similar juxtaposed spaces in the Paris Saint-Honoré d'Eylau Church are separated with thin columns and pointed arches.

FIGURE 4.18 Frank Lloyd Wright created a transitional space leading from the street into the V. C. Morris Gift Shop (San Francisco, 1948).

PD-User: Daderot

FIGURE 4.19 The two intersecting barrel vaults over the streets in the Galleria Vittorio Emanuele II, in Milan, are interconnected with a glass dome, creating a distinct spatial feature.

CC-BY-SA-3.0/chensiyuan

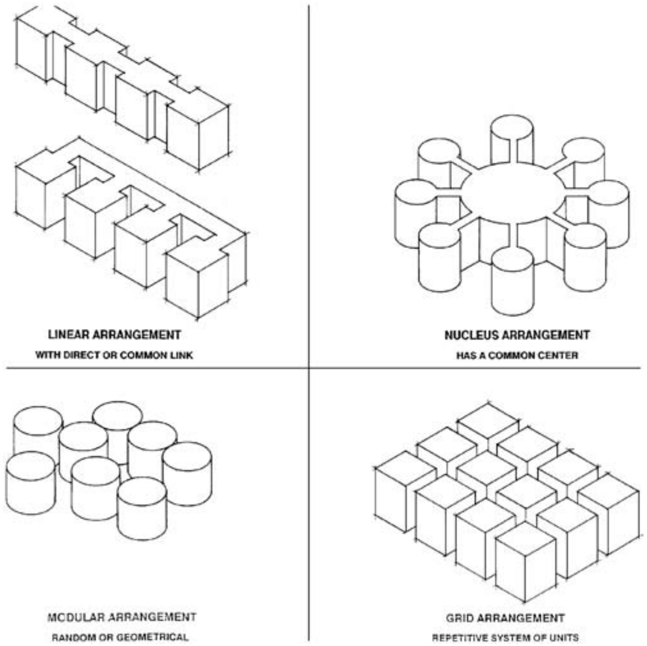

FIGURE 4.20 Spatial arrangements can be categorized through several basic ordering systems.

Spatial Arrangements

Architecture and interior design represent the art and science of enclosing space for human habitation or to suit a particular purpose for human use—the skyscraper, the igloo, the hospital, and the tent, for example.

Space can be arranged in several basic ways to define the specific functional and visual requirements it is to satisfy (Figure 4.20), such as accessibility, privacy, or orientation. The following spatial arrangements are the basic methods of ordering space conceptually.

LINEAR ARRANGEMENT A linear configuration of space is composed of a series of spaces placed next to each other in a direct line that can be straight, curvilinear, or segmented (Figure 4.21). These spaces can also be directly linked through a separate common space.

FIGURE 4.21 A series of paired columns and vaults create a linear configuration of spaces.
PD-User: Architect of the Capitol

FIGURE 4.22 This elevated conference room serves as the nucleus of this office, with supporting spaces grouped around it.

© Skidmore, Owings & Merrill LLP I © Gregory Murphey

NUCLEUS ARRANGEMENT A plan that consists of a central, dominant space with supporting spaces grouped around it or extending from it is called a nucleus arrangement. These supporting areas can be in geometric or organic shapes and can extend from the nucleus in a linear or a radial manner. These areas can be similar or contrasting in shape and function (Figure 4.22).

MODULAR ARRANGEMENT An organization of space where related functions and/or purposes are grouped to form a unit is a modular arrangement. Two or more modules can then be organized into one cohesive pattern or plan. Modular spaces can be arranged around a central axis, such as in an entry to a building or a courtyard, to help unify the overall plan and articulate the circulation from one module to another (Figure 4.23).

GRID ARRANGEMENT A grid arrangement is created by a regular pattern of points located at the intersections of two sets of parallel lines laid perpendicular or at an axis to each other. The grid creates equal, repetitive units of space. Various spatial configurations can evolve within the grid while maintaining a constant reference to the grid pattern. For example, in a large industrial building, structural bays (or spaces) may be subdivided into smaller units, but with the grid pattern still evident in the column and beam spacing. In architecture, structural systems are usually designed in a grid pattern to use fewer materials, to provide better structural qualities, and to simplify construction methods (Figure 4.24).

These various arrangements of space are not meant to be "absolute" spatial configurations, but instead can be modified or combined to create a multitude of configurations based on the spatial needs of a situation and the needs of the individuals using the space.

Psychological and Emotional Space

Designers must also carefully consider the psychological and emotional qualities of space. Everyone has a personal sense of space; sometimes the size of a particular space or the arrangement of furniture is not in harmony with a person's sense of what should occur in the space. Each individual has a sense of "territory," which is often referred to as "personal space" or as a "space bubble." This natural characteristic of human beings and animals is referred to as *territoriality*, a term coined by Dr. Edward Hall (1914–2009). See Chapter 7 for a discussion of these terms.

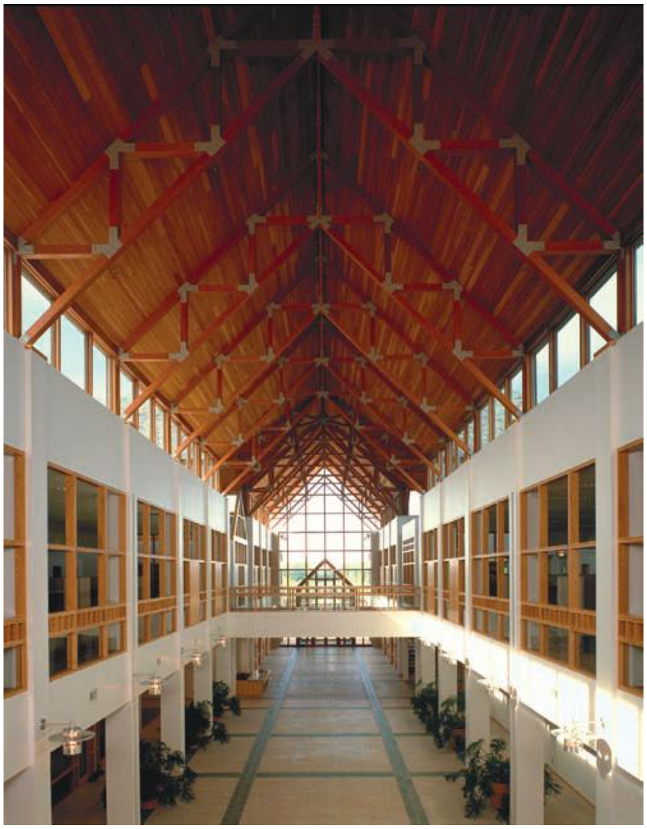

FIGURE 4.23 The modular spaces within Heritage Mutual Insurance are arranged around a central courtyard to help unify and articulate the circulation from one module to another.

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FIGURE 4.24 The State of Illinois Center by Murphy/Jahn and Lester B. Knight is based on structural systems that are grids formed and exposed for visual expression.

CC-BY-SA-3.0/Fernando González del Cueto

FIGURE 4.25 This interior drawing by Gary Saxton primarily uses line to represent objects and textures. However, line is also used in the design of the structure, furniture, and material representation.

Dr. Hall, a professor of anthropology, is credited with the original theories of people's perceptions and uses of space, which vary among individuals and within specific groups and cultures. People's invisible bubble of space is their defensible, or territorial, space. If they allow a few other individuals to penetrate these bubbles, it is usually only for a short duration. Outside forces, such as other people, objects, and the immediate environment, can expand or contract these space bubbles. In turn, this invasion of space can affect individuals' feelings about and reactions to everything around them. Although these spaces are seemingly nonphysical, they are very real to each individual. Designers work with physical-spatial relationships but also must be aware of the impact of emotions on those spaces.

Line

Line is one of the most basic elements of design theory. Throughout civilization—from cave dwellers' doodlings to scientific diagrams of electronic circuits—people have used lines to connect points or express relationships. Even televisions and computer video equipment utilize many varieties of lines on their screens. We can perceive as lines the spider's web, the veins in a leaf, or the horizon as seen on the ocean. Some of these lines—such as the "line" between the sky and the earth that we perceive as the horizon, or the junction between mountaintops and the sky—do not actually exist in nature but are implied or abstractly interpreted.

When asked to draw something, we often draw the outline of it. That is, we tend to see or infer a line that separates the various planes of the object from the surrounding spaces or other objects. This contour line defines the shape or form of the object (Figure 4.25).

Line is classified as straight, curved, vertical, horizontal, or diagonal—depending on how the viewer uses or perceives it. These categories imply that line has direction and can project emphasis by the apparent path it takes. For example, horizontal lines can seem to elongate a plane or space, while vertical lines can give an impression of height (Figure 4.26). We can also think of lines as having character, emphasis, or quality of expression. We can further distinguish lines as thick, thin, jagged, smooth, flowing, or tapering. Line is used in interiors with other principles, so we must view the overall use of the line and its relationship to the design, the users, and their inner feelings. It is not enough simply to say that horizontal lines always elicit responses of relaxation and that vertical lines are strong or formal or increase height awareness. Instead, it is the quality and the context of the line in its surroundings that establish both how we "feel" about the line and what it seems to imply.

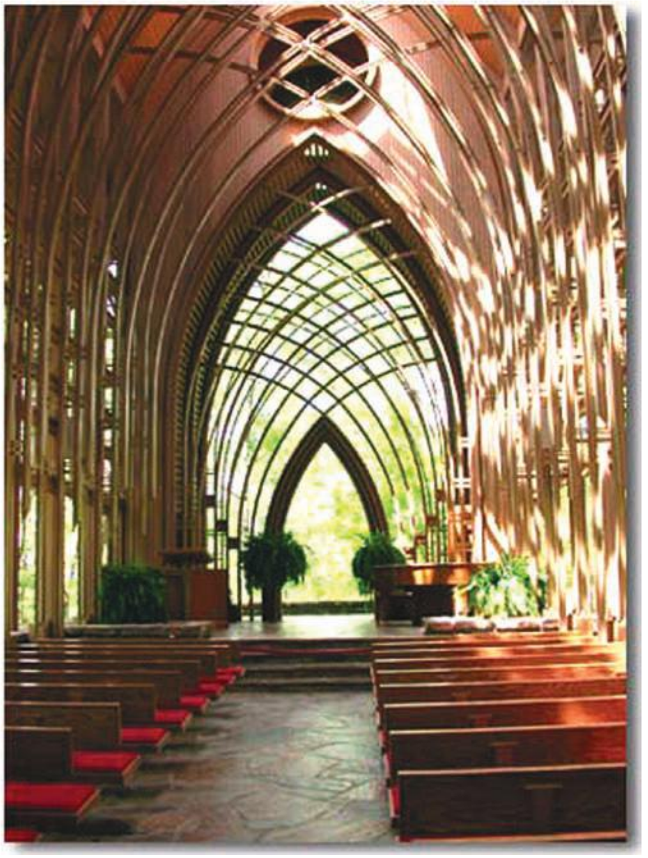


FIGURE 4.26 The structural shapes in the M. B. Cooper Memorial Chapel by E. Fay Jones, FAIA, are designed as vertical sweeping lines that accentuate the height of the space.
Photographer: Thomas S. England

FIGURE 4.27 This clay sculpture is an abstracted form that represents an artist's interpretation of her feelings.

Form

Although "form" is often used synonymously with "shape," there are distinctions. When we speak of shape, we are often referring to the outline of an object, such as the shape of a human body, a piece of furniture, or a building. Form, however, can be compared to mass, which is three-dimensional and exhibits volume. The manipulation of space creates form, and, in turn, form gives space dimension and mass. Generally, we speak of furniture and other objects used in interior design and architecture as having physical form. However, form can mean more than just a physical or substantive mass. The term is also used abstractly by designers to express the essence and inspiration behind a design concept. For example, we can say that a sculpture was created in the form of a feeling, thus speaking of the abstract approach the designer was creating, as opposed to the physical form, as illustrated in Figure 4.27. Also, the physical form of an island and the form of a concept based on an island are not necessarily the same thing.

Form can include substance (such as solid or liquid form), vaporous elements (gases), or internal structure (the skeletal framework for an airplane). A form can also exhibit implied or apparent weight; a box painted flat black will seem to most people to weigh more than a clear plastic box. A colorful and dark piece of furniture placed in an interior will have more apparent weight or dominance than a chair of similar scale that is covered with a light-colored fabric and placed in a light-colored environment (Figures 4.28 and 4.29).

Shape

Although many designers often use the word "shape" interchangeably with "form," shape is defined as the outline, or identifiable contours, of an object. Geometrically speaking, we can refer to the basic shapes of rectangles, circles, squares, and triangles. In turn, these shapes might be expressed as curved, angular, or rectangular. Geometric shapes are derived from mathematics and seem to dominate our built environments (Figure 4.30).

FIGURE 4.28 The strong color and form of this sofa visually give more weight and dominance to it in this library.
CC-BY-SA-3.0/Onnemtce

FIGURE 4.29 These chairs would appear visually heavier or more dominant if they were a darker color.
Courtesy of Kohler Co.

FIGURE 4.30 The Berlin Central Railway Station is designed with strong geometrically derived structural shapes and finishes.
CC-BY-SA-3.0/Mihael Grmek

FIGURE 4.31 The curved raised seating area and steps harmonize with the curved ceiling forms in this healthcare facility.
Courtesy of Kimball Office.

FIGURE 4.32 The tall, rectilinear shapes and lines in this reception area convey a sense of formality, stability, and procession. *Courtesy of Perkins + Will; photograph by Steve Hall. © Hedrich Blessing*

The effective use of shapes in design, whether such shapes are derived from geometric or naturalistic sources, depends on how they are applied to a particular situation. Shapes can be manifested in a very precise, regular manner or in an irregular or organic way. Not all shapes are used in their purest form, such as a perfect circle, square, or triangle, but most are derived from one or more of these pure shapes.

We generally use shapes with specific characteristics in conjunction with similar shapes. For example, curved shapes might be used with other circular, flowing curved forms to create an overall harmony (Figure 4.31). However, we seldom find interiors totally made up of a single category of shape, since creative designers combine and mix shapes to accent and balance the overall interior environment. Shapes elicit a particular response from people when they see the inherent relationships of the objects; for example, the straight geometrical lines in a table and chairs constructed of similar geometrical features, plus other groupings of straight geometrical pieces, will seem harmonious as a result of the unifying rectangularity of their shapes. A curved element introduced into that space might contrast with the straight, geometrical forms and become a focal element.

Shapes are applied to interior spaces through any of the design approaches to create exciting environments. Today's designers are shaping internal space with a new freedom by redefining the concept of stability and repose previously linked to the square, triangle, and circle. Some common qualities attributed to these shapes are listed in the following paragraphs. Remember, however, that these qualities are not absolute.

Based on their orientation, size, proportion, color, and placement within a space, rectilinear shapes can create different effects. Tall, rectilinear shapes usually convey a feeling of clarity, stability, and formality (Figure 4.32). If the longer side of a rectangular shape is horizontal, it can connote a restful feeling. However, if a rectangle, square, or cube is placed on end, it becomes a very dynamic shape (Figure 4.33).

Triangular shapes seem to imply direction as they reach toward a terminal peak and are very dynamic because of their nonperpendicular sides (Figure 4.34). Structurally, triangles are considered very stable because they cannot

FIGURE 4.33 This metal sculpture expresses a sense of instability by placing the cube on end.
CC-BY-SA-3.0/Corn Fed Chicks

be modified without bending or breaking one of the sides. This stability is apparent with the broad base of a triangle at the bottom, but if the apex of the triangle is reversed and at the bottom, the triangle becomes very unstable.

Curvilinear shapes tend to imply movement by creating a feeling of continuity, motion, and change. Curvilinear shapes and forms can be very pleasing, because they reflect nature and natural objects (Figure 4.35). Because of their continuous character, they tend to express unity. Compared to other shapes, circles or spheres also can enclose more space using the least amount of area and surface, making them very economical in design.

Texture

Texture refers to the visual or tactile characteristics of natural and man-made objects or materials. The terminology used to describe textural characteristics is associated with both sight and touch. Tactile or "actual" textures, such as bricks, sandpaper, or a wool carpet, can be physically felt and represent three-dimensional qualities. Visual textures, also called simulated or illusionary, can be smooth to touch but visually appear to have textural qualities similar to real ones (Figure 4.36).

A strong relationship exists between the tactile sense of touching and the visual sense of seeing. People respond to seeing something by wanting to feel it. Textural qualities are further classified as soft or hard, rough or smooth, dull or shiny, dark or light (Figure 4.37).

Perception of texture can be influenced by the quality of light and how the form or surface reflects or absorbs the light. Because very rough textures tend to absorb light, they can create interesting contrasts of light and dark shadows. On the other hand, a very shiny, smooth surface will create design interest with the amount of light it reflects (Figure 4.38). The use of concentrated light and shadows can emphasize texture. Diffused light, such as that produced by overhead fluorescent lamps, tends to soften textural qualities.

Variation in texture can contribute to physical and emotional comfort in our surroundings. Smooth textures generally seem "cold" when they dominate a space, whereas rough textures, associated with plush fabrics and carpeting, uneven wall surfaces, and live plants, can create a sense of warmth. Contrasting of textures can allow the eye and

FIGURE 4.34 The triangular shapes in the Air Force Academy Chapel, Colorado Springs, Colorado, exhibit very dynamic shapes and contrasting angles. It emphasizes stability by its broad base as its apexes point upward.
Carol M. Highsmith's America, Library of Congress, Prints and Photographs Division.

hand to experience changing sensations. A space with smooth walls and floors, for example, might be furnished with a strong textural quality (carved wood), soft fabrics, and leafy plants for an interesting contrast.

The scale of texture is also an important factor. If it is used inappropriately, such as by placing large masonry blocks in a small, intimate space, a visually uncomfortable space will result. An environment with too many and overly powerful textures, used without sensitivity to the contribution of each, may contribute to this disturbing feeling also.

FIGURE 4.35 The cutaway of this chambered nautilus shell shows how it is composed of curved shapes that form a visually flowing natural design.
CC-BY-SA-3.0/Chris 73

FIGURE 4.36 The illusionistic shapes and textures are painted on this coffered ceiling and arched wall opening. The surfaces are smooth—the forms and textures are artificial.
Courtesy of Brett A. Moore

FIGURE 4.37 The rough stone texture on this fireplace contrasts with the smooth windows, walls, and ceiling finishes.

FIGURE 4.38 The shiny, smooth surfaces in this marble floor in the Haworth Showroom in Calgary, Canada, reflect light and other elements, creating a variety of interest and sparkle.
Photo Courtesy of Haworth, Inc.

Acoustical control is another important quality of textural surfaces. Smooth, hard surfaces will reflect and magnify sound, whereas soft, uneven, rough surfaces will absorb it. These characteristics are particularly important in planning commercial environments, where sound control must be a strong consideration.

Patterns of texture can be produced by "repetitive forms," such as wood flooring, wall siding, floor tiles, bricks, plant leaves, or woven fabrics. The overall texture created by the repeated shapes causes more emphasis than does the individual object.

Two-dimensional patterns are also used to simulate the visual effect of actual three-dimensional texture. Examples include paint, plastic laminates, wallpaper, and marbleized tile (Figure 4.39).

The integrity of materials is directly related to the quality of textures and how they are used. Most people appreciate the natural quality of wood, its texture, and its pattern. This quality can be brought out through using finishing processes that emphasize the wood rather than high-gloss finishes that overcoat or hide the material. Exposing ordinary materials, such as the old brick of many buildings being renovated and rehabilitated, can give much visual delight (Figure 4.40).

No matter how aesthetically pleasing, exciting, or honest a particular texture might be, it must be appropriate to the use of the space, since maintenance of the finish can be a problem. A high-traffic area, such as a building lobby, would not be an appropriate place for a deep, textural pile carpet that would wear out very quickly. Sometimes, also, maintenance and building codes limit the choice of materials and textures that can be used.

Time

In the section "Time-Space Perception," earlier in this chapter, the close relationship between time and space was discussed. Moving through space at various time intervals produces varying impressions of the space.

FIGURE 4.39 The patterns and texture on this column are "faux marble" as created with paint by Brett Moore of Restoration Paintwerks.
Courtesy of Brett A. Moore

FIGURE 4.40 A new atrium was created between the upper floors of this historic old building for the headquarters of The Christman Company, which was the world's first building to receive triple Platinum LEED certification.

Photo courtesy of The Christman Company and Gene Meadows, Photographer

FIGURE 4.41 The untreated wood siding in the Sea Ranch buildings (1960s) were intentionally left to age and develop a distinct natural weathered look over time.

CC-BY-SA-3.0/Sanfranman59

The elements of design discussed previously have been expressed as two- and three-dimensional concepts—that is, as fixed design entities. However, they are not fixed in existence, since time will have a marked influence on their ability to withstand nature's forces, such as the way rain and extreme cold affect the texture of a brick or adobe wall over many years. Colors will fade, textures may erode, forms will evolve, and shapes may change, yet some of these occurrences can be planned for. For example, some exterior woods will eventually be bleached by the sun to a soft, silver or gray patina (Figure 4.41).

Time is the fourth-dimensional design element that designers should plan for with their ideas and proposals. They should be aware of what time might physically do to the project, and should even consider how people's attitudes and impressions may change with time.

THE PRINCIPLES OF DESIGN

The scientific world speaks of the elements of matter that in turn compose larger or holistic forms. In design, as previously mentioned, we also speak of the elements or basic components and how they in turn are applied through the use of the principles of design (see Figure 4.12). However, we may find that many designs do not follow these specific categories exactly. They seem to violate or intermix the principles but still produce pleasing or strong, exciting characteristics. The experienced designer understands the principles of design, yet can go beyond the basic rules (or principles), break those rules, and create successful interiors.

Balance

From childhood, when we learned to stand upright, walk, and ride a bicycle, we were aware of balance and its importance. This is *physical* balance, and it relies on natural principles of gravity and equilibrium. Our inner-ear functions allow us to perceive unstable balances and attempt to counteract them.

The designer speaks of *visual* balance, which is often related to the apparent perceived relative weights of objects in architecture and interiors. These relationships are determined by the psychological impact they make on the individual experiencing them. Balance does not always reflect a state of repose; it can be in an ever-changing state of equilibrium, seeking to counteract instability. Referring to physical balance again, one example is the minor weight shifting we use to overcome the forces of gravity while riding a bicycle. The same principle holds true when the visual or apparent balance of a room changes as a person moves through it. It is important to note that a magazine photograph of a "balanced" interior might not have the same effect if a person could move into the space and view it from another angle. These movements in space can be anticipated and taken into account in the designer's overall scheme.

The discussion that follows concerns the three basic types of balance: symmetrical, asymmetrical, and radial.

Symmetrical Balance

Symmetrical or bilateral balance refers to the arrangement of objects that seem to have an imaginary mirror placed along a central axis that bisects the form and presents each half as a mirror image of the other. In nature, the human body, various plants, and animals exhibit these forms. This type of balance is the one that designers most readily perceive and most frequently use—perhaps because it appears naturally in our environment. Symmetrical compositions of spaces, objects, and furniture, as seen in Figure 4.42, appear to most viewers as stable, static, and dignified. Many buildings, particularly historic buildings designed in the "classical style," with entry doors placed directly in the center of the facade and windows set equidistant on either side (Figure 4.43), exhibit symmetry. Historically, the classic periods in architecture produced many symmetrical buildings and interiors that created formal, stately impressions. It seems that people desire symmetry in their environments; however, too much formal symmetry can result in dull, static arrangements.

Asymmetrical Balance

In asymmetrical balance (sometimes called informal balance), the visual arrangements or weights are neither identical mirror images nor equivalent images, but they do tend to stabilize one another. Two unequal people (a small child and an adult) on a seesaw are an example of arranging the locations of the objects (people) to balance in physical equilibrium. In design, brightly colored objects can visually balance the use of a dull color, and a large object can be balanced by a grouping of smaller objects (Figure 4.44). Often, asymmetrical balance is perceived to be more active, exciting, vigorous, and informal than symmetrical balance.

FIGURE 4.42 The entrance hall of the Rudolfinum in Prague is designed in a symmetrical composition of form and space.
CC-BY-SA-3.0/Wintermute314

Radial Balance

Radial balance is similar to symmetrical balance but has a central point, or core, from which elements extend outward, or radiate. Radial balance can also seem to exhibit circular, expanding movement. A wagon wheel, rose windows in churches, a daisy, or the planets revolving about the sun are forms of radial balance. However, if we removed a petal from the daisy or a spoke from the wagon wheel, the radial balance would seem incomplete or unbalanced. We see radial examples in interiors (Figure 4.45), furniture arrangements, and circular objects, such as lighting fixtures, plates, and even flower arrangements.

FIGURE 4.43 The Andrew-Safford House in Salem, Massachusetts (1819), was styled in the Federal style, which exhibits a symmetrically balanced facade, typical of many historic buildings.
CC-BY-SA-3.0/Fletcher6

FIGURE 4.44 In this example of asymmetrical balance, an imaginary axis is drawn through the center of the fireplace along the coffee table, which illustrates that the sofa on the right is balanced on the left with two chairs of a stronger color.
Courtesy of Kohler Co.

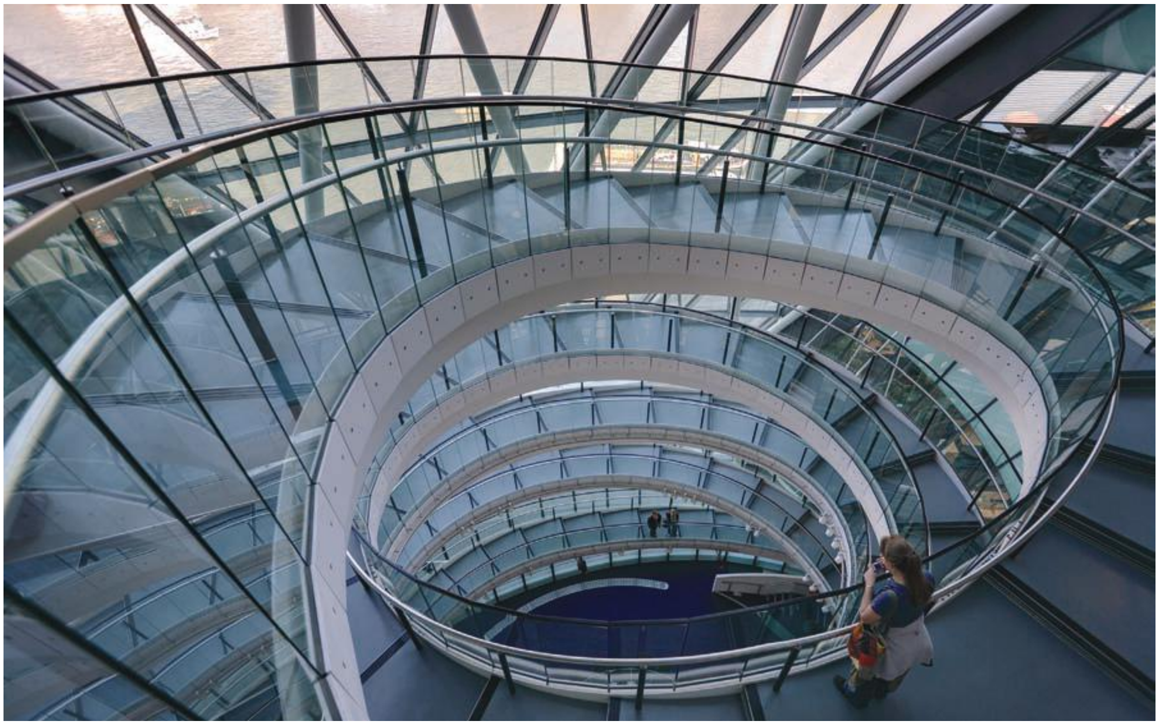


FIGURE 4.45 The interior helical staircase in London City Hall radiates around a central core in this spherical building.
CC-BY-SA-3.0/David Iliff

FIGURE 4.46 The panels for these teller windows create rhythm by their structured, organized placement.
© Skidmore, Owings & Merrill LLP

Balance can be expanded to include more than just the physical arrangement or shapes of objects. Specifically, we can speak of-balance in the elements of design, such as balance of texture, color, line, and space. Balance can also be a fluid relationship, such as that of dancers moving in space as well as through time, complementing one another and the essence of their movements in the routine.

Rhythm

Rhythm can be thought of as organized movement, regular intervals, or recurrence, such as the pattern of a heartbeat or of water dripping from a faucet. Visually, it can be seen in the repetitive use of brick forms in a wall, columns in a Greek temple, or repeated forms of leaves in a tree. Rhythm can be accomplished through repetition, alternation, and progression.

Repetition

In repetition—the most basic pattern of rhythm—elements or concepts are repeated in a structured, organized manner. In interiors, this repetition can also be utilized to carry the eye throughout the space by repeating simple forms, textures, or colors (Figure 4.46).

Alternation

Alternation of rhythm can create a slightly more complex system of design by alternately changing the elements of the design. Fabric with a pinstriped pattern creates an alternating rhythm, as do more naturalistic alternations such as the zebra's black and white stripes (Figure 4.47).

Progression

Progression of rhythm suggests movement and draws the eye into directional sequences. Examples include the rhythmic progression of a series of light colors to dark colors or of small objects to large objects and the progression of patterns in various wallpaper designs (Figure 4.48).

FIGURE 4.47 The tiles used in this bathroom are an example of alternation of rhythm, as they are three different sizes, as well as different masonry coursing, which creates a unified and rhythmic design.

National Kitchen and Bath Association

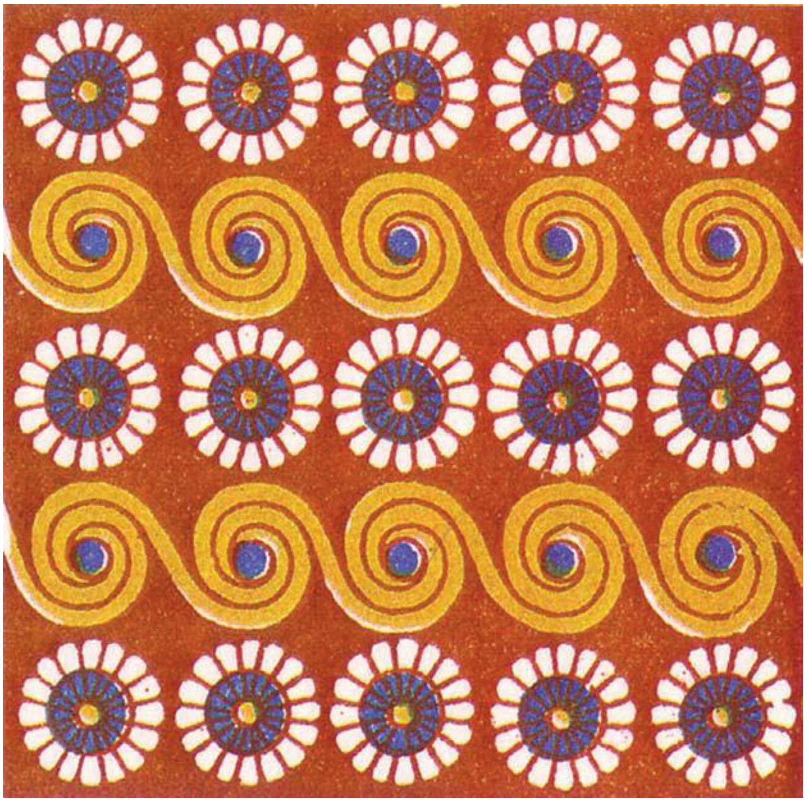


FIGURE 4.48 The interconnected progression of spiral forms in this Egyptian design leads the eye in a rhythmic direction.

PD-User: Owen Jones

Emphasis

Emphasis is employed as a design principle when certain elements are accented more than others, creating a relationship of dominance and subordination. Emphasis gives a variety and character to interiors by creating focal points and centers of interest through dominant and subordinate use of forms, colors, textures, and lines (Figure 4.49).

The dominant forms have the greatest impact or importance; the subdominants are secondary and complement the former. Yet all are visually necessary, and each should be visually strong and exciting in itself as a part of the design concept.

In interiors, designers might use important features, such as a fireplace, a large bookcase, a picture window, or even a plant, as the point of emphasis or center of interest in a space. The emphasized element should be carefully selected and balanced by or contrasted with other elements.

Proportion

Proportion as a principle of design is often closely associated with scale, because both express concepts of relative size and magnitude. Proportion is defined as the relationship of the parts to one another or to the whole, whereas scale refers to the size of a thing in relation or comparison to other things. We often speak of scale as related to the human body, in architecture and interior terms, whereas proportion is thought of as the relationship of parts contained within the object. Scale is the relationship in size of the object and a scalar unit of measure outside the object.

Proportion can be expressed as matters of width in relation to length, with which designers seek to balance or relate the parts to one another, to create an aesthetic composition. The Greeks set down some of the basic principles of proportion when they devised the "golden section" axiom. The system they derived sought to set down pleasing proportions in architecture and sculpture (Figure 4.50). The progression of numbers 1, 2, 3, 5, 8, 13, 21, 34 . . . demonstrates the relationship of the "golden section," in which each number is the sum of the two preceding ones. Designers have applied this progression to produce pleasing results.

The Greeks also developed the "golden rectangle," with its sides as a ratio of two parts to three. The golden rectangle represents the division of a form or line in which the relation of the side of the smaller portion to the larger is identical

FIGURE 4.49 The large treelike columns and the curved beams they support in the terminal at Barajas Airport (Madrid, Spain) provide an emphasis in color and form to the space.
CC-BY-SA-2.0/David Dennis

to that of the side of the larger part to the whole. The "golden mean" represents the division of a line between one-third and one-half of its length, which produces a more pleasing proportion than an exact division of the line.

In more modern times, other designers and architects have developed their own theories of proportion for designing buildings and objects. Le Corbusier (discussed in Chapter 3) created proportions based on the human body's dimensions, such as height and arm reach. He developed his proportional theory in 1948 and termed it *Modulor.* The system seeks to establish a system for controlling dimensions and their relationships to one another. He used this theory in the design of a number of his buildings at that time.

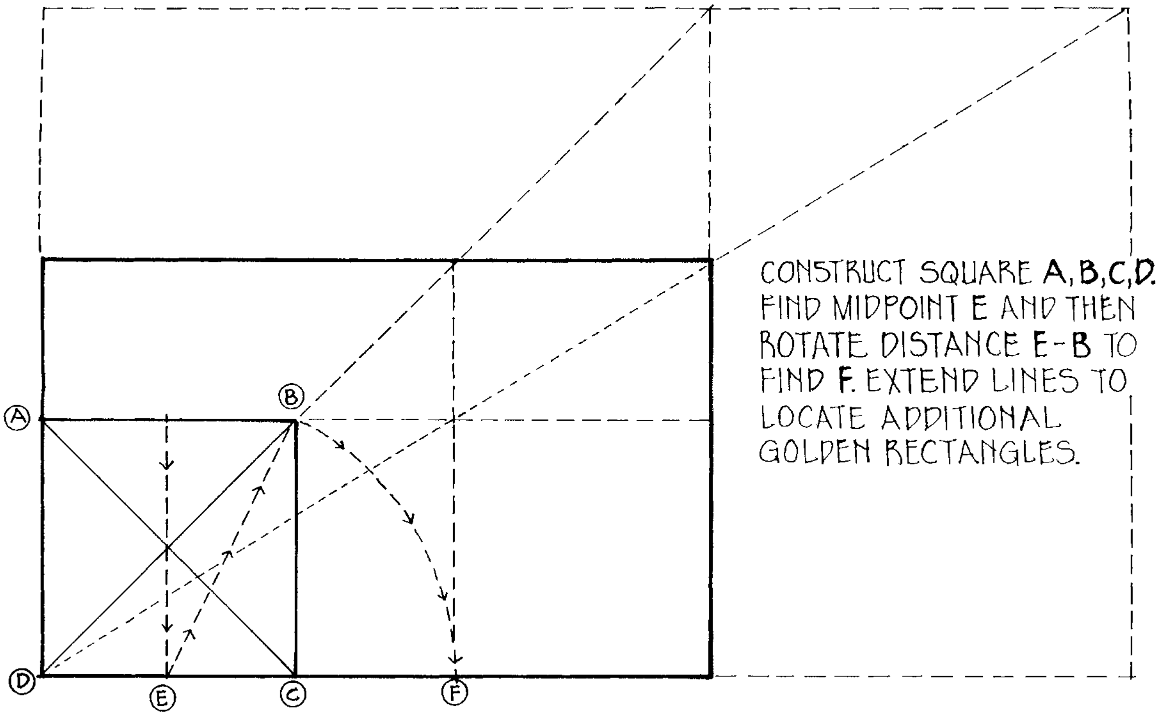
Scale

We have discussed the fact that scale is usually closely related to proportion, except that scale is primarily viewed as a relative standard or measure outside of an object and related to some constant unit. In architecture and interior design, when we speak of scale, we are comparing the size of an object or an environment to man (Figure 4.51). For example, the ancient pyramids are of such a gigantic scale that man appears to be a small insect when compared in size to them. If we doubled the size of one of the pyramids and kept its proportions the same, it would be unchanged, except for being much larger. However, if we compared it to man, it would be doubled in scale.

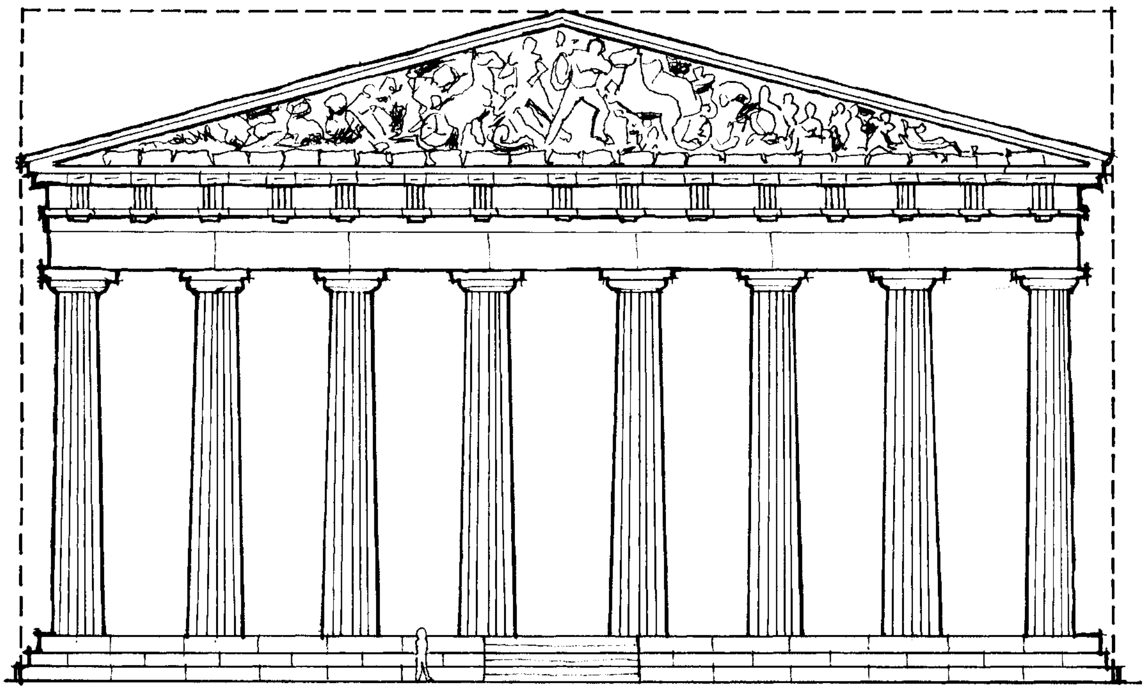
Scale can refer to small or diminutive, as well as to large or grand, size. Models of objects, interiors, or buildings are usually made small in scale. However, most model makers will establish a unit of relative measure (man) by placing appropriately scaled figures, cars, or other readily perceived objects in or on the model, for scale unit measure. In turn, we can relate to the scale of the model.

Unity and Harmony

Unity is primarily defined as oneness, or the state of being one. It also refers to the totality of the related parts. As designers, we often look for compositions, objects, or spaces that have unifying elements because they appear



ONE METHOD OF DERIVING THE GOLDEN SECTION AND RECTANGLE.



THE FACADE OF THE PARTHENON AT ATHENS (447–432 B.C.)
FITS ALMOST EXACTLY IN THE GOLDEN RECTANGLE.

FIGURE 4.50 The Greeks developed some of the basic principles of proportion. They proposed the golden section, the golden rectangle, and the golden mean.

FIGURE 4.51 The very large scale of the Taj Mahal in India (1632–1653) is evident when people are placed in the environment. *CC-BY-SA-1.2/Muhammad Mahdi Karim*

less chaotic or haphazard to us. Unity is all around us in the natural world. For instance, people look different as individuals, but as human beings, they represent a unity of composition and form.

Unity is established in designed compositions in many ways. One of the most fundamental approaches is the use of repetition in shape, form, pattern, or texture (Figure 4.52). Color also can be used to mold seemingly different objects or spaces into a unified whole. In fact, it is difficult to speak of unity and variety without discussing them

FIGURE 4.52 The geometrical repetition of form, line, texture, and pattern in the Unity Temple by Frank Lloyd Wright gives the interiors a sense of unity and order.

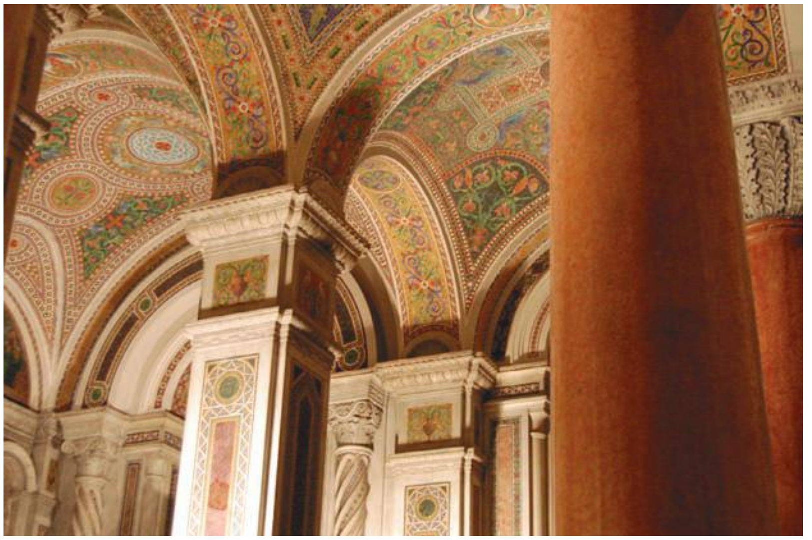


FIGURE 4.53 Louis Comfort Tiffany created a variety of surface textures, colors, and forms in the All Saints Chapel in the Cathedral Basilica of St. Louis.
CC-BY-SA-2.5/Andrew Balet

in terms of harmony. Harmony results from a composition fitting together, from a correct combination and balance of unity and variety, and it provides a sense of belonging, consonance, or oneness. It is the basic principle that holds the components of a design together, in a harmonious relationship, but that design could become dull or monotonous without a sense of variety.

Variety

Variety abounds throughout our natural and man-made environments. Designers use interesting things that capture our attention—by their uniqueness or simply by being different—to create excitement and interest in otherwise static, dull compositions (Figure 4.53). However, variety should be combined with some degree of unity or harmony, because it can create discord if used to excess.

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5

Color and Light

After the design element of space, color and light are probably two of an interior designer's most powerful design tools. Color and light can alter the use and perception of a space, since they can be manipulated for effect or emotion. Color can be used to define form and give a sense of scale rather than merely provide a background. Color is an integral part of the world around us. Color can be used to create an illusion or to emphasize a dramatic architectural form. Color cannot be explained as just a scientific theory, an art, or an emotional reaction to our environment, because it is an integral part of all of these. The need for color is often a reaction to an otherwise drab world.

Writings on color theories first appeared around the 1400s, and the subject was further developed in 1704 by Isaac Newton. As we shall see later in the chapter, there have been more developments on color theory since those early experiments to define exactly what color is, how to create it, and how to apply it.

Color is usually associated with commonplace physical objects, such as brightly colored flowers, multicolored leaves in autumn, the sky at sunset, or a painting. In design, color is generally thought of in terms of objects and surfaces, such as walls, carpets, cars, and buildings. Color affects, and is crucial to the success of, the design of an environment (Figure 5.1). Color is a mood-setting and emotion-producing tool. Putting together a color scheme for an interior design project is a very pleasurable and rewarding aspect of design work. Working with color is a science as well as an art. Developing skill in using colors begins with the study of color systems, which are based on the scientific principles of light and color.

Color is not a physical part of objects we see, but rather is the effect of light waves bouncing off or passing through the objects. In fact, if there were no light, there would be no color. Therefore, light and color are inseparable. For a designer to use color, it is important to know first how light affects color. We perceive colors because of the way light strikes objects and the way our brains translate the messages our eyes receive (Figure 5.2). Other factors that determine how we perceive the color of a given object are the light source under which it is examined, the material the object is made of, and the physical condition of the viewer's eyes.

LIGHT SOURCES

Light is a form of radiant energy that exists in the shape of repeating wave patterns emanating from a source in straight paths and in all directions. An example of this radiant energy is the sun and its projecting rays. Light is considered to be a radiant energy wave and a part of our larger wave spectrum, referred to as the *electromagnetic spectrum* (Figure 5.3). Figure 5.3 shows that the visible spectrum, which is responsible for color, is a very small part of the overall spectrum of radiant, electromagnetic energy. The eye distinguishes different wavelengths of this radiant energy and interprets them as different colors. The longest wavelength in the visible spectrum is red,

FIGURE 5.1 Color makes a strong design statement in this neutral-colored showroom interior.
Courtesy of Knoll, Inc.; © Paul Warchol

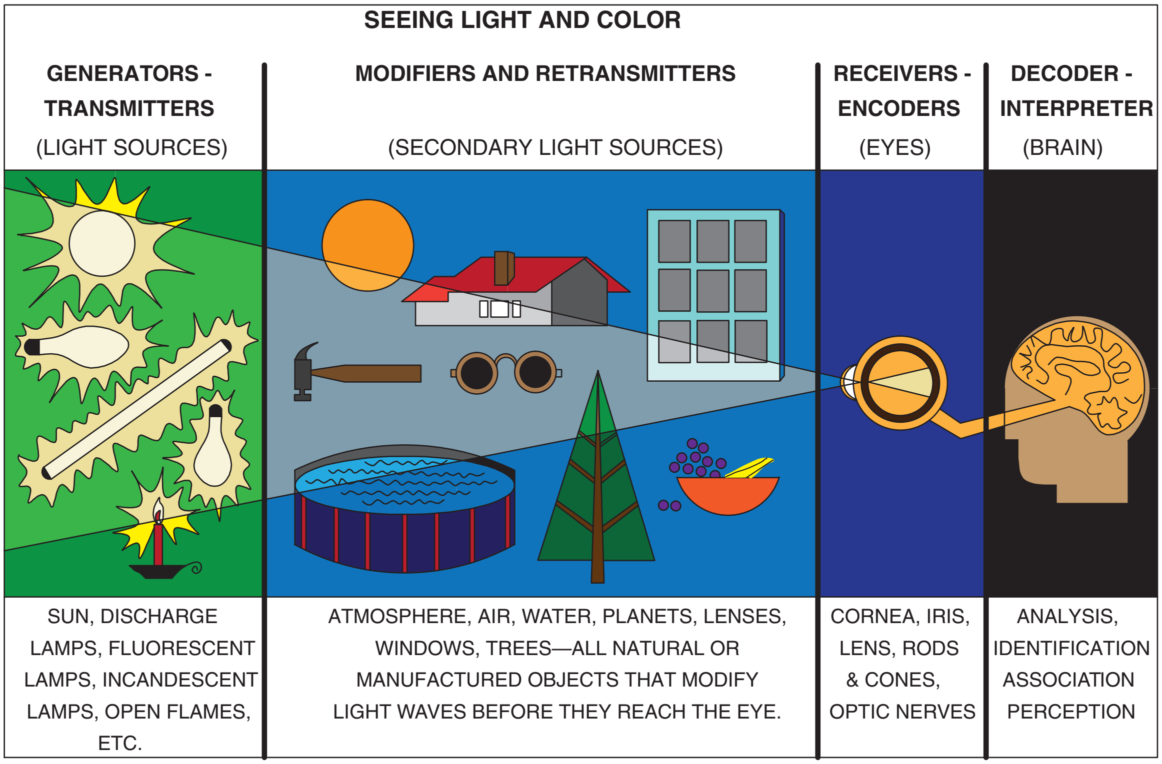

FIGURE 5.2 Light and color perception are influenced by the many variables and factors categorized under one of the four columns in this illustration.

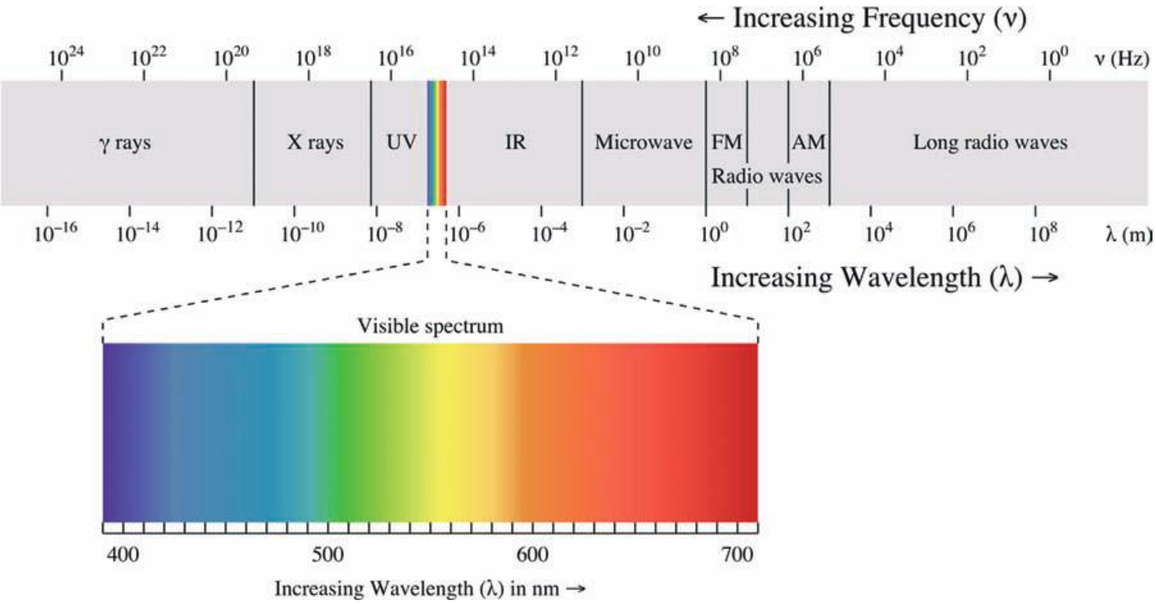

FIGURE 5.3 The human eye responds to that very small portion of the electromagnetic spectrum known as the visible spectrum. However, it does not respond uniformly, as it senses the yellow-green region as the brightest and the red and blue regions as the darkest.

followed in descending order by orange, yellow, green, blue, indigo, and violet, the shortest visible wavelength. Wavelengths are measured in nanometers, each one-millionth of a millimeter, and range from 380 to 760 nanometers. Wavelengths shorter or longer than this range, such as ultraviolet and infrared light, do not stimulate the receptors in our eyes; hence we cannot see them.

In the 1600s, Sir Isaac Newton (1642–1727) demonstrated that color is a natural part of sunlight or white light. When he passed a beam of sunlight through a prism of transparent material, he found that as the light emerged from the prism it dispersed, separating the individual wavelengths into different colors. These colors arranged themselves according to the colors of a rainbow: red, orange, yellow, green, blue, indigo, and violet (Figure 5.4). Newton carried his experiment one step further by utilizing a second prism to mix the waves back into sunlight. This verified the fact that color is basically made up of light and that when "colored" lights are mixed, the result is white light.

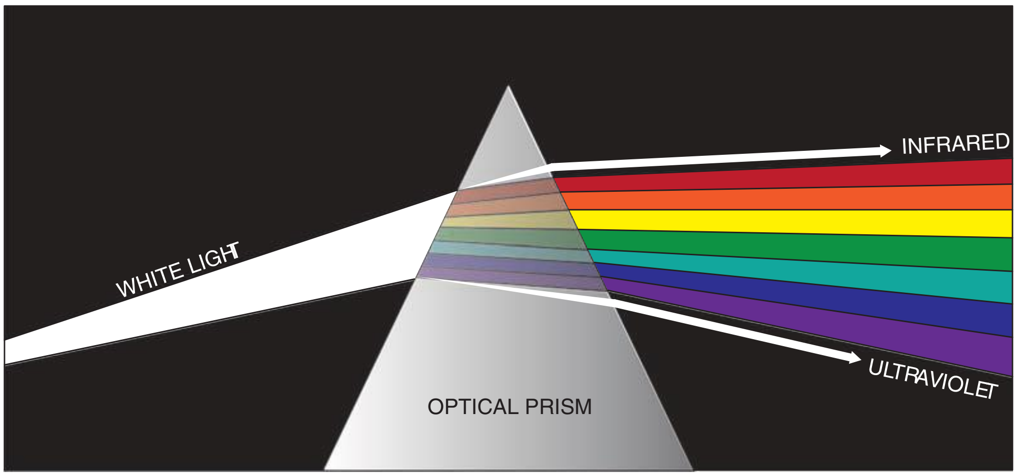

FIGURE 5.4 The effect of passing rays of white light through a prism is to bend the shorter wavelengths more than the longer wavelengths, thus separating them into distinctly identifiable bands of color.

When a light source emits energy in relatively equal quantities over the entire visible spectrum, as in the case of the sun or a bright light bulb, the combination of the colored light will appear white to the human eye. However, if a light source emits energy over only a small section of the spectrum, it will produce that corresponding colored light. Examples can be seen in our electric light sources, such as the high-intensity discharge mercury lamp that produces a blue-green light or the deep yellow low-pressure sodium lamp.

MODIFIERS OF LIGHT

Indeed, color cannot exist without light, because colors are actually other names for various mixtures of radiant, electromagnetic energy. But how then do we explain colors in actual objects? The colors that we see in objects are the result of light waves that reach the eye after the object has selectively absorbed some of the wavelengths and either reflected or transmitted the others. In other words, the color, or pigmentation, of an object absorbs all colors of light except its own color, which is either reflected or transmitted to the eye. For example, if white light falls on a red surface, that surface will absorb all the wavelengths except the red ones, which are reflected back to the eye, allowing us to perceive the color red, as illustrated in Figure 5.5.

Similarly, if a white light is passed through a transparent surface, such as a piece of green glass, the transmitted wavelengths will appear green because the other wavelengths have been absorbed. An object or surface will appear black when light is totally absorbed.

The material or texture of an object will also influence how much light is absorbed, reflected, or transmitted. When light falls on an unpolished (diffuse) surface, light waves are reflected in all directions (Figure 5.6) because of the overall even surface. Smooth, shiny surfaces reflect more light, and dull or matte surfaces absorb most of the light waves, thus modifying the visual appearance.

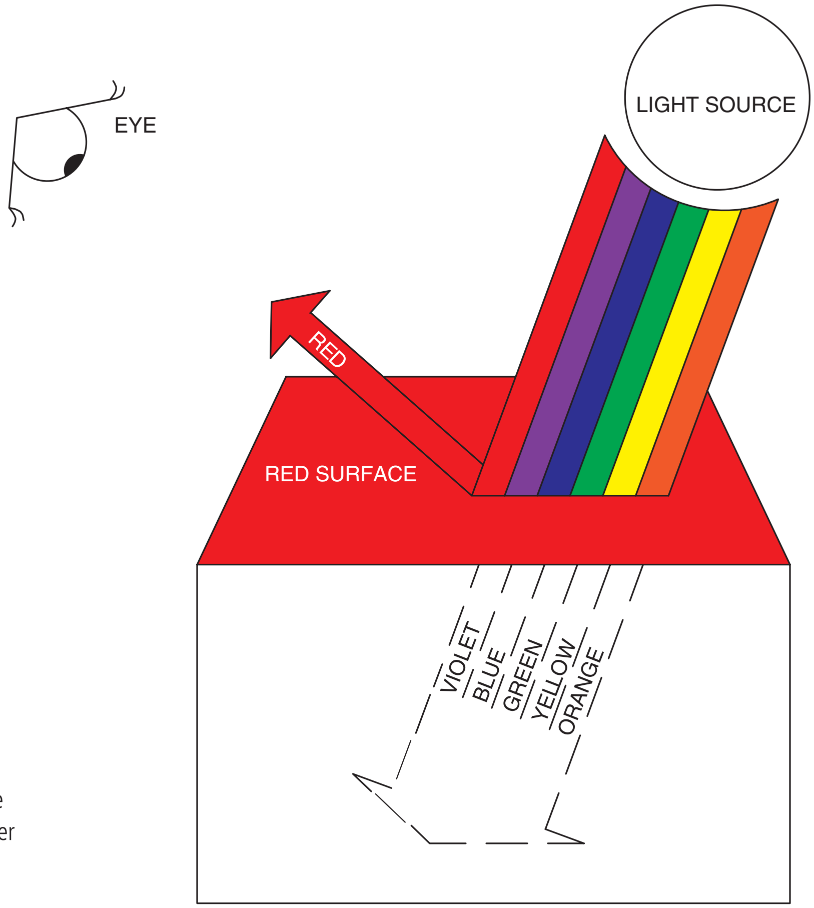

FIGURE 5.5 Only red light waves are reflected back to the eye after all other wavelengths are absorbed by the red surface.

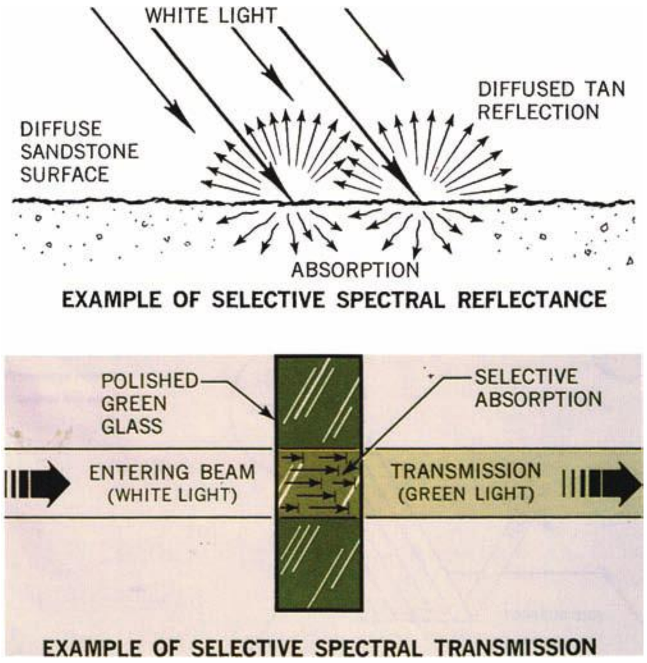

FIGURE 5.6 Selective spectral reflectance occurs when light falls on matte or diffuse surfaces such as sandstone (a). Spectral transmission occurs when a light falls on a transparent surface or object.

HUMAN VISION AND PERCEPTION

Because light and color are related to vision, it is necessary to understand how the human eye works. The human eye is a delicate and complex instrument that functions in many ways like a camera. Both the eye and the camera have a light-sensitive plane on which a lens focuses an image; in the eye this plane is the retina, and in the camera it is the film. In each, the amount of light entering the lens can be controlled by the iris in the eye and by the diaphragm in the camera (Figure 5.7).

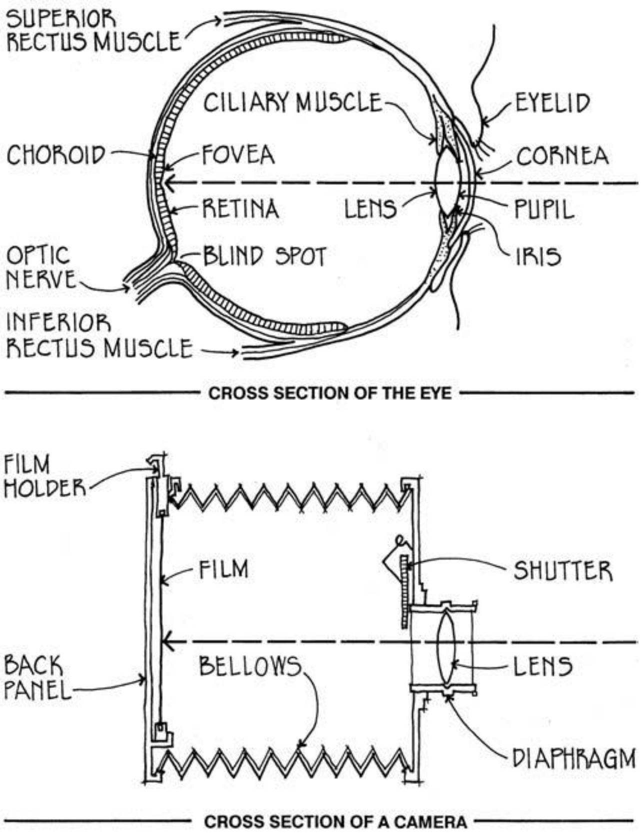

FIGURE 5.7 Comparison of a human eye to a camera.

For light to be visible, it enters the eye through the pupil, whose size is controlled by the iris. The pupil expands or contracts in response to the stimulus of the optic nerve to control the amount of light entering. The light then passes through the lens and focuses to form an image on the retina. The optic nerve then transmits the visual message by electric impulses to the brain to create the mental picture we see. The image perceived is dependent on the central portion of the eye, which is located near the fovea and contains light-sensitive cells called cones because of their shape. These cones are responsible for the ability to see color and to discriminate fine detail. There are three kinds of cones in our eyes, each of which is sensitive to a certain wavelength area. The peaks of the three spectral sensitivity curves in Figure 5.8 correspond to the spectrum's short, middle, and long wavelength areas, which respectively give us the color sensations blue, green, and red. Cones discriminate detail primarily because they are connected to their own nerve ends. The muscles allow the eyeball to rotate until the image is focused and falls on the fovea. Cone vision is referred to as photopic, or daytime, vision.

The rod, a second type of cell within the eye structure, is also named after its shape. These cells are extremely sensitive to low levels of light, enabling the eye to see at night or under extremely low lighting conditions. However, rods lack color sensitivity, which accounts for the fact that in very dim light (rod vision), we have no color perception. Also, since several rods are connected to a single nerve end that provides a general picture of the field of view, rod cells cannot discriminate fine detail. Rod vision is referred to as scotopic, or night, vision.

As the eye focuses on individual objects, what it actually sees depends on the quantity and quality of light available. As light bounces off objects and is reflected back to the eye, variations in brightness, color, size, shape, distance, and texture are recorded on the retina and then translated into a picture that we learn to understand as the appearance of whatever we are viewing. Human vision and the perception of color and light vary widely according to factors such as aging, experience, and behavioral perceptions. These concerns are addressed in Chapter 12 under "Lighting Needs and Application."

COLOR THEORY AND SYSTEMS

To understand the effects, relationships, and applications of color, it is helpful to organize color into a systematic classification or theory. Before any of the color systems can be described, however, it is essential to understand the relationship between the primary colors of light and the primary colors of pigments, and how these are mixed to produce other colors.

Additive Method of Mixing Light

The first method of mixing light is called the RGB color model and is an additive process (Figure 5.9) dealing with light. The three primary colors of light are red, green, and blue (RGB). When two of these are added together, they produce secondary colors of light-magenta (red plus blue), cyan (blue plus green), and yellow (green plus red). If

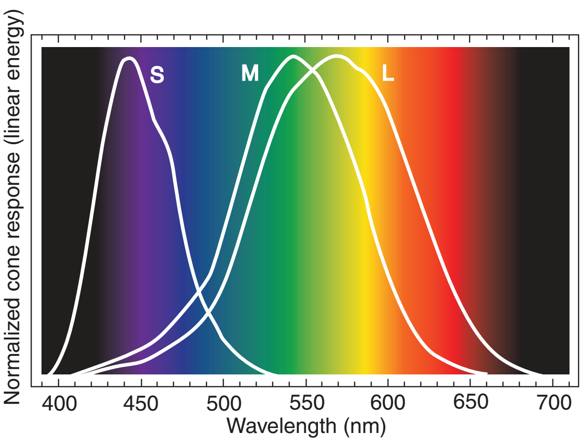

FIGURE 5.8 The relative sensitivities of the cone mechanisms within the eye correspond to the blue, green, and red wavelength areas of the visible spectrum. The sensitivities of the three receptor peaks are not necessarily equal, as the eye perceives the yellow-green region as the brightest.

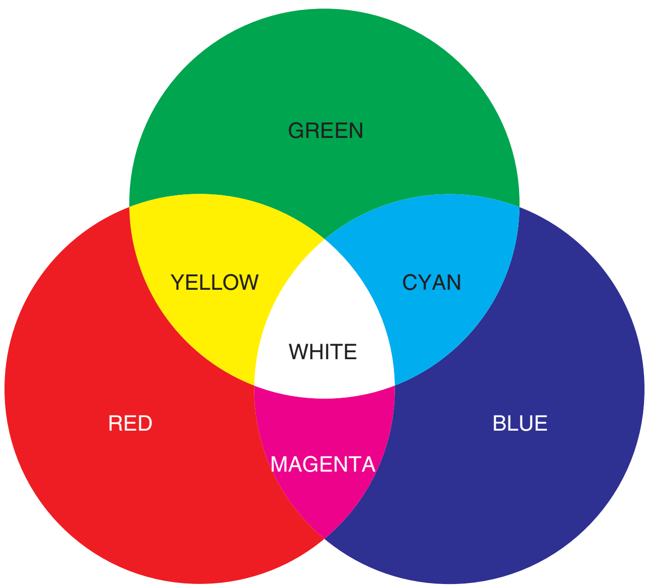

FIGURE 5.9 Additive mixtures of the primary colors of light.

a secondary color of light is mixed with its opposite primary, white light will be produced. For example, a mixture of cyan and red light will result in white light. Thus, cyan and red are complementary colors of light. Other complementary colors of light are yellow and blue, and magenta and green. When all three colors are overlapped, white light is produced from the three additive primaries. This process of mixing light consists of adding "energy" on top of "energy," thus creating lighter colors.

The main purpose of the RGB color model is for the representation of colored images in electronic systems, such as televisions, computers, cell phones, and video projectors. The mixing of colored light is also used in theaters for stage lighting. However, it has also been used in some interior spaces, such as retail and restaurant environments, to create similar stage effects. Care should be taken in the use of colored lights, especially where color selections are important, because these lights can distort real color and cause eye fatigue or irritation.

Subtractive Method of Mixing Light

The other method of mixing color through light is a subtractive process and is related to pigments (Figure 5.10). Pigments are materials that change the color of transmitted or reflected light as a result of selective absorption. That is, when light hits a pigment surface it only reflects some wavelengths, thus producing the appearance of a color to our eye. The other wavelengths have been absorbed, or subtracted. For example, a blue pigment appears blue because it doesn't reflect red or green light. This method involves mixing transparent colorants, such as dyes, inks, stained glass, and water colors. In the subtractive method, the primary colors are magenta, yellow, and cyan (the secondary colors of light). When overlapped, magenta and yellow produce red, yellow and cyan produce green, and cyan and magenta produce blue. When the three subtractive primary colors are overlapped, all color is absorbed or subtracted from white light, producing black.

The CMYK (cyan, magenta, yellow, and black) color model is a subtractive model that is used in color printing. It is subtractive because inks, used in the printing process, subtract brightness from white. A majority of the world's printed material is produced by this method of color mixing.

Paint-Color Mixing

When dealing with opaque pigments, such as paint, the theories of mixing light do not apply. However, mixing paint colors is closely related to the subtractive method of mixing light. The color of an object or a material absorbs, or subtracts, all the colors of light except the color of the object, which is reflected to the eye. The three primary colors of opaque pigments are red, yellow, and blue. When two primaries are mixed—that is, yellow plus blue, red plus blue, and red plus yellow—they produce secondary colors of green, violet, and orange, respectively. When the three primaries are mixed, they produce black (Figure 5.11).

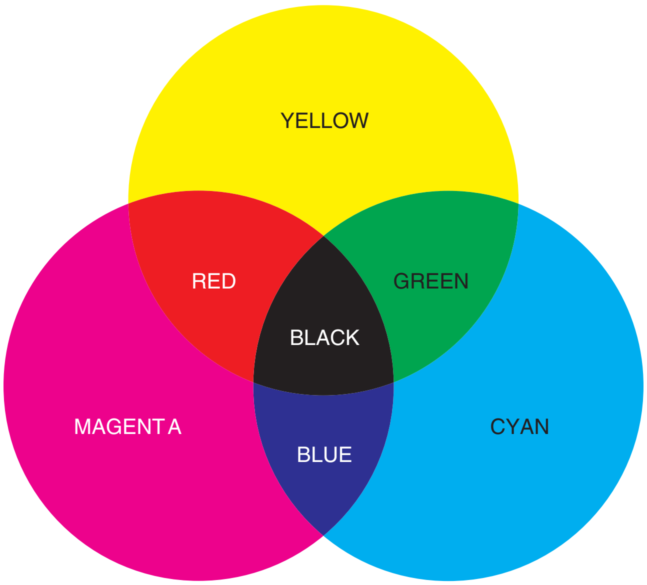

FIGURE 5.10 Subtractive mixtures of the secondary colors of light

FIGURE 5.11 Paint-mixing method of combining primary and secondary colors

Harald Küppers (1928–) recognized that the additive and subtractive mixtures of light did not apply to paint or opaque pigments and came up with a new law of mixtures called the "integrated mixture." In his book *Color: Origin, Systems, Uses*, published in 1972, Küppers identifies eight "integrated" primary colors: white, yellow, magenta, cyan, blue, green, red, and black. He feels that these are "pure" colors and cannot be produced by any other colors. His complete color system will be discussed later.

Color Properties

To describe a color with reasonable accuracy, three basic properties have been designated to identify the dimensions, or qualities, of color: hue, the name of a color; value, the lightness or darkness of a color; and intensity, or chroma, the degree of purity or strength of a color.

Hue

Hue is one of the primary properties of a color, its name, such as red, blue, or yellow, which is given to each color to distinguish it from the other colors. It refers to the color in its purest form—that is, with no blacks or whites added. The color (hue) is the function of light wavelengths as discernible by the human eye. For example, the color red generally lies within the light wavelengths of 630–748 nanometers (nm). Green would be found within 520–570 nm. See Figure 5.12 for all the visible colors and their related wavelengths.

Value

Value designates the darkness or lightness of a color. Figure 5.13 shows the values between black and white, that is, all the gray values in between. This gray scale of values can be broken down into perhaps more than 100 gradations. However, in most color systems, the gray scale is usually expressed in approximately nine steps, often called the achromatic scale. This means it is free of any color, consisting of only black and white.

Values can be expressed by shades, tints, and tones (Figure 5.14). Shades are produced by the addition of black to a color, which will darken the hue; tints are determined by how much white is added to a hue, which lightens the color; and tones are produced by adding gray to a hue.

Chroma

The chroma of a color is the purity, saturation, or amount of pigment it exhibits. Colors that exhibit a high degree of chroma are those that are not grayed, but rather are at their ultimate degree of vividness and seem more intense. Adding black or white to a color can lower its intensity, or vividness, making it more muted and closer to gray (Figure 5.15). Adding a complementary color can also lower the saturation of a color.

Color Systems

As Sir Isaac Newton continued his experiments with light and the color spectrum, he recognized that a relationship formed between each color and its adjacent color. By joining the end colors, red and violet, to form a circle, he found that the bands of color flowed together in a continuous spectrum. From these early experiments, the color circle, or color wheel, was developed and further refined into color systems. Several color systems have evolved since Newton's early experiments, each one based on a different group of basic, or primary, colors. We will look at some of the most commonly used systems.

12-Part Color System

The most familiar and simplest color system is based on the work of Johannes Wolfgang von Goethe (1749–1832). His color circle (Figure 5.16) was made up of the three primary colors of red, yellow, and blue and the three secondary colors of orange, green, and purple. Goethe's theory was expanded to the common 12-part color wheel (Figure 5.17), often credited to Herbert E. Ives, David Brewster, and Louis Prang. It is often referred to as the RYB color system or the "standard color wheel." This system is based on paint-color mixing properties and the belief that the three primary colors cannot be mixed from other colors or be broken down into component pigments.

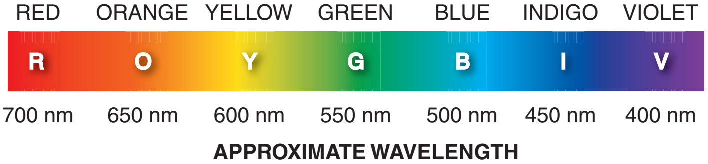

FIGURE 5.12 Colors of the visible light spectrum as arranged from the lowest to the highest energy. The order can be remembered using the mnemonic name "ROY G. BIV."

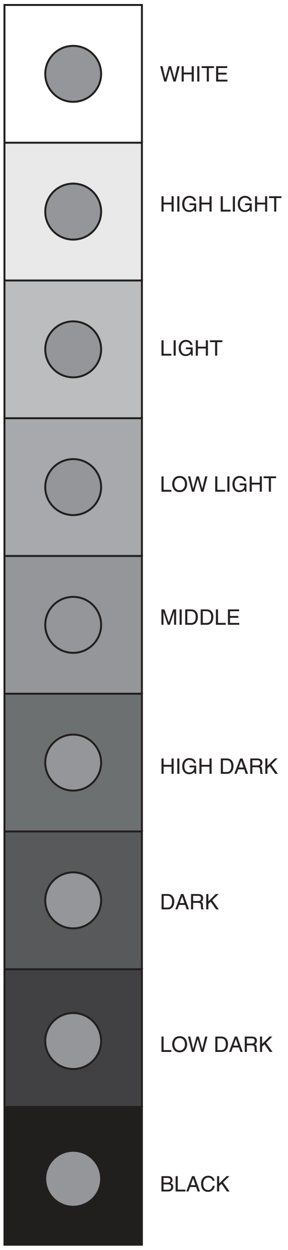

FIGURE 5.13 Seven graduations of a gray value scale between white and black. The dots (all of a middle value) appear darker against a light background and lighter against a dark one.

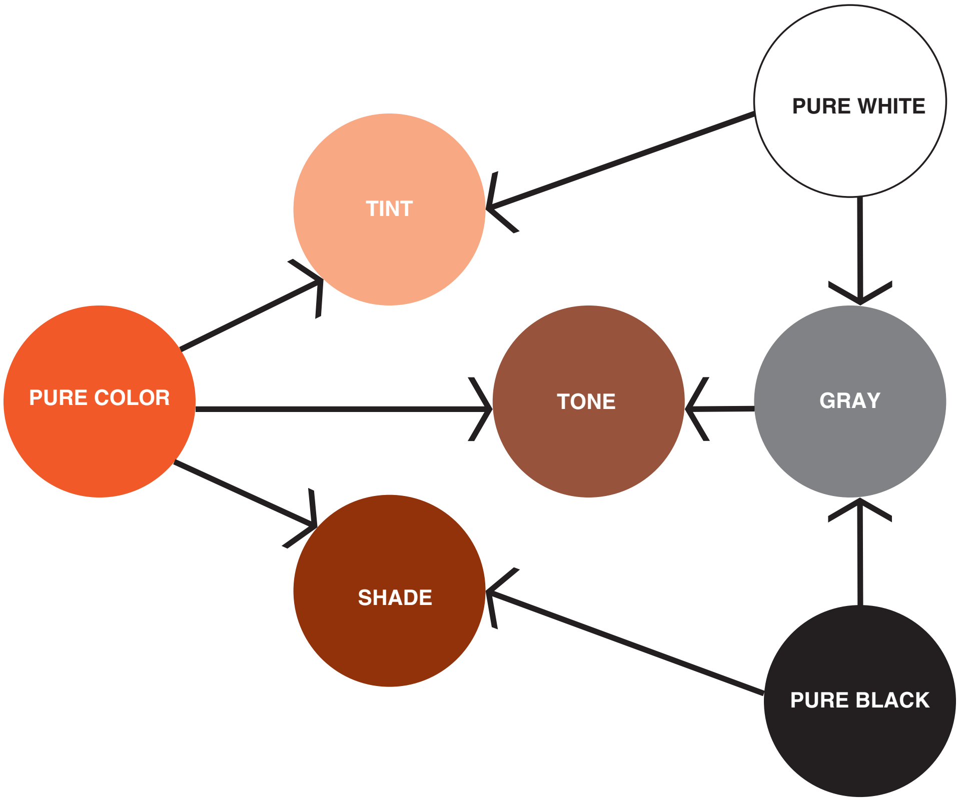

FIGURE 5.14 Tints, tones, and shades can be produced by adding white, gray, or black to a pure hue.

FIGURE 5.15 If black is added to an original hue, the chroma is decreased, and the color appears more muted and closer to black.

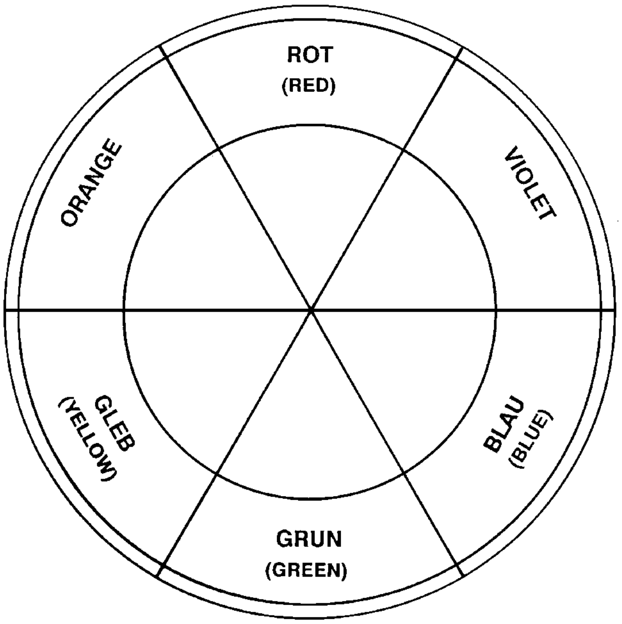

FIGURE 5.16 Goethe's color wheel of 1793 had six equal color designations.

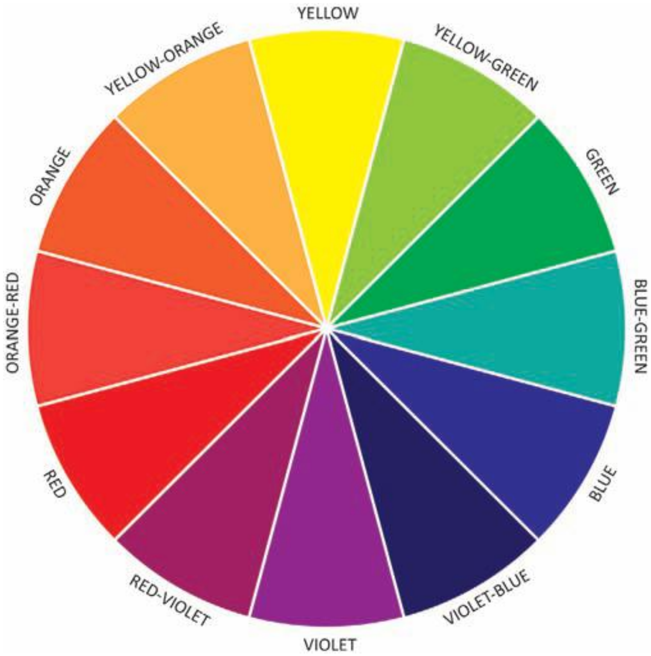

FIGURE 5.17 The traditional RYB color wheel is composed of the primary colors red, yellow, and blue. Secondary colors of orange, green, and violet are formed from these. Combining primary and secondary colors forms the tertiary colors.

Secondary colors are formed when two of the primary colors are mixed in equal parts: red and yellow mixed together will produce orange; yellow and blue will produce green; and blue and red will form violet. This process can be expanded by mixing equal parts of a primary color and a secondary color to create six tertiary, or intermediate, hues. These resulting colors are yellow-green, blue-green, blue-violet, red-violet, red-orange, and yellow-orange.

The 12-part color system may appear too simplistic or limited to some people, but it is only a beginning. An infinite number of variations can be produced by combining adjacent hues or varying the proportions of other added colors, as well as by adding black, white, and gray. Also, the visual quality of a color can be further modified by the effects of background colors and light, to be discussed later.

The Munsell Color System

One of the most widely used systems of color notation is the Munsell color system. It was developed, at the turn of the century, by Albert Munsell (1858–1918), an American artist and art teacher. His theory of color is based on five principal hues: red, yellow, green, blue, and purple, and five intermediate hues: yellow-red, green-yellow, blue-green, purple-blue, and red-purple (Figure 5.18) . Each of these principal and intermediate hues is then subdivided into 10 equal parts, totaling 100 different hue variations. These hue variations are designated by capital letters, such as R for red, Y for yellow, and YR for yellow-red, preceded by a number. Each principal and intermediate hue is designated by the number 5, which signifies that it is the "pure" color of that particular hue family. In addition to the part numbered 5, each hue family is divided into three other equal parts, designated by 2.5, 7.5, and 10. When these numbers are combined with the letters symbolizing a particular color, such as 2.5R, that combination designates the exact hue variation. For example, 2.5R indicates a color toward red-purple, whereas 7.5R is toward yellow-red. Further gradation refinement is then possible, to create the total 100 hue variations designated by the numbers on the outer circle.

This two-dimensional circle of hues is then extended into a three-dimensional form where "value" is the vertical axis (Figure 5.19). Munsell's value scale is divided into nine steps, ranging from 0 for black to 10 for white. Thus, a color can be identified according to its degree of lightness or darkness based on its position on the value scale.

The horizontal axis of Munsell's three-dimensional solid represents the chroma levels, or saturation possibilities, of each hue. The chroma levels extend from 0 for the neutral axis to 10 or more steps for the more vivid hues. As colors vary in saturation, some hues extend as far as 16, while others may only extend to 6, thus creating a solid that is not symmetrically balanced.

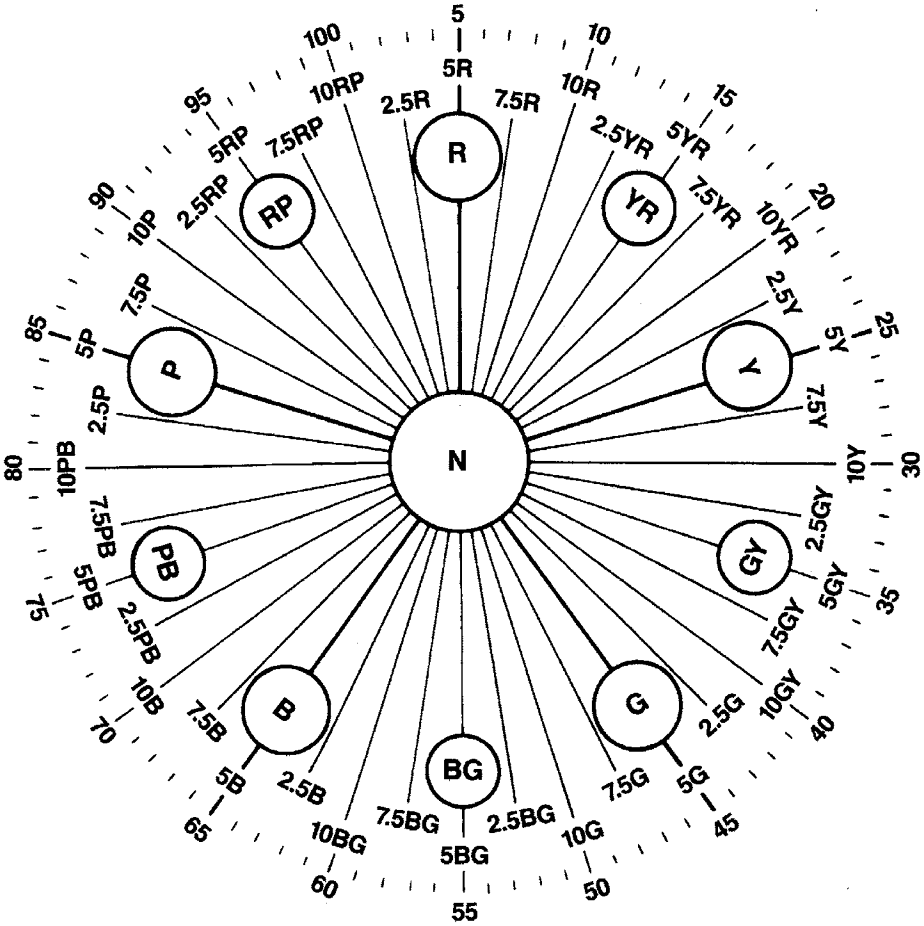

FIGURE 5.18 The Munsell color system divides the spectrum into five principal and five intermediate hues, which are indicated by a letter. These 10 are then divided into 10 additional hues indicated by a letter and a number, thus creating 100 hues in the circle.

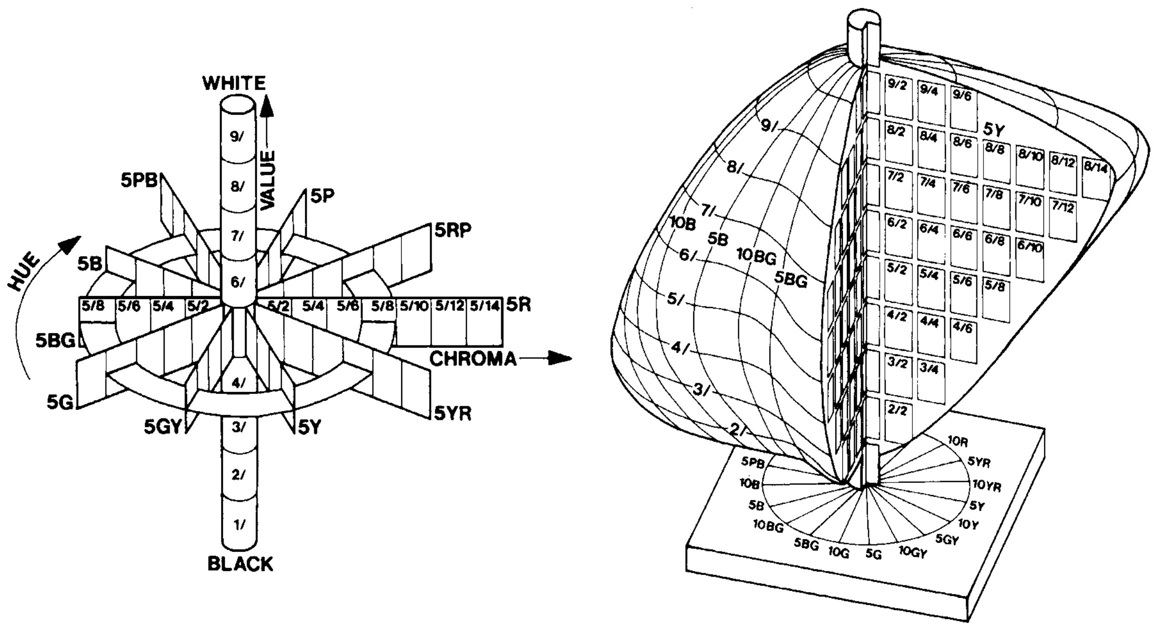

FIGURE 5.19 LEFT: Chroma (or saturation) scales radiate in equal steps from the neutral axis outward to the periphery of the color model. RIGHT: Increasing steps of chroma are indicated in Munsell notations by degree of departure from the neutral gray of the same value.

Munsell also developed an intricate method of classification to further identify each color within his system. The letter-number combination exactly locating each hue on the 100-hue color wheel is followed by the value level and the chroma level written as a fraction. For example, 5R 5/10 designates "pure" red at the middle value level (5) and maximum chroma level (10). A very grayed (low value) yellow would be designated as 5Y 3/2. Based on this notation system, Munsell also developed a standardized way to "harmonize" colors. If two or more hues are to harmonize, they must be in the same hue family or at the same value or same chroma level. Thus, if a "pure" blue (5B) were to harmonize with "pure" red (5R 5/10), the selected blue would need to be at the fifth value level or the tenth chroma level, for example, 5B 5/8 or 5B 6/10. As a result, it becomes simple to plan a color scheme if the following relationships exist:

1. Any two colors of the same hue family will go together (harmonize).
   Example: 5R 5/10
   2.5R 8/4
2. Any two colors of the same value level or with the same amount of "gray" in them will harmonize.
   Example: 5Y 6/8
   5G 6/10
3. Any two colors at the same chroma level will harmonize.
   Example: 5B 3/6
   5YR 5/6

The Ostwald Color System

Wilhelm Ostwald (1853–1932), a German physicist and chemist who won the Nobel Prize for chemistry in 1909, also developed a color system. His system (Figure 5.20) is based on four primary colors: red, green, blue, and yellow, and four intermediate colors: orange, purple, green-blue (turquoise), and yellow-green (leaf green). Each primary and intermediate hue has two auxiliary hues, one added to each side, for a total of 24 hues around his color wheel. Each hue is then designated by a number from 1 to 24.

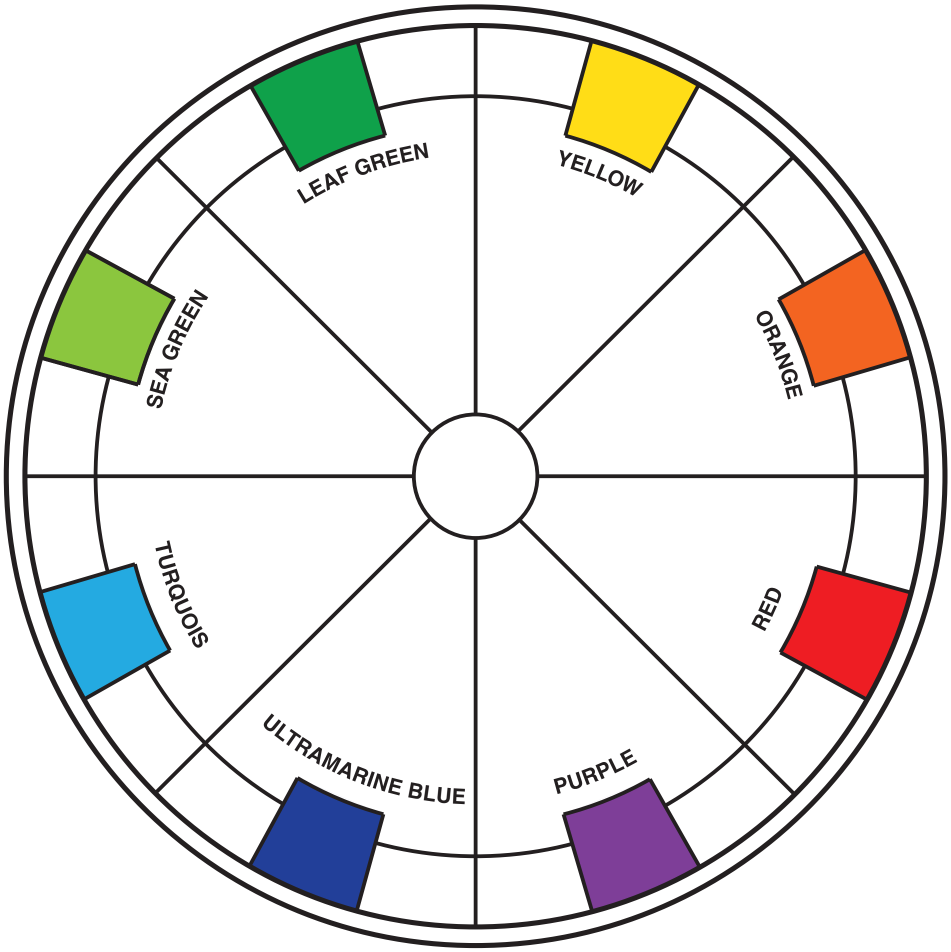

FIGURE 5.20 The Ostwald color wheel is based on four primary hues of sea green, yellow, red and ultramarine blue and four intermediate hues of orange, purple, turquoise, and leaf green.

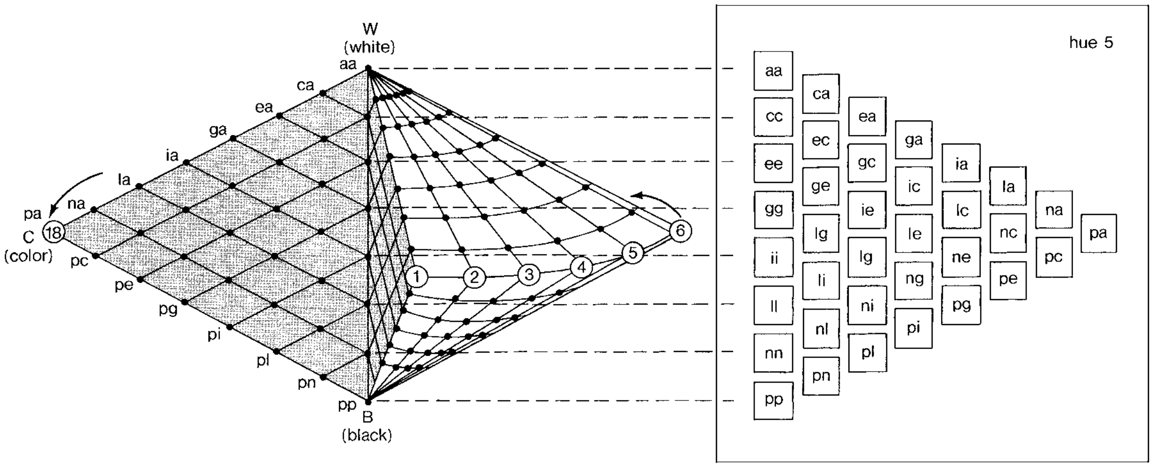

FIGURE 5.21 Ostwald's three-dimensional color system takes the form of a solid double cone (partially cut away here to illustrate relationships). The most saturated hues are at the equator of the cone and become neutralized as they move to the central axis of the gray scale. A triangle, at the right, illustrates how 28 variations of each hue are produced.

Similar to the Munsell system, Ostwald's color system also takes the form of a three-dimensional solid, but it is shaped like a double cone rather than a sphere (Figure 5.21). In this system, the 24 pure hues are grouped around the equator, with the eight value steps from white to black in the form of a central vertical axis.

Ostwald's system is based on the theory that any color can be mixed from combinations of black, white, and a pure hue. This system makes no distinction between value and chroma. Similar to the standard color triangle in arrangement, Ostwald's gray scale ranges from white (lettered A) at the top to black (lettered P) at the bottom. Then mixtures of white, black, and pure hue are added to form 28 variations of each of the 24 hues in terms of lightness or darkness; the results are similar to the tints, tones, and shades of the standard color system. Ostwald's complete solid contains a total of 672 chromatic hues and 8 neutrals.

Like Munsell, Ostwald also developed his own hue notation system for use in selecting color harmonies. Ostwald's system specifies the number of the hue (from 1 to 24) followed by two letters, for example, 14 ea. The first letter indicates how much white is added, and the second letter, how much black. Intermediate values are noted as c, e, g, i, l, and n. For example, the Ostwald notation for a tint of red would be 8 ca. To harmonize with that hue, either a hue must be the same number, such as 8 le, or the letters following it must be identical, such as 15 ca. These "harmonizing" hues are located according to geometric relationships within the various parts of the color solid.

The Gerritsen Color System

In 1975, Frans Gerritsen developed a color system that is based on the laws of perception and explained in his book *Theory and Practice* of *Color.* Gerritsen began his training in the Netherlands in art, photography, graphic arts, and education. He then went on to work as a designer and consultant, and on occasion worked with Le Corbusier on his pavilion for Expo 1958 in Brussels.

Gerritsen's color system (Figure 5.22) is based on six basic colors: yellow, cyan, magenta, green, red, and ultramarine blue. These six colors are made up of three "eye" primaries: blue, green, and red (as discussed under cone

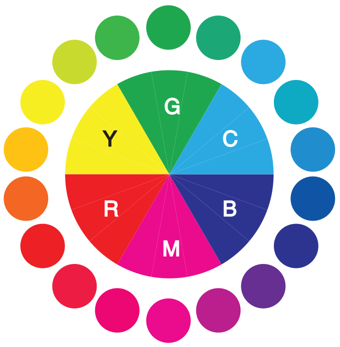

FIGURE 5.22 This color circle is based on Gerritsen's color system.

vision) and three "eye" secondary colors: yellow, magenta, and cyan. In Gerritsen's theory, when we activate two eye primaries simultaneously, we perceive the secondary color sensations; that is, red and green activated at the same time produce the color sensation yellow; red and blue produce the color sensation magenta; and green and blue produce the color sensation cyan.

Gerritsen's color tone circle can be separated into infinite divisions of the basic colors. The circle surrounding the basic colors consists of two in-between colors next to each basic color, which totals 18 colors. The more the colors are divided, the smaller the sections of the basic colors become. As the colors are divided, they are still "pure" and are not neutralized or modified by any other color. The second ring on the circle, which consists of 54 colors ($3 \times 18 = 54$), only illustrates the transition to the outside circle of infinite divisions. The Gerritsen color circle is divided by systematically activating one of the eye's two sensitivities for spectral light, as illustrated by the perception schemes shown for the 18 colors in the middle ring.

The value scale in Gerritsen's system also is based on spectral sensitivities and color perception qualities of the eye. The brightness axis ranges from white through various grays to black, with the perception schemes placed next to each step. The highest possible brightness (white) can be produced only by activation of all three spectral sensitivities (blue, green, and red) simultaneously. The perception schemes show that all three spectral sensitivities are equal and none dominates. This is Gerritsen's definition of neutral, and he has named the steps of the value scale "special" tertiaries, which are coded from white to black with the letters A through J. Color with optimum saturation is fixed at 100, and color fixed at 0 has no color and is neutral.

Gerritsen's color theory is also illustrated by a three-dimensional form that shows the relationship between value and saturation levels for all colors. Each basic color is placed on the outside of a cylinder wall according to the same lightness found on the value axis. Since the value level is different for the basic colors—yellow is at the C level, red at G, magenta at E, ultramarine blue at H, cyan at D, and green at F—an irregular, zigzag line results when these points are linked. This irregular color form organizes all full colors by hue and their own inherent lightness, according to the laws of color perception.

In his book *Evolution in Color* (1988), Gerritsen says that the color circle Newton introduced in the 1600s was irregular, because the basic colors of magenta and cyan were missing. He explains that the color wheel based on the mixing properties of paint, with red, yellow, and blue as the primaries, is misleading and outdated. He says that magenta, cyan, and green are spectral sensitivities that cannot be produced by mixing any other colors. Another major difference between Gerritsen's color system and those of others is his complementary color pairs. In his system, because they lie opposite each other on his color circle, ultramarine blue and yellow, green and magenta, and red and cyan are the complementary color pairs.

The Küppers Color System

Harald Küppers, a partner in the printing firm of Wittemann-Küppers K.G., explains his color theory in his book *Color: Origin, Systems, Uses.* In an effort to identify the primary colors, Küppers explains that the monochromatic colors of the spectrum are what he feels are "original" colors and that they make visible everything that we see. To progress from the original colors of the visible spectrum to the primary colors necessary for the laws of color mixture, Küppers theorizes that the color spectrum (Figure 5.23) contains the five regions of blue, cyan, green, yellow, and red. He also explains that although magenta is not present in the spectrum as a monochromatic color, it is produced by superimposing the red and blue spectral regions. Therefore, his color system is based on those six primary colors.

The Küppers color circle corresponds to the arrangement of the colors of the spectrum (see Figure 5.3). He feels that a color circle is really a spectrum that has been bent into a circle, with magenta used as a transition. The outer ring of his color circle illustrates how one color merges into the next without a break. The middle ring shows certain hues isolated from the continuous color spectrum. This particular arrangement shows 24 isolated hues (also called a 24-sector color circle, using the same colors as in the Ostwald system). Küppers explains that his color circle can consist of an infinite number of isolated hues as it is expanded outward toward infinity (which is the continuous spectrum). None of the mixed colors consists of more than two primary colors.

His three-dimensional system for mixing color is based on a rhombohedron. The rhombohedron is a geometrical form that has six faces and resembles a cube but differs in that the two diagonals of a face are not of equal length.

Both Küppers's and Gerritsen's color systems are based on updated theories that include green, cyan, and magenta as primary colors along with red, yellow, and blue. They both agree that Newton and others who considered only red, yellow, and blue as primaries were inaccurate because in those earlier days no pigments of present-day standards of purity were available as magenta and cyan.

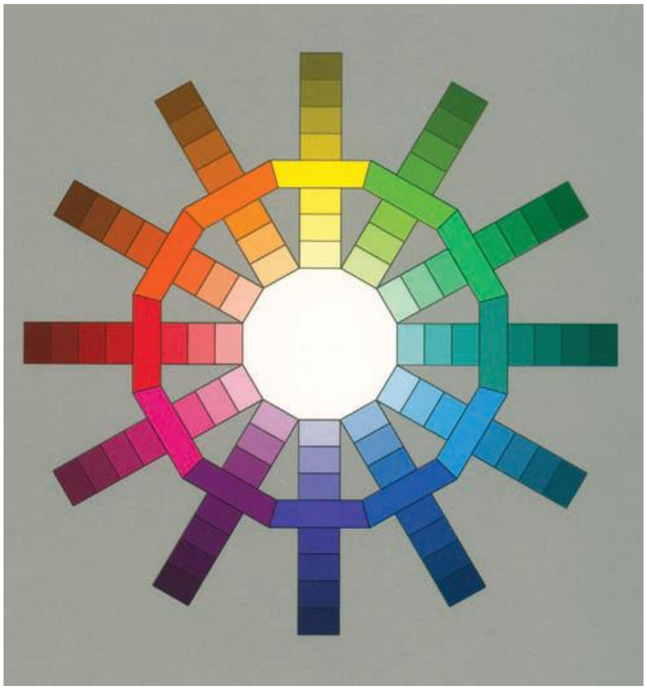

FIGURE 5.23 Küppers color system is based on the visible spectrum that has been bent into a circle, with magenta used as the transition. It is produced by superimposing the red and blue spectral regions as illustrated in the outer ring.

The Pantone Color System

Pantone is a corporation that began as a commercial printing company in the 1950s. However, it is best known for its color-matching system (PMS), as seen in Figure 5.24. Pantone's system consists of approximately 1,114 ink colors that are produced from 13 base pigments (15 including white and black) mixed in specific amounts. Each color is identified by a three- or four-digit number followed by a C, M, or U, such as PMS 123-C. The letters following the number refer to the type of paper they are printed on, such as C = coated, M = matte, and U = uncoated. The Pantone system can be used with the CMYK mixing process as well as the screen-based RGB process. Although Pantone's color-matching system is primarily used for printing, it is sometimes used in the manufacturing of colored paint, fabric, and plastic.

FIGURE 5.24 This Solid Matte Formula Guide from Pantone is used for color matching.

Color Schemes

The concept of color harmony is the basis of understanding the theories of arranging colors into practical color schemes. Just as the Munsell and Ostwald color systems use a systematic approach to determine harmonies, guidelines for arranging colors based on other systems have also been developed. Designers establish color schemes to set a basic guide, or rule of thumb, to build upon. The schemes that follow are exactly that—a foundation of color principles to build upon. They can be interpreted differently or modified according to the situation. In fact, some designers' color schemes do not seem to follow any of the basic schemes, yet work very well. A successful color scheme is not necessarily determined by which concept was followed, but by how it was applied and to what proportions.

Color schemes can be applied to the standard 12-part color wheel (Figure 5.25) or to other color systems, such as Gerritsen's color tone circle, as illustrated in Figure 5.26. These schemes are based on the organization and harmonizing effects of colors, irrespective of the number of hues in a color circle. These color schemes can be placed in two general categories: contrasted or related (analogous). Contrasting schemes are those made up of hues opposite or far apart on the color wheel. Designers tend to use these hues as accents in a color scheme. Related color schemes are made up of adjacent hues on the color wheel. When a designer wants to express harmony or unity through the use of color, these schemes often are the easiest route.

Monochromatic Schemes

The monochromatic is perhaps the simplest and most basic of the color schemes. A single hue is varied throughout in tints, tones, and shades. The one-color combination seems to ensure some unity or harmony through color application (Figure 5.27). However, designers should consider that some colors lend themselves to monochromatic schemes better than others, and that certain monochromatic concepts can become rather monotonous. Some variety in intensities, textures, and forms should be used to give life to the interior.

Analogous Schemes

The next easiest scheme is the analogous color scheme, which uses colors (often three or more) that are adjacent on the color wheel. Analogous schemes offer more variety than the monochromatic schemes, yet are harmonious (Figure 5.28). The hues are intermixed in varying proportions, values, and intensities to provide successful interiors. Many designers select one of the colors as a dominant theme and accent with the other analogous hues.

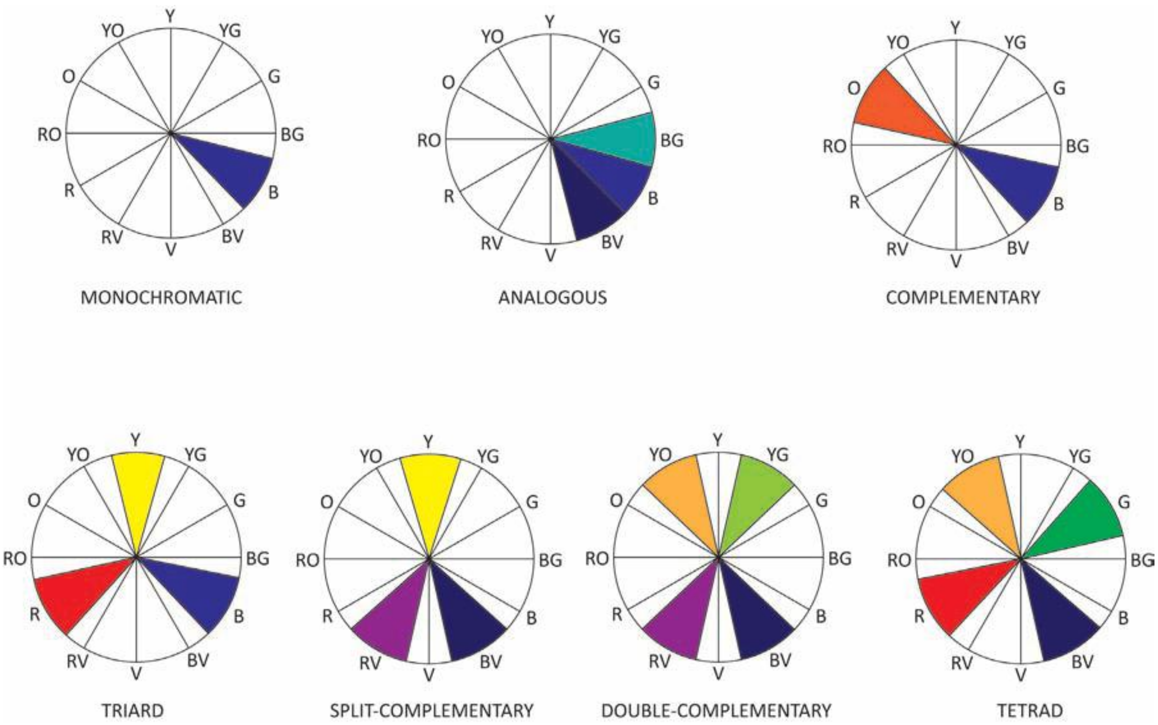

FIGURE 5.25 Seven basic color schemes can be composed on the 12-part color wheel.

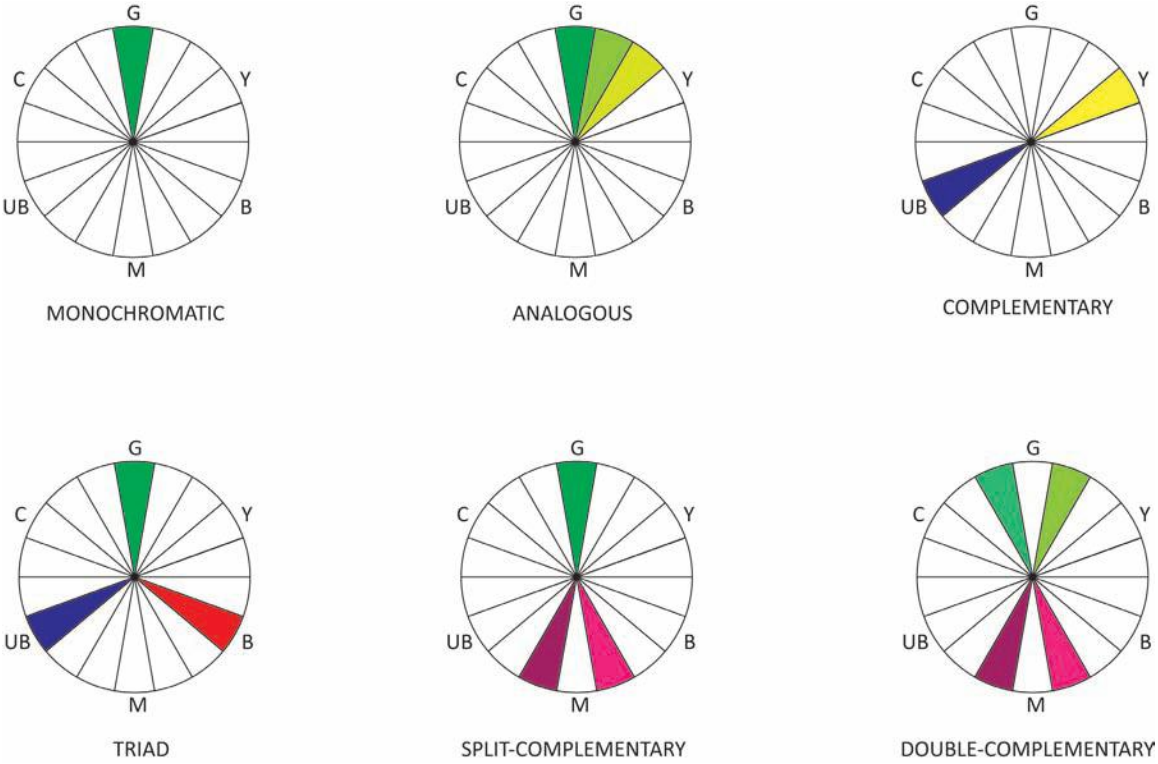

FIGURE 5.26 Six basic color schemes can be composed on Gerritsen's 18-part color wheel.

FIGURE 5.27 A monochromatic color scheme is used in this kitchen with accents of stainless steel and wood tones to offset the use of one dominant color.

Courtesy of National Kitchen & Bath Association

FIGURE 5.28 This interior is an example of an analogous color scheme that ranges from orange through yellow and green to blue.
Courtesy of National Kitchen & Bath Association

FIGURE 5.29 This collaboration area within a corporate office is designed using a complementary color scheme to inspire the users.
Courtesy of Kimball Office.

Complementary Schemes

The complementary color schemes offer an even greater variety in contrast or accent by using colors that are directly opposite on the color wheel. When these colors are in their purest form and placed next to one another, they appear more intense than if viewed separately, because they contrast with one another. They can also visually tend to actually vibrate along their borders. These brilliant contrasts are frequently used in graphic design when a forceful visual impact is needed. In interiors, however, the hues are generally toned down, reduced in amounts, or varied in value and intensity to lessen the harsh visual statement (Figure 5.29).

Triad Schemes

Any three hues that are equidistant on the color wheel compose a triadic color scheme. These colors might be the basic primary or the basic secondary colors. These combinations can produce some of the most diverse color schemes of all the systems. Sometimes, strong primary hues are used in interiors to provide visual excitement and contrasts for sensory stimulation (Figure 5.30). However, for most interior schemes they are toned down or varied in value and saturation.

Other Color Schemes

NEUTRALS A simple color scheme can be created by using black, white, gray, off-white, beige, tan, or brown. Interiors with neutral, or achromatic (meaning without color), schemes tend to visually expand a space and make good backgrounds for colorful furniture, artwork, and accessories. In most neutral color schemes, one or two chromatic hues are added for accent (Figure 5.31). Neutral backgrounds are advantageous in that they are flexible; it is easy to change color schemes through varying accent colors, rather than changing wall and floor colors.

SPLIT AND DOUBLE COMPLEMENTARY A split-complement scheme resembles a narrow-armed Y on the color wheel rather than being exact opposites or complementary colors. Such a scheme thus provides three colors instead of the two of complementary combinations, thereby offering a wider range of color selection (Figure 5.32). The split-complement scheme can be expanded to a double-complement on the color wheel, taking the shape of an X with its legs and arms adjacent to each other. If it is a balanced arrangement, it is also referred to as a tetrad scheme.

FIGURE 5.30 Blue and yellow wall paints in this interior are accented with red furniture, creating a strong triad color scheme. *Courtesy of Knoll, Inc.; Photographer: Michael Moran*

FIGURE 5.31 The building elements of this interior are done in an off-white achromatic color scheme, with color used as accents for furniture, carpets, and paint.
Courtesy of Knoll, Inc.

TETRAD Four colors equidistant on the standard 12-part color wheel form a tetrad scheme. The tetrad scheme does not present itself equally and is therefore not valid in the Gerritsen color system or other systems unless the color circle is extended to include 24 hues. This scheme can also be thought of as a balanced double-complement color scheme, although the colors are not adjacent.

Color Interaction

Color never appears visually as it physically is supposed to, because color is perceived in relation to the total environment, rather than by itself. Color can even deceive the eye, for it has the ability to change or influence other colors. These visual illusions are very important to interior designers, as their desired color effect can change as a result of the interaction of hues with one another.

Josef Albers (1888–1976) was an artist and designer who is credited with the formal studies on the interaction of color. He taught at the Bauhaus and later immigrated to the United States and finally became the department head of the design department at Yale University, where he published his teachings on color. His works demonstrated how our perception of color is influenced by placing colors adjacent to or on top of another color(s). His handbook *Interaction of Color* was originally published in 1963 and has remained in print since then.

SUCCESSIVE CONTRAST OR AFTERIMAGE In all color systems, two hues directly opposite each other are called complementary colors. When complementary hues are placed next to each other, they produce a strong contrast and vibrancy, referred to as successive contrast. For any given color, the eye requires balance from the complementary color and will generate the complement spontaneously if it is not present.

If a person looks at a particular hue, such as a red surface, for a period of time and then suddenly shifts to a white or gray surface, his or her eyes usually will visualize the color green (or cyan) instead of white or gray. The phenomenon of "seeing" the complementary color is called afterimage (Figure 5.33). A practical example of the importance of understanding the afterimage is the hospital operating room, where walls, cover sheets, and surgical gowns used to be white. When surgeons and nurses looked up from their work, after concentrating on red blood and tissue, they would see green spots before their eyes. Today, most surgical gowns, walls, and cover sheets are light green or blue-green to act as a background to neutralize these afterimages and eye fatigue. By understanding the concept of afterimage, designers can prevent such undesirable color relationships and visual perceptions.

FIGURE 5.32 The acoustical panels used in these collaborative areas within Haworth's Paris showroom are based on a split-complementary color scheme of violet, yellow-green, and yellow-orange.
Photo Courtesy of Haworth, Inc.

SIMULTANEOUS CONTRAST Color is rarely seen in isolation, especially in interior environments, where different colors are usually viewed together. This creates an optical effect referred to as simultaneous contrast, a perceived change of a color as the result of the influence of a surrounding contrasting color.

Simultaneous contrast is an illusion of color, since one color can be made to appear as two different colors when it is placed against two different backgrounds (Figure 5.34). To make one color look different, the backgrounds or surrounding environments can be contrasted to it. Designers should be aware that large color masses influence smaller ones and that the stronger the contrast of the backgrounds, the more the center color will change in visual appearance. For example, if two areas of a neutral gray are surrounded by a larger area of white and black, respectively, the gray surrounded by the black will appear to be brighter and lighter in value than the gray surrounded by the white. This happens because the adaptation of the eye is less sensitive to low brightness and will evaluate the gray area as being very bright (Figure 5.35). The same kind of contrast will occur between most other colors, not just between black and white, if a strong contrast exists. For example, a neutral gray placed against a surrounding red background will appear to have a tinge of green (the complement of red).

The visual illusion of simultaneous contrast can be effectively applied to interior design: A colorful accent can be made to appear stronger by placing a contrasting color or object next to or around it.

REVERSED GROUNDS The illusion of simultaneous contrast can be expanded by making three different hues appear as only two. This is done by selecting the mixture of two background colors to be the middle color. When this middle color is placed on each of the two background colors, it produces the visual illusion of the other background color (Figure 5.36).

SUBTRACTION OF COLOR The background color "absorbs" or "subtracts" its own hue from the center color. This process is referred to as the subtraction of color, and it can be used to create still another illusion involving the use of color: making two different colors look the same (Figure 5.37).

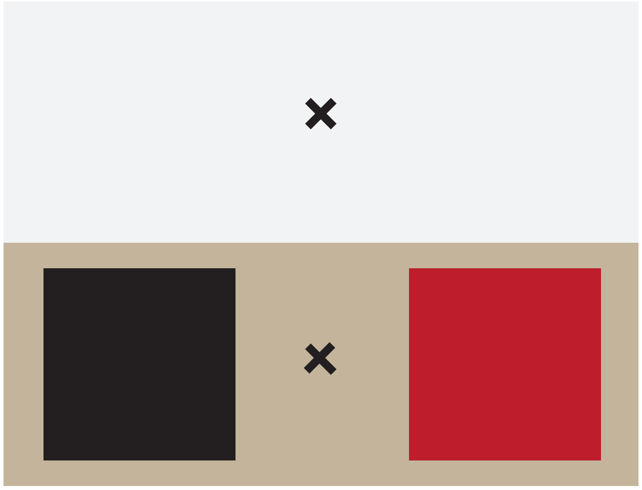

FIGURE 5.33 Successive contrast/afterimage can be experienced by staring at the red surface for a short period of time, and then suddenly shifting to the black "x" on the white surface.

FIGURE 5.34 Simultaneous contrast is a perceived change of color when one color appears as two different colors when placed on different colored backgrounds.

FIGURE 5.35 Simultaneous contrast in value. The gray spot surrounded by white appears to be of a lower (darker) value because of the bright surroundings. When the background is black, the eye is less sensitive to the lower value of black and perceives the gray spot to be lighter or of a higher value.

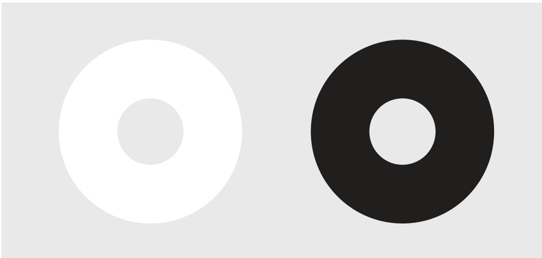

FIGURE 5.36 Reversed grounds: the illusions of making three different hues appear as two

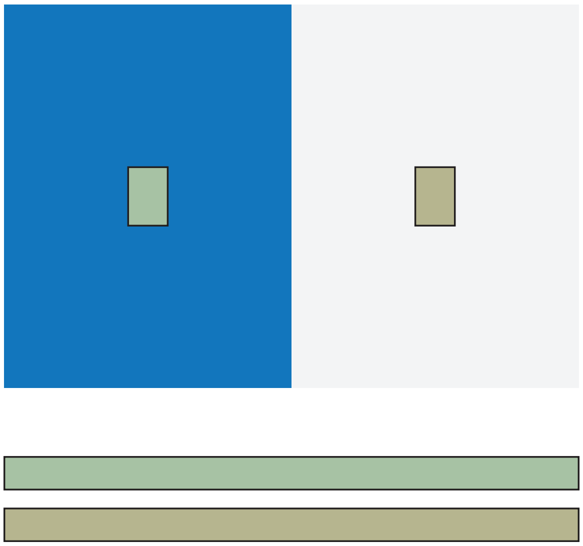

FIGURE 5.37 Subtraction of color is an optical effect that makes two different hues appear as one.

It has been demonstrated that color changes are caused by two factors, hue and light—generally by both simultaneously. Recognizing this, we can visually affect the appearance of a color by "pushing" its hue and/or lightness away from its first appearance toward opposite qualities, using contrasting backgrounds—in other words, by adding opposite qualities or by subtracting the qualities of color that are not wanted.

By experimenting with colored objects on colored backgrounds or in colored environments, we find that a ground will subtract, or absorb, its own hue and thus project the remaining hues. A blue-green sofa against a blue background will appear "green" because the blue ground absorbs the "blue" from the "blue-green" color. The lightness or darkness of a color will also be absorbed in the same way that its hue is. Thus, light colors on light backgrounds will appear darker because the light ground subtracts the lightness of the center object's color.

PSYCHOLOGY OF COLOR

Interior designers must understand the perception and use of color and its resulting effects on human behavior. Studies have shown that color can create excitement, relaxation, calmness, or cheerfulness and can even increase productivity in working environments. The way people interpret or feel about color can vary according to experiences, education, and cultural associations with color. Color association, or symbolism, is generally based on a person's individual innate personality or cultural background. For example, in Western cultures, black generally symbolizes death and mourning, whereas in Eastern civilizations, the symbolic color of death is white. Some common color associations in Western societies include:

Red is associated with battle, blood, fire, passion, love, and excitement. Historically it represents royalty, majesty, and triumph.

Orange symbolizes friendliness, pride, ambition, warmth, and relaxation, and is stimulating to the appetite.

Yellow symbolizes sunlight and is associated with springtime, cheerfulness, and optimism. Yellow also connotes the feeling of safety because it is easy to see.

Green represents nature and the feeling of calmness, friendliness, and freshness.

Blue stands for truth, honesty, loyalty, and integrity. It also is associated with coolness, repose, and formality.

Purple or violet is the color of royalty and has religious significance.

Many studies have attempted to identify the emotional impact of color on people, but most of the studies cannot determine whether the reactions are cultural or emotional. Color response also differs according to the context in which it is experienced. For example, red is commonly associated with love and passion, yet it can also evoke a feeling of danger.

Colors are also commonly associated with a psychological "temperature" and are divided into warm and cool categories (see Figure 5.38). Reds, oranges, and yellows produce a warm and active feeling, similar to sunlight. They also appear to advance toward the eye because they seem nearer than they actually are. A chair or sofa in an intense red fabric will generally appear larger than the same piece in a cool color, such as blue. Also, if the walls of a room are painted the same intense red, the walls will appear closer, decreasing the apparent size of the room.

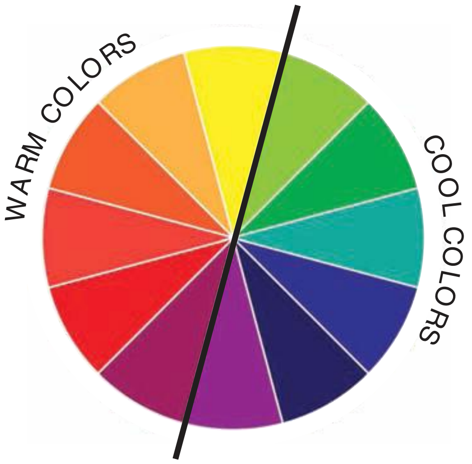

FIGURE 5.38 Colors on this color wheel can be grouped as warm and cool color divisions.

The cool colors are blues, greens, and violets. These colors tend to remind us of the ocean, sky, grass, and other elements found in nature. Tints of these colors create a restful and soothing feeling unless they are too intense in chroma. Cool colors are also known as receding hues since they appear farther away than they actually are. The apparent size of a room will increase when these colors are applied to the walls, but furnishings using cool colors will seem smaller.

A major factor in the determination of advancing or receding colors is intensity. A very intense, bright cool color will seem to advance, but a dull warm color will recede. Whether a color psychologically advances or recedes depends on the hue (warm hues advance, cool hues recede), value (high or light values recede, low or dark values advance), and intensity (bright advances, dull recedes). Studies on the psychological effects of color have revealed that people actually feel warmer in red and orange spaces than they do in blue and green spaces, when the temperature is constant in both environments.

People attach all kinds of different meanings and emotional responses to color. We all have heard about "feeling blue" or being "tickled pink." One hypothesis is that people respond to color with their emotions rather than their intellect. We do not experience color in isolation but in relation to the total environment. Thus, color alone does not affect our behavior and emotional state, but in relation to the objects, patterns, texture, light, and so on within an environment, it does affect us.

The complex area of the effect of color on people is still being researched. Interior designers should be aware of some of the emotional effects color can create—especially in isolated environments.

Color Perception

Color and Space

The effect of color on space perception (the apparent versus the actual, size and distance of objects) and perceived distance from a viewer is a very complex relationship and will vary with different users.

When hues are placed closer to the viewer, they will appear more brilliant and darker than the same hues placed at a greater distance. More intense and darker colors will appear less demanding when used in very large spaces than in small spaces. Spaces with white or very light, cool colors on the walls generally appear more spacious than those with darker warmer hues.

Colors also appear more intense, or stronger in chroma, when covering large areas. For this reason caution should be used when selecting wall colors on the basis of very small samples or color chips, for the color will often appear darker when applied to large areas.

Color and Texture

The textural quality of an object or surface will also affect the visual appearance of color. Rough-textured materials will generally appear darker because they absorb light and color rather than reflect it, as do shiny surfaces and materials. Also, textured materials, such as nubby fabrics, pile carpet, and velvets, will cast small shadows within themselves and appear darker than a smooth material of the same hue, value, and chroma.

Color Distribution

Color distribution is important in creating a feeling of unity within an interior environment. Every color plan should ideally include some light, some dark, and some median values to create the desired effect.

There are primarily two popular methods utilized for color distribution. The first specifies that the backgrounds (floors and walls) should be the most neutral colors, and the strongest chroma should be used in the accents, such as accessories and furniture items (Figure 5.39). The second method is to put the darker values, or stronger chroma, in the backgrounds (floors and walls) and the small accent items, and use more neutralized tones for the major furniture items (Figure 5.40).

The choice of one method over the other depends on personal preference and what is to be emphasized in a space—the background or the objects in it. Light values against dark values produce the strongest contrast. Then as values become closer to each other, such as a light-value chair against a light-value wall, the shape of the object will tend to merge with its background. A dark-value chair placed against a light background will produce a dramatic effect but be less pronounced in contrast than a light-value chair against a dark background.

Generally speaking, most successful spaces are planned around one dominant color and two subordinate colors that are varied in value and intensity. These colors do not have to be present in every piece of furniture, but they

FIGURE 5.39 The neutral background of this interior is accented with strong color in the furniture and accessories.
Courtesy of Knoll, Inc.

should be repeated at least once to create a unified feeling. Remember, however, that an even distribution of color could become boring and create a monotonous feeling.

Color Application in Interiors

Color is a design tool. Its practical application ranges from using luminescent colors for safety in highway signs and markers to using specific colors for hunting gear, life jackets, and reflectors for bicycles in order to be seen instantly.

A number of studies have been done on using color so that it is conducive to activities designed for specific interior environments. For example, hospital interiors have been painted in specific colors because studies have shown that particular colors can affect behavior and personality. The following discussion mentions some examples of color usage in commercial spaces.

Offices

Job performance is closely associated with satisfaction in the working environment. Because the work environment has a direct relationship to employee efficiency, drab offices can be counterproductive. It is important to design office spaces that will lift spirits, not depress them (Figure 5.41). Off-white, buff, and gray surroundings are not very stimulating if additional color is not used effectively. Earth colors can be comforting in an office environment, and yellow has been found to create a cheerful atmosphere and improve work concentration.

Greens and blues are thought to be calming, but that effect depends on the value and saturation level of the hues (Figure 5.42). Too much white in a workplace can produce too much glare. More saturated colors, such as deep green or purple, are often used as accents, especially in executive or reception areas, to give a feeling of status and dignity. Another way to express prestige and status is through the use of natural materials, such as marble and wood.

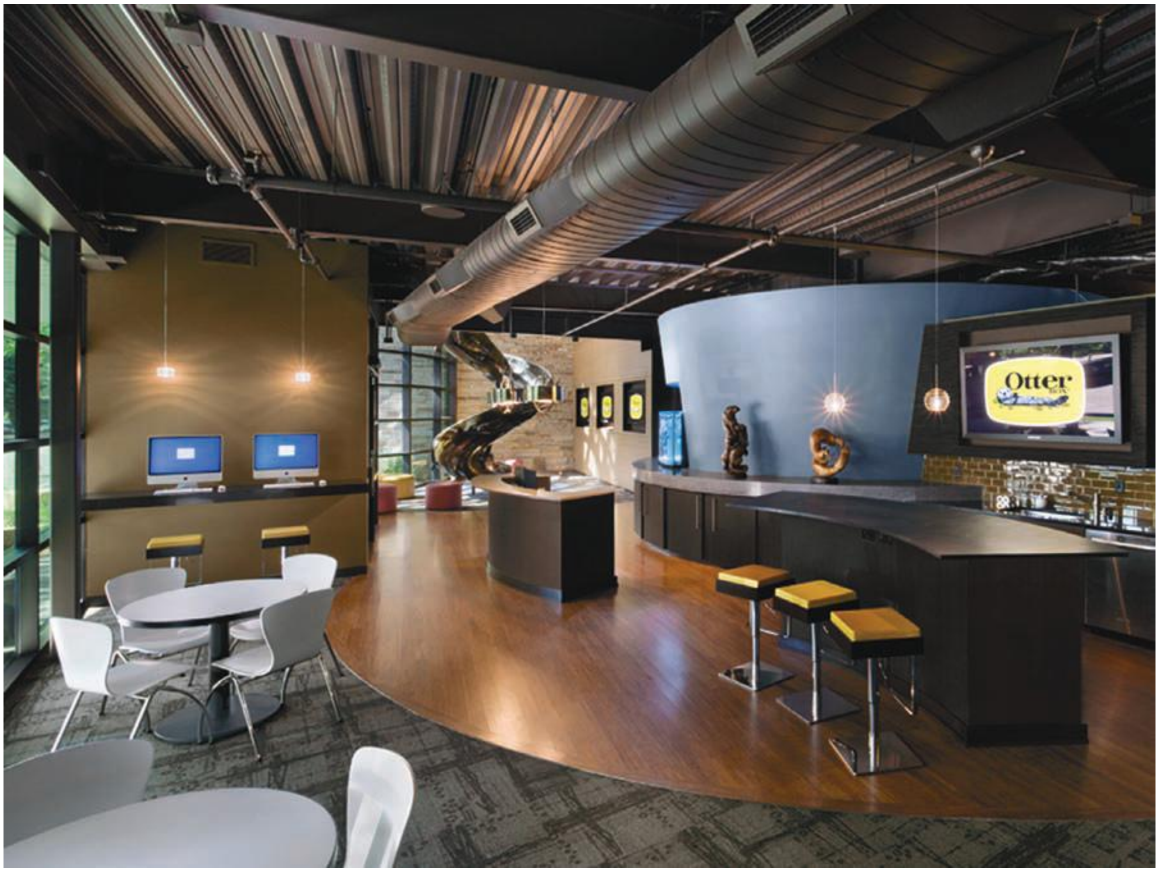

FIGURE 5.40 The floor, walls, and ceiling of this café are done in darker values, as contrasted with light-colored furniture and bright stool cushions.
Courtesy of Kimball Office

FIGURE 5.41 Accents of color are used on these workstations to offset the neutral background of this office.
Courtesy of Kimball Office

FIGURE 5.42 These bright-colored "Fit" chairs by Kimball Office liven up this touchdown station in an office environment.

Courtesy of Kimball Office

In some office environments, creating a corporate image is important. Black, gray, and white with one or more accent colors might be used, for example. However, the brightness contrast ratio needs to be proportionate. Because white reflects 80 percent of light, and black approximately 5 percent, a brightness contrast ratio of 16 to 1, there could be physical eye discomfort.

Gray can be ideal for desktops and working surfaces since it is a neutral color and not distracting. And because it creates a good balance in contrast between black and white, gray is able to keep the eye at a comfortable and uniform brightness level.

In offices where a great deal of concentration is necessary, cool hues tend to be a better choice. In general office areas, either warm or cool hues can be used, depending on users' preferences. High-stress environments can use color to achieve a calming atmosphere. Low-reflective surfaces should be used in areas where workers must use their eyes a great deal for visual tasks. Also, to ease the strain of working long hours at a computer terminal, flat, absorptive colors can be effectively used.

Educational Facilities

Traditionally, a pale green has been thought to be a good color for school walls because it creates a quiet mood that enhances concentration. However, pale green can also create a very monotonous environment and should be used for specific situations, not a general scheme for all spaces.

Warm, bright color schemes are thought to be a good choice for preschools and elementary grades, since children in these age groups tend to be more extroverted. Such schemes also can reduce anxiety and can stimulate activity.

In secondary schools, beige, light greens, and blue-greens are often used to create a more passive effect while enhancing the ability to concentrate. Brightly colored accents can add cheerfulness and encourage participation among students.

Using a different color for the front walls in classrooms where students face a specific direction not only draws attention to the front of the room but creates an effective contrast with visual aids, such as chalkboards and bulletin board materials, to allow students to relax their eyes when looking up from their desks. Visual monotony can be lessened also by adding a contrasting color to the front wall. The side and back walls then could be more neutral, such as tan or beige.

Medical Facilities

The correct application of color in medical facilities contributes to the well-being of the patient and the efficiency of the staff. In the study "Effects of Color," M. N. Bartholet hypothesizes that color could be used to motivate sick people to get well and, possibly, to improve nursing care.[1] It was also concluded that since green is frequently associated with sickness and nausea, patient rooms should not be painted this color. After doing research into color preferences of a depressed group, Dr. Deborah T. Sharpe reported in *The Psychology of Color and Design* that the group members had a strong preference for bright, gay colors.

In general, warm neutrals, light greens, and blues are used in healthcare environments. Blue walls create a calming effect and give an impression of expanded space that will help keep patients from feeling confined. This does not necessarily mean, however, that all walls should be blue. Medium tones of green or blue-green are recommended for operating rooms, as discussed under "Successive Contrast or Afterimage."

Large expanses of yellow used in hospital patient areas can give patients a sickly pallor. Pure white is seldom used for hospital walls because it is highly reflective and harsh on the eyes. Even though white has been traditionally associated with sterile environments, such as hospitals and healthcare facilities, it, too, can make a patient appear sickly. Gray is not a good color to use in large applications for healthcare facilities, because it appears cold and harsh.

Public areas of healthcare facilities, such as waiting rooms and corridors, generally use more brightly saturated colors to create a cheerful atmosphere, and can be used as a method of wayfinding throughout a facility (Figure 5.43).

FIGURE 5.43 Bright colors and artwork are used in this reception area of the Helen DeVos Children's Hospital to create a cheerful atmosphere. Graphics used in the flooring aid in wayfinding, to help guide the patients throughout the hospital. *Photo Courtesy of Haworth, Inc.*

Restaurants

Color is used in a number of different combinations and accents for restaurants and other eating establishments (Figure 5.44). Color is a major factor in our evaluation of the freshness, ripeness, and palatability of food. Experimental studies show that people's appetites are stimulated by viewing food under normal light. When colored light is substituted, unnatural food colors are produced, such as dark-gray meat or violet potatoes. Even though people know the food is edible, many are not particularly drawn to it.

Other studies on appetite and color reveal certain trends to stimulate appetites. Red, red-orange, and orange tend to produce the most favorable appetite sensations. Blue-greens, such as aqua and turquoise, can be used successfully as backgrounds for food displays because their afterimage of red-orange enhances these colors. Green salads will appear greener on cool pink backgrounds.

Another consideration for color in restaurants is the use of color flattering to human complexions, for example using pink or warm lights to shine on warm neutrals or soft reds and oranges. However, in a fast-food establishment, bright, stimulating colors and light tend to encourage rapid eating and movement.

Retail

Color can also be an important element in the marketing and selling of merchandise. We are presented with a huge variety of colors on products and in those retail outlets that sell them (Figure 5.45). Yellows and reds are used for aggressive, attention-grabbing messages, whereas earth tones are often used for subtler product messages.

Brighter, more saturated hues are often used for store identification, traffic patterns, and shopping bags to assist in image making and ease of purchasing.

Industry

Color is important in industrial plants and related manufacturing areas. Using intense colors for warnings in hazardous areas or on potentially dangerous machinery and products emphasizes safety. Light colors (except stark white) can be used over all to reflect light and can be accented with bright, cheerful colors.

FIGURE 5.44 This restaurant uses a variety of colors for an inviting atmosphere.
© ARCO / P Goll / age fotostock

FIGURE 5.45 This showroom offers a variety of furniture selections in bold colors. Note that the light fixtures also reflect these strong color accents.
Courtesy of Knoll, Inc.

Eye fatigue can be lessened by reducing contrasts and the afterimage effects of dark and saturated colors. Matte surfaces are also preferred over shiny, reflective ones where workers must concentrate on a specific task or product.

Color can also be used to create a sense of place in industrial areas or to identify positions on an assembly line. Color coding can be more effective than words to designate specific work or storage areas and to break up a large area into smaller spaces.

Communicating Color Decisions

After understanding the theory of color and proposing a suitable scheme for a particular project, designers must communicate these decisions to others. An effective way to do this is through the preparation of sample boards, palette boxes, and computer realistic renderings (Figure 5.46).

Color Samples

Designers must first have readily available many paint chips, upholstery and drapery fabric swatches, and samples of carpets, wallcoverings, and accessory colors. With these color samples at hand, the designers can put together several trial schemes for client viewing.

Today, most of the initial searching for products can be made online or from material swatches/binders for the designer's use. Then small samples can be acquired for actual viewing and touching. Most manufacturers will also supply large "memo" samples of fabric, carpet, plastic laminate, wall vinyls, and wood panels. It is sometimes a good idea to see a larger sample of patterned objects because their appearance may be drastically different from that of the small sample.

It is important to select colors under lighting conditions that approximate those in the actual project space. Because light directly affects color, a variance in light conditions between the location where colors are chosen

FIGURE 5.46 This student presentation board shows materials, details, furniture, and renderings for the design of a new retail kiosk.

and the location where they are applied can create color discrepancies. This phenomenon, known as metamerism, means that colors look different under different lighting systems. Many designers have several types of lighting (incandescent, fluorescent, and natural) available in their offices to use when matching colors.

Sample Boards

Samples of actual materials, along with color samples representing paint or other solid colors, are then arranged and attached to a sturdy sample board (Figure 5.47). The actual board color should be neutral and not distract from the colors of the material samples. These are presented as an overall "color palette" in small projects or are detailed with a key to a floor plan in more complicated or larger projects. Careful attention must be given to making sure the sample material is not outdated or has not been discontinued by the manufacturer. Most designers maintain an updating system in their resource libraries to weed out outdated material samples. They can also contact the manufacturer's representative to make sure the sample is still current and available. A record is made of each sample attached to the board, unless the manufacturer's identification is readily apparent. This record later serves as a guide for the actual specifying and ordering of materials and furniture.

Ideally, large areas of color or texture, such as walls and floors, should be represented by large samples, and small samples or swatches should represent smaller areas or accents. However, it is not always possible to obtain samples in the desired proportions. Sometimes larger than proportional samples are needed to show accurately how a particular pattern or texture would look. In some projects, sample boards are not used for presenting color selections to a client. For example, a large fabric sample might be draped over a client's existing sofa for color selection.

Presentations

The sample boards are presented to clients to explain the designers' overall color and materials concepts. When approved, the boards and the color chart can become a record of the final selections. In small projects, the sample board can be used directly as an aid to the installer or painter. In larger projects, additional color specification charts or floor plan keys are made to assist in getting the selected colors to the proper location.

Symbol	Qty.	Manufacturer	Description	Fabric/Finish	Location
A	1	Kimball Office	Definition Wood U-Unit with 36x72 Inch Single Pedestal Desk with Recessed Modesty Panel, 24x48 Bridge, 24x102 Inch Modular Single Pedestal Credenza, Wood Door Highback Organizer and Glass Door Bookcase Organizers	Wood with White Laminate Top	Reception
B	5	Kimball Office	Array round table with X-base and Bullnose rim	White Laminate, Metal Base	Employee and Guest Seating; Regional Manager's Office
C	6	Kimball Office	Hum 4-Workstation group with two 82-inch laminate dual-sided personal spaces, Meet Me spaces, Box Terraces, Elevated Terrace, See Me Screens, Monitor Arms, and Mobile Pedestals	Designer White Laminate, Cloud Blue Paint	Resident Workstations
D	1	Kimball Office	Prevail U-Configuration with desk, bridge, and return	Autumn Wood	HR Manager's Office
E	1	Kimball Office	Prevail L-Configuration with extended desk, Credenza, and Wall-mount cabinets	Autumn Wood	Regional Manager's Office
F	6	Kimball Office	Arpeggio magazine table with beveled edge	Autumn Wood with Beige Laminate Top	Lobby; Touchdown 1; Touchdown 2; Touchdown 3
G	1	Kimball Office	Conference table, Contemporary 60x240 Standard rectangle with Laminate top, Rim Group 1	White Laminate	Conference Room
H	2	Kimball Office	Interworks 2-Person 7x16 Shared Workstation with Powered 42-inch Interworks Panels, Laminate Worksurfaces and Metal Storage	Designer White Laminate, Dune Paint	IT Technicians; Research Assistants
I	4	Kimball Office	Fit one-seat lounge chair, model KFI01	Custom Color	Touchdown 2; Touchdown 3
J	19	Kimball Office	Xantos high back chair with upholstered back, model KX3627	Knoll Earthwork in Bismuth; Carnegie Grid in 10; Carnegie Grid in 12	Reception; Conference Room; Regional Manager's Office; HR Manager's Office; IT Technicians workstations; Research Assistans workstations
K	24	Kimball Office	Itsa 2.0 task chair with rounded seat, mesh back, height adjustable arms, & knee-tilt control, model QK38CC	Carnegie Grid in 10; Carnegie Grid in 12	Resident Workstations
L	22	Kimball Office	Acapella armless high back side chair, model K46DD	Knoll Hourglass in Gull; Knoll Hourglass in Aegean	Employee and Guest Seating; Regional Manager's Office; HR Manager's Office
M	14	Kimball Office	Arpeggio side chair with pillow back, model ARP-GC4E	Maharam Fiddle in Teak; Carnegie Grid in 10; Carnegie Grid in 12	Lobby; Touchdown 1; Touchdown 2

FIGURE 5.47 Sample boards are created to convey ideas of materials, color, and finishes of the interior spaces, furniture, and furnishings.

Courtesy of Brigitte Demmel

NOTE

1. M. N. Bartholet, "Effects of Color," Nursing Outlook (Oct. 1968): 51.

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6

Design as a Process

The process of designing interiors involves defining problems within interior environments, generating and evaluating alternatives, and implementing solutions. Design can be viewed as a strategy of problem solving in which creative ability utilizes art and science to generate solutions to problems. Good interior design does not just happen; it is a process planned to yield interiors that perform well and are aesthetically pleasing. Good interior design results when designers, clients, consultants, and builders join in organized, creative problem solving.

Designers solve problems in many different ways. Frequently, however, they go through a pattern or sequence of steps that they have previously found effective for achieving their designs from conception to completion. The process may be a conscious or subconscious effort that designers use on almost every project.

Many studies have been written on design methodologies. These studies critically analyze, evaluate, and compare design processes, and propose alternative methods for creative problem solving, to help designers understand their own style and find new alternatives for achieving solutions. It is generally believed that an improved design process will lead to an improved design.

Some designers use a subconscious, intuitive approach, feeling their way through the problem and arriving at a solution. This may involve mulling over a problem and seeking solutions without a clear understanding of the problem or how to proceed in solving it. These designers go through a series of actions that seem right, until, after a period of incubation, a solution suddenly appears. They do not realize exactly how they arrived at that particular solution or understand the design process used to achieve it. The interior design field demands a more conscious and systematic approach, to achieve solutions that not only are aesthetic but serve the needs of the users of the spaces involved. Interior design is a professional field that must be creative, yet solve problems and produce solutions to be implemented.

By identifying and utilizing a design process, designers attempt to get to know and understand the whole problem or situation, not just their particular view or unique area of concern. A process also helps designers see themselves moving toward a result as they go from one step to the next. This allows more flexibility in design decisions by permitting trade-offs that address the scope of the user's needs. For example, an interior designer might choose carpet material manufactured for longer wear (although it is more expensive) and eliminate fabric wall coverings in favor of paint (a less expensive choice). In this way, the designer might offer a more utilitarian solution based on the client's maintenance and budgetary needs, rather than a pure aesthetic choice of "pretty" materials that do not meet the stated needs.

There are several approaches to designing or creative problem solving. The key word is *creative*, which implies that designers not only solve problems or make designs but create things where they did not previously exist. Creativity can involve convergent thinking, leading to a direct solution. It can also involve divergent thinking, which creates multiple options or point of view, leading to unique solutions. To be creative is also to be conscious of one's self, actions, and place in the environment.

All design processes, simple or complicated, propose that the designer must be aware of the problem or situation before it can be tackled. Generally stated, a design process can be thought of as two phases. In the *analysis phase* the problem is identified, researched, dissected, and analyzed (Figure 6.1). The process seeks to break down a complex problem into more manageable parts in order to gain a better understanding of the situation. From this phase, designers come up with ideas or proposals about how to proceed in solving the problem or changing the situation. The second phase in the process can be labeled the *synthesis stage*, where the parts are pulled together to form a solution that is then implemented. The synthesis stage seeks to form ideas by creating something new or finding a solution to the problem.

THE DESIGN PROCESS: THE SEQUENTIAL STEPS

This simplistic two-phase design process can be further broken into eight specific steps, as seen in Figure 6.2. These steps do not necessarily have to be linear, but could instead be cyclic, as illustrated in Figure 6.3, or could even take the form of a spiral (Figure 6.4). An easy way to remember the steps of the process is to use the first letter of each step to make up a catchy sentence (Figure 6.5). Note that the steps are sequential, and the design process concentrates on one step before moving to the next one.

No specific design process will solve every problem or be useful to every designer. The model of design processes shown in Figure 6.6 demonstrates one approach interior designers can use to achieve solutions to problems. This model breaks down complicated problems into simple steps for project development and methods of communication.

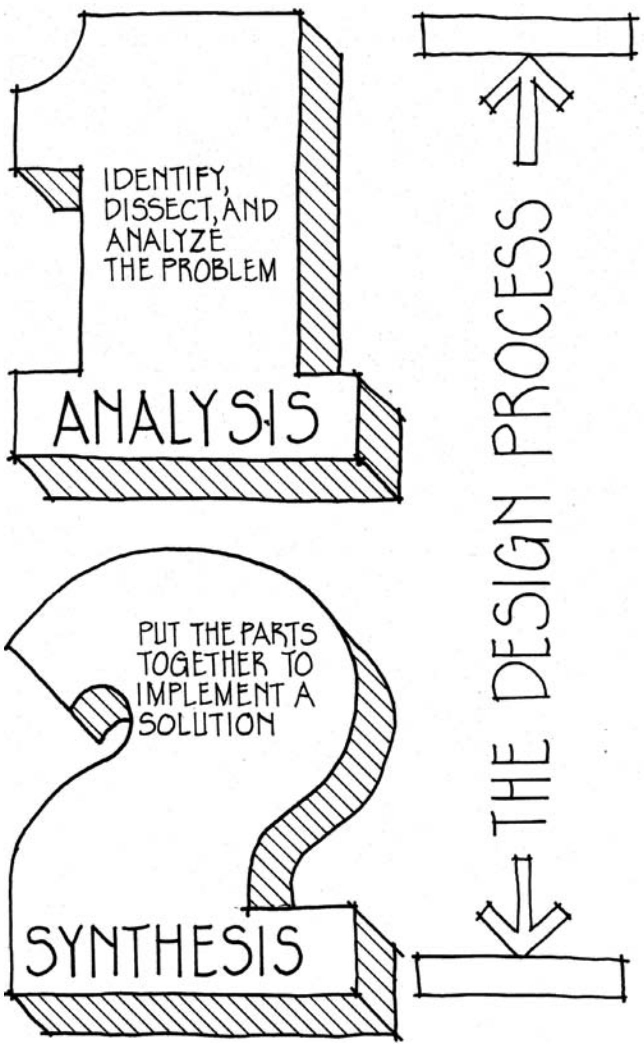


FIGURE 6.1 Design processes can be broken down into two simple phases: analysis and synthesis.

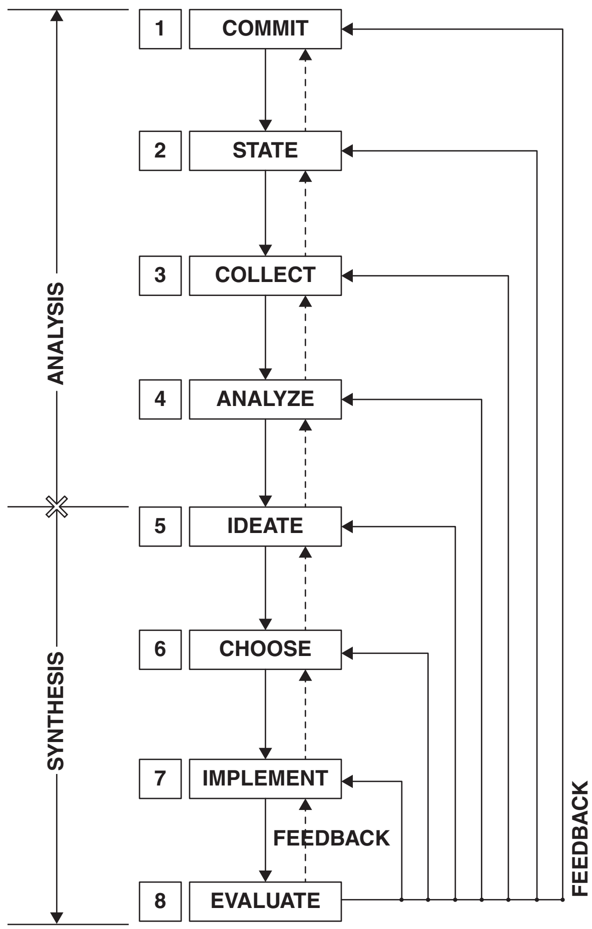


FIGURE 6.2 The design process is a series of sequential steps with feedback to all former steps.

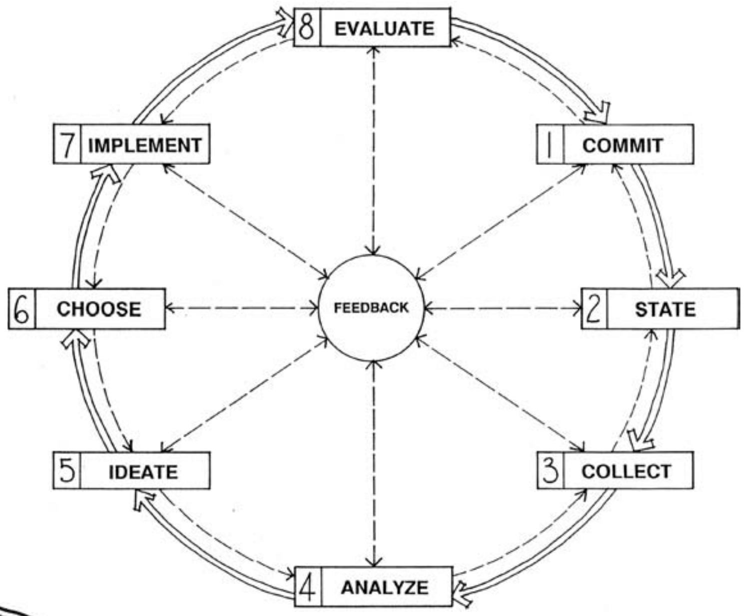


FIGURE 6.3 The design process can also be seen as cyclic steps with feedback across the axis.

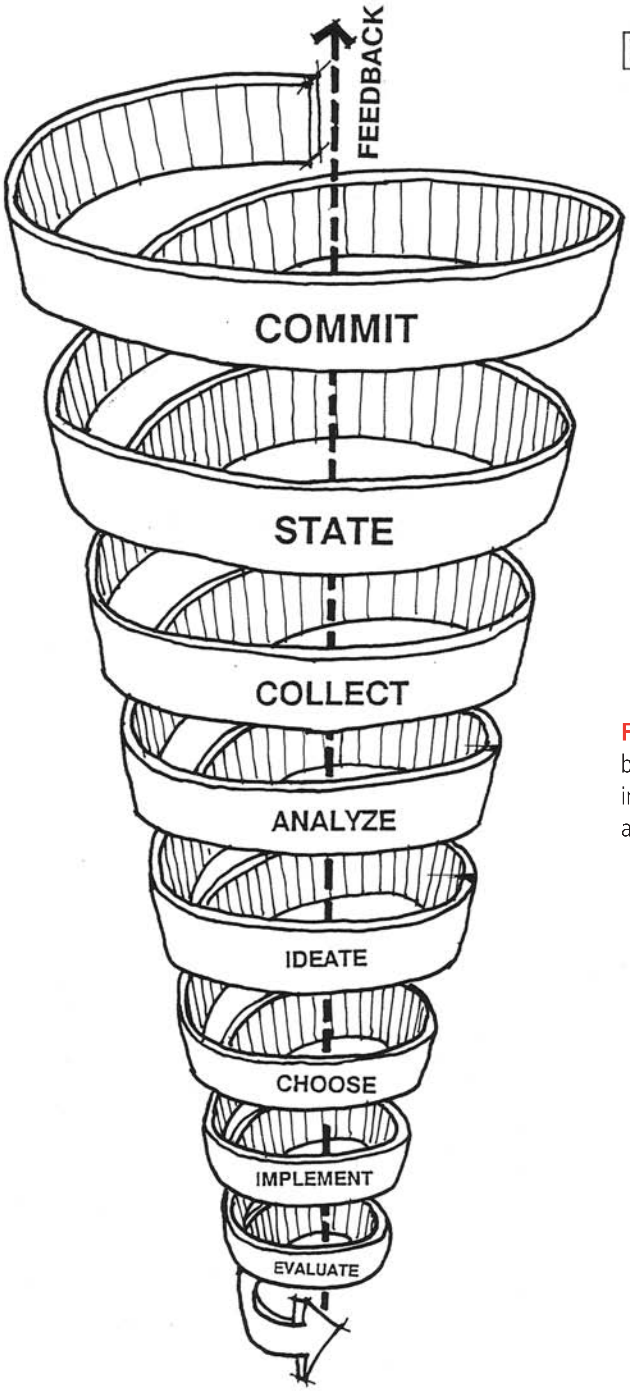


FIGURE 6.4 The design process can also be seen as a spiral or funnel that focuses into a solution. Feedback then occurs along the central axis.

"Come See Circus Acts In Chicago Involving Elephants"

Commit State Collect Analyze Ideate Choose Implement Evaluate

FIGURE 6.5 The design process can easily be remembered by taking the first letter of each step and making the sentence "Come See Circus Acts in Chicago Involving Elephants."

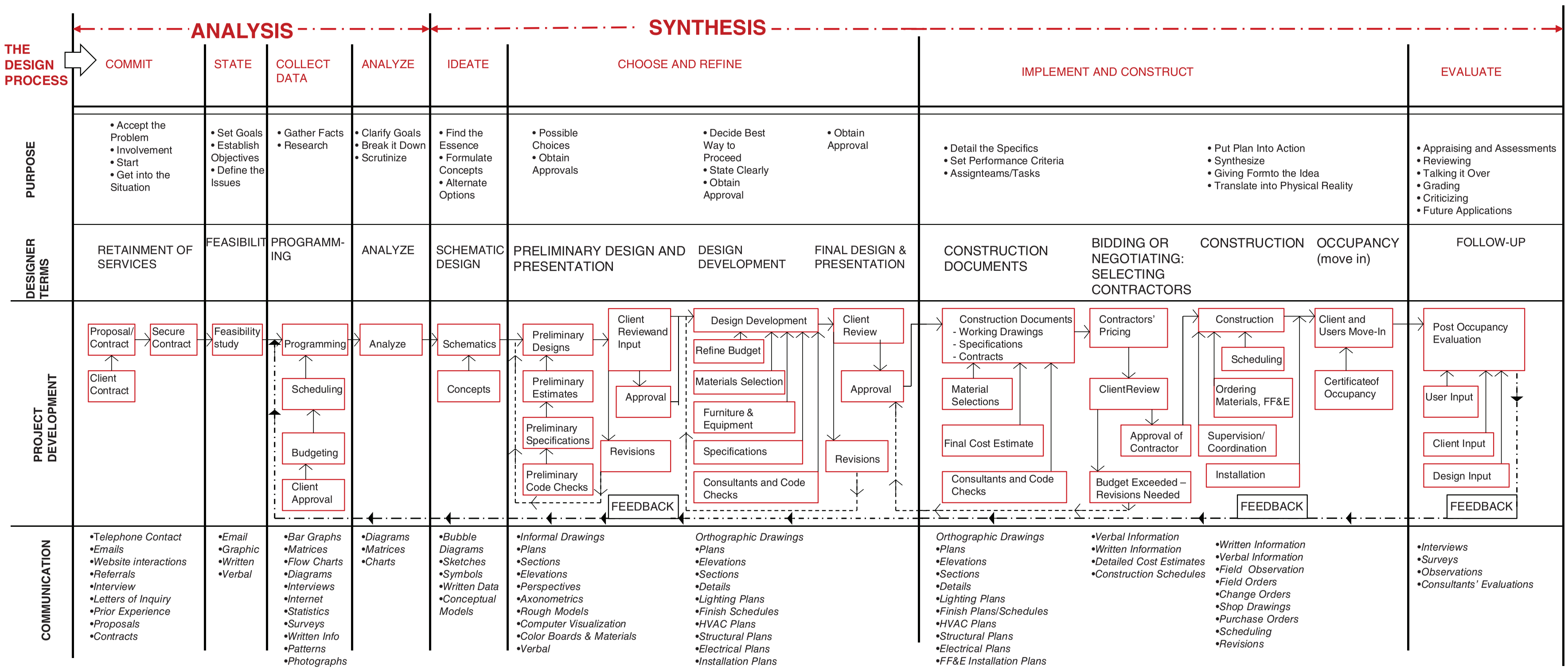


FIGURE 6.6 Relationships between the design process and phases of a project. Note the column at the left that defines the purpose, professional terminology, phases of a project, and the various forms of communication.

Commit (Accept the Problem)

Recognizing a design problem and committing to it is the first step a designer undertakes in the design process (Figure 6.7). To get motivated, the designer must first accept the problem as a personal assignment and jump in with heart, soul, and both feet. Partial involvement leads to partial solutions.

Some students and designers tend to procrastinate when given an assignment or problem to solve. One of the reasons is that they have not really committed and dedicated themselves to the situation. Time management problems, such as outside activities, personal time commitments, displeasure with the assignment or parts of it, or a multitude of other factors might be preventing them from getting started. The process of designing also involves a commitment to deadlines or due dates, a commitment that can be as crucial as the act of designing. The designer could be fired, or the student penalized, if the process does not move in a timely manner and reach fruition.

Techniques for Committing to the Problem

Methods for designers to apply in taking on a problem might be listed as prioritization, reward concept, or personal value analogies. The first of these, prioritization, concerns time management and requires listing priorities and determining involvement with the project in terms of personal time available. The time estimated for solving the problem is compared with the actual time available. Adjustments must be made as necessary so that the designer can devote more of himself or herself and more time in order to solve the problem while meeting other deadlines, in addition to the design project at hand.

In another method, called the reward concept, basically the designer asks, "What's in it for me? What do I expect to gain, or how will I be rewarded from involvement with this problem?" The designer then lists these rewards as tangible assets, such as money; recognition; skills; or other desirable traits to be gained.

As its name suggests, personal value methods can be thought of as ways to make the problem more personally valuable. This value may not have a monetary basis but can be rich in personal satisfaction, such as knowing a problem has been solved in a unique and creative way. For the professional designer, the personal value might be the signed contract that indicates the client's confidence in the designer and commitment to hiring him or her. Or it could be a glowing reference from a client that has recommended the designer to others, based on the services the designer provided for that former client.

State (Define the Problem)

As stated previously, a problem or project must be identified or stated before a designer can effectively deal with it (Figure 6.8). This is the important next step in the process. How clearly the problem is defined in the early stages can have a tremendous impact on how it is solved. Good designers try to approach new problems with a fresh outlook; that is, they do not let preconceptions of previous problem solutions cloud the new solution. Creative designers must constantly remind themselves that each problem is unique and may have a unique solution.

This defining step generally involves establishing the problem requirements, constraints, limitations, and assumptions with which the designer is operating. This is often called the start of the program phase. Programming is further discussed in Chapter 7. If a program is to be a written document, it will generally state the goals and

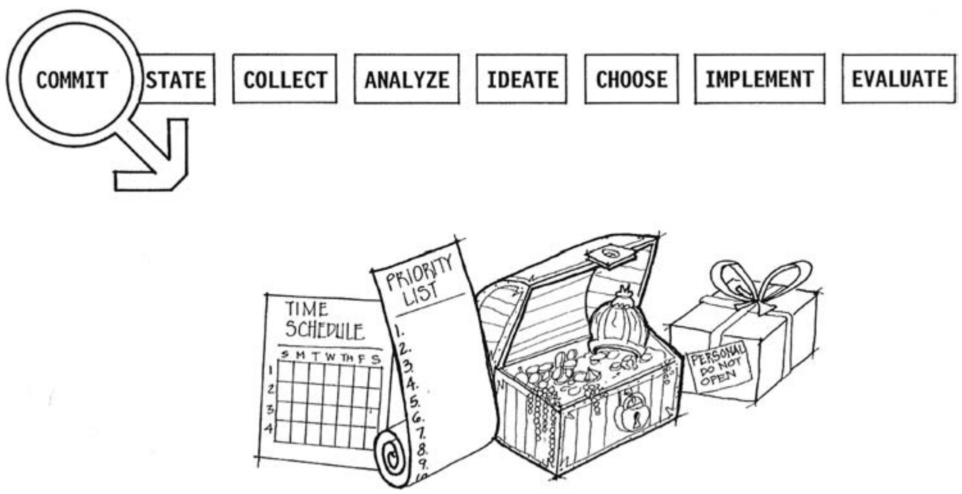


FIGURE 6.7 Techniques for committing to a problem can be listed as prioritization, reward concept, or personal values.

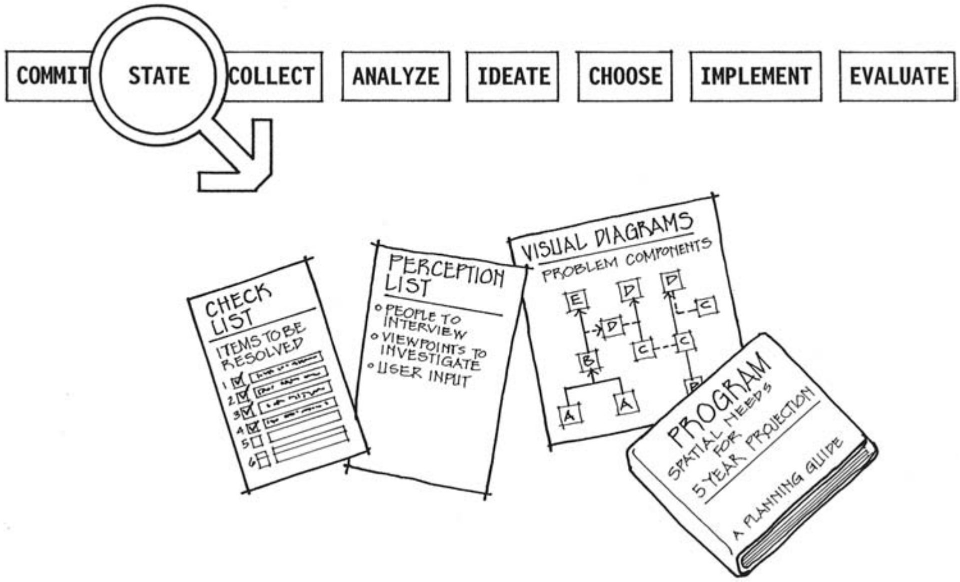


FIGURE 6.8 Techniques for the problem statement can be implemented through checklists, perception lists, visual diagrams, or a printed program.

objectives to be resolved (discussed in more detail in Chapter 7). This would then be considered the problem statement. If the program is not prewritten, the designer defines the key issues of the problem and continually asks, "What really is the problem? What am I trying to resolve? Does my solution truly resolve the situation?

Techniques to Perceive, Define, and State the Problem

CHECKLIST The designer devises a checklist of precisely what needs to be resolved to solve the problem, listing all aspects (physical, social, psychological, and economic) that are to be considered in order to better understand the overall problem.

PERCEPTION LISTS A perception list names everyone with an opinion or direct input (such as the user) about the problem. The designer tries to perceive the situation as these people might see it, perhaps by asking questions of the client or other "experts," such as architects, designers, or consultants. Their points of view could offer different insights into the problem.

VISUAL DIAGRAMS If a program has been supplied, it might list the goals, objectives, and problem statement in diagrammatic form. This generally helps the designer to visualize and organize the information.

If no program is supplied, a simple chart or sketch should visually list all the components of the problem, which can then be rated according to their importance and relationships to one another.

Collect (Gather the Facts)

Once the designer has a clear understanding and definition of the problem, pertinent information should be gathered (Figure 6.9). This stage is generally referred to as "programming" and involves collecting data that are categorized and presented as a published program. (This step involves a great deal of research, data, surveys, etc., and is explained in more detail in Chapter 7.) However, additional information may be needed if not fully supplied in the program. For example, the program may have stated that seating is required in an auditorium-type setting. At this time, the designer may have to gather additional information on various types and sizes of appropriate seating.

Today, the rise and usage of the Web has made gathering information quicker with search engines and the proliferation of material worldwide. Collecting information can often become an electronic two-way street as more detailed information can be gleaned with instant queries to people, companies, manufacturers, and other sources of facts.

Techniques for Collecting Information

Collecting and researching background and related information on a large project can result in vast amounts of documents and graphical inputs. Various techniques are used to categorize the information and arrange it in a hierarchal manner to clearly distinguish between priorities and desirable factors.

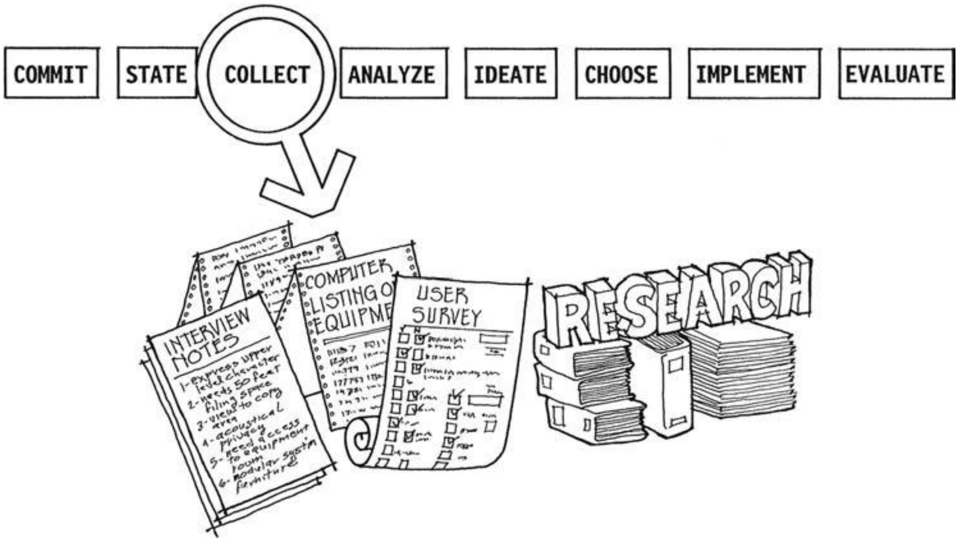


FIGURE 6.9 Techniques for collecting information can be implemented through interviews, user surveys, and research of published accounts of similar projects.

If no program has been furnished with background information, the designer can use research, interviews, and surveys to gather that information. See Chapter 7 for specific examples.

Analyze

A designer must now look over all the gathered information about the problem and organize it into related categories (Figure 6.10). This is particularly helpful when an abundance of data and facts prevents a designer from drawing any direct conclusions or easily seeing the relationships within the information. The designer sifts through the data and notes those items that are primary to affecting the final solutions and may have a direct bearing on the problem. For example, if the givens for an examination room in a doctor's new medical offices include natural daylight and a low-maintenance floor, the lighting data have greater impact on the final design solution, since the room location must provide a window or a skylight. A number of alternative coverings can be suggested for the flooring, which is a secondary concern.

Techniques for Analysis

Among the many ways to break a complex problem or a mass of data into smaller, more manageable parts is using charts or matrices (see Chapter 7 for more details). As the individual parts are scrutinized, overall relationships can often be found that lead in the direction of solving the problem or give meaning to all the data collected.

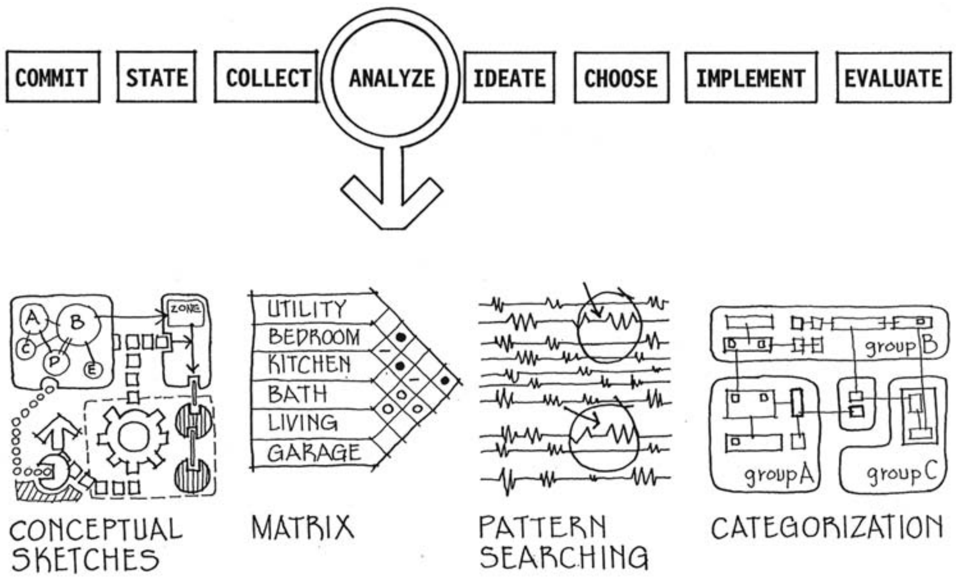


FIGURE 6.10 Techniques for analyzing information can be implemented through the use of conceptual sketches, matrices, pattern searching, and categorization.

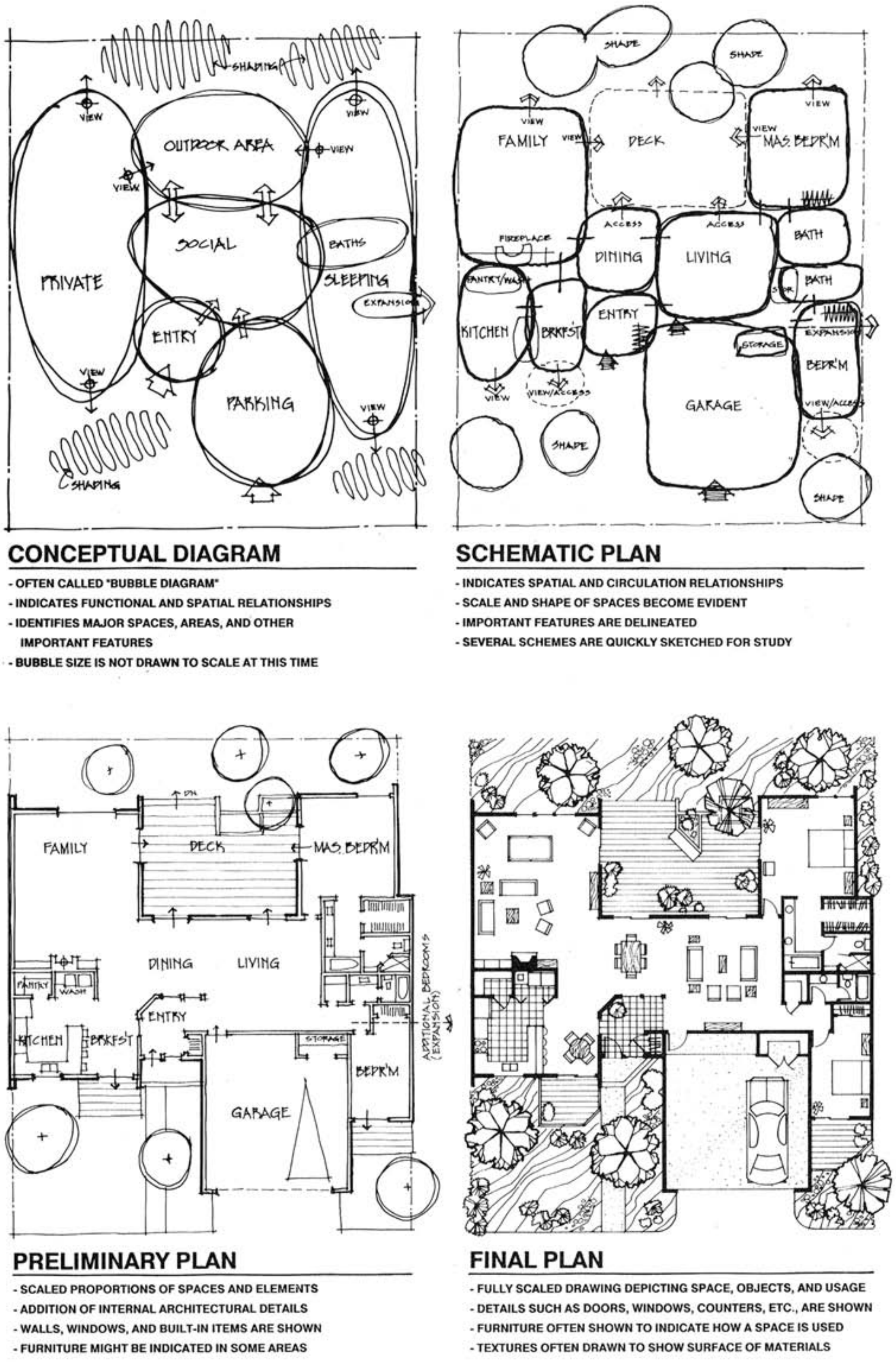


FIGURE 6.11 Typical design sequences for visually developing a floor plan from the conceptual stage to a final plan.

At this time, the designer begins to generate simple visual sketches of the plan, by developing it from conceptual diagrams to final design plans. This design sequence, as illustrated in Figure 6.11, continues through to the implementation step.

CONCEPTUAL DIAGRAMS Conceptual diagrams are the beginnings of visualizing functional relationships for the problem. These abstract sketches help to reinforce a design concept. Ideas are sketched into abstract forms that represent program activities and physical circulation patterns (see Figure 6.12).

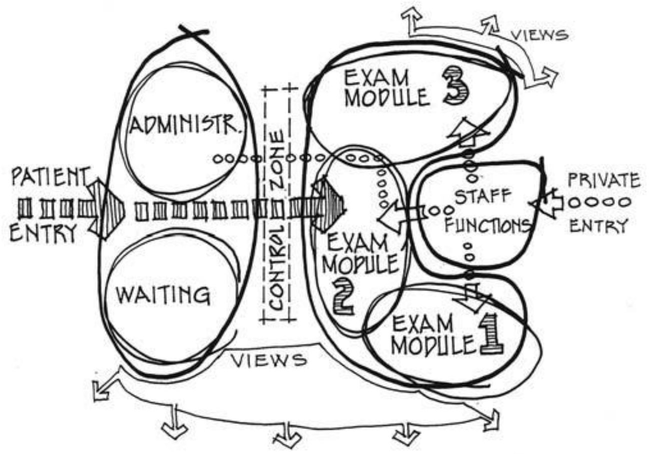


FIGURE 6.12 Conceptual diagram of a proposed medical suite for three physicians. This sketch shows some possible activities, circulation, and relationships required by the users.

These conceptual sketches are often called bubble diagrams and identify major spaces or areas. The bubbles are not drawn to scale, since at this stage these reflect general relationships, as opposed to actual sizes or shapes (see Figure 6.13). This lack of scale in the early stage helps the designer explore many relationships, and not be overly concerned with making the size of the bubbles accurately represent square footages (or meters).

The designer explores a number of alternative arrangements with the bubble diagrams. Generally, designers use a minimum of two or three bubble diagram schemes, comparing them for the most preferred arrangement (see Figure 6.14).

PARTI DIAGRAMS The term "parti (pahr-TEE)" is from the French, meaning "parted." Parti diagrams are visual diagrams that communicate the organizing idea behind the project. They use graphic images to represent abstractions in a more direct visual manner and seek to provide the main organizational ideas of the schemes (Figure 6.15). Parti diagrams can also represent cultural aspects and spatial relationships. These diagrams help shape the building and interiors into a unified whole and strengthen the design concepts.

Ideate

The ideation step is perhaps the most exciting and creative segment of the design process. The concept of ideation, as used in the book *Universal Traveler,*[1] means generating as many ideas or alternatives for achieving project goals as possible. It is seeking different creative ways of solving the problem and establishing the overall design concept. However, ideas should be generated only after gaining thorough understanding of the problem, as outlined in the earlier steps.

The process of ideation involves two distinct phases: a drawing phase, referred to as schematics, and a concept statement, expressed in a written or verbal form.

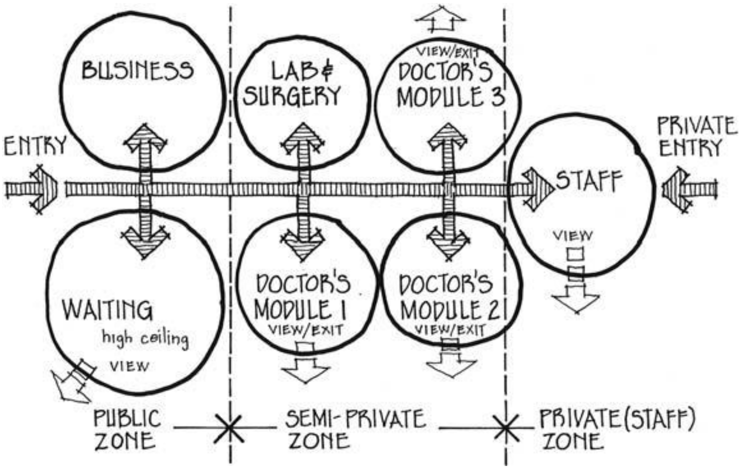


FIGURE 6.13 Bubble diagrams indicate spaces, relationships, circulation, and other important features. The areas can also be further separated into individual zones.

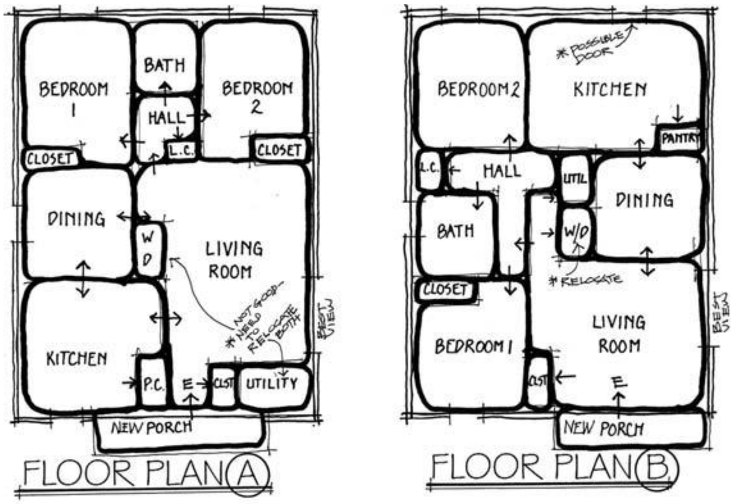


FIGURE 6.14 At least two alternative arrangements are explored with bubble diagrams.

Schematics

The designer's imagination is stretched to find as many creative alternatives as possible that can be generated to solve the problem's givens. These alternatives are then sketched or recorded to build a series of different ways the problem can be resolved. Creative designers force themselves to look at the problem from many different viewpoints, attempting to resolve these into one strong solution. This phase involves the drawing of diagrams, plans, and sketches that express spatial and functional requirements, as well as the image, feeling, or character of the environment (Figure 6.16).

Schematic sketches are further refinements of the bubble diagrams. They are generally drawn in proportion to the size or square footage of each area and begin to suggest boundaries, circulation systems, and articulations. Important requirements, such as views and storage, are delineated. See Figures 6.17 and 6.18 for examples.

Concept Statement

At the same time, while the designer is visually exploring the alternatives, he or she begins to develop a concept of how to achieve the problem objectives. These ideas are stated or written as the concept statement, which establishes the underlying principles that the resulting designs will address. Concept statements are often called the "heart and soul" of a design idea. These concepts establish the inspiration of a project and help the designer create uniformity throughout. This statement should be written in simple, declarative sentences that concisely describe the principal ideas, both functional and aesthetic, behind the proposed design. The concept statement should discuss the methods that bring about results; it does not state what those results will be.

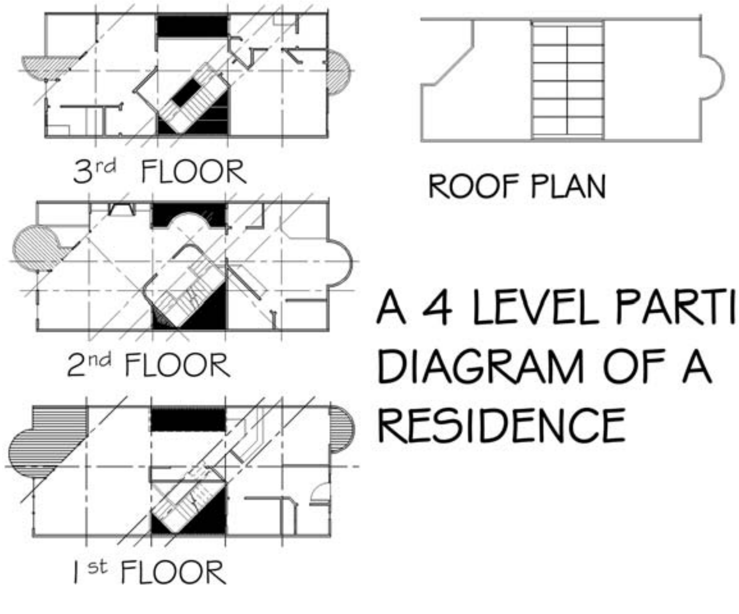


FIGURE 6.15 Parti diagrams use graphical layouts and images to communicate organizational ideas.

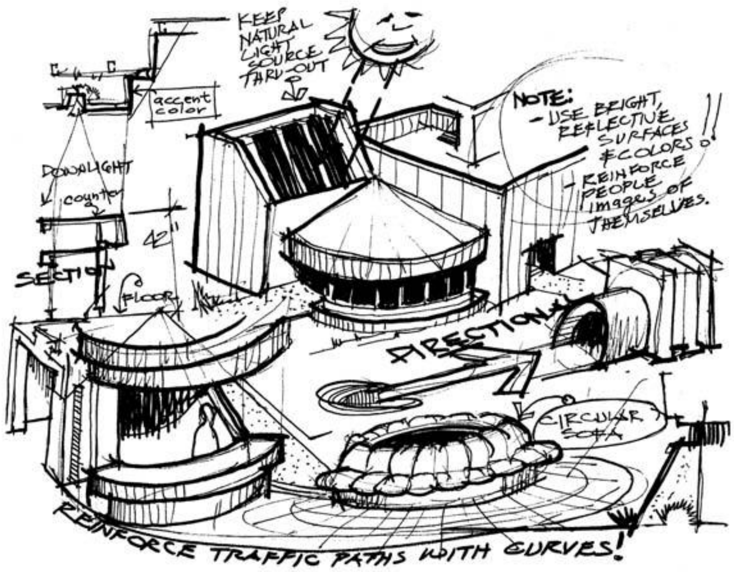


FIGURE 6.16 In the conceptual stages of a project, designers also execute exploratory sketches that express imagery and character in addition to functional requirements.

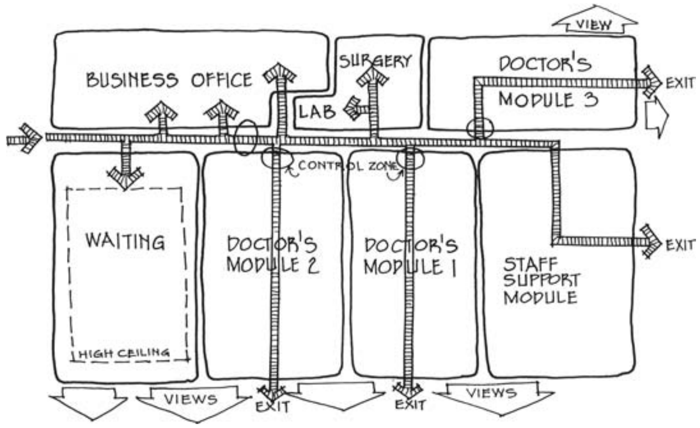


FIGURE 6.17 Schematic sketches can be regularized in order to begin refining spatial relationships and approximate sizes.

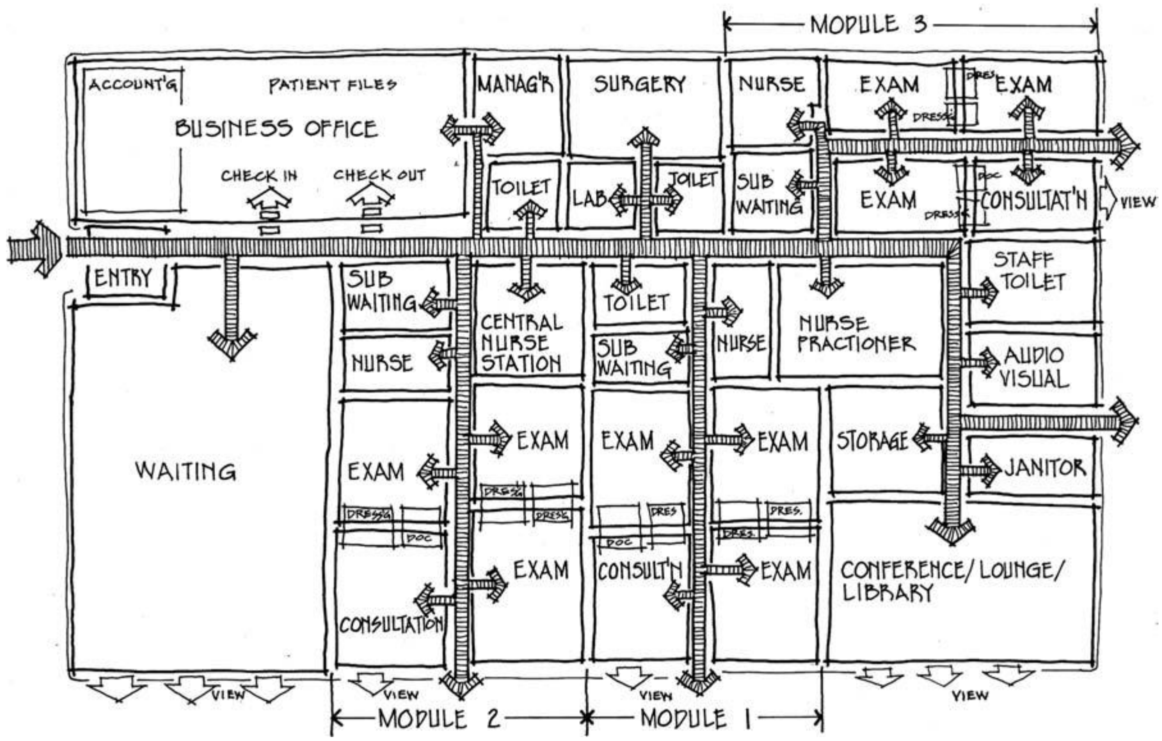


FIGURE 6.18 The schematics are further refined into specific spatial relationships and circulation within subzones.

The design concept should relate to the needs and special requirements of the situation. For example, a concept statement might say, "The multipurpose room will be designed to be flexible in use by providing . . ." or "Physically impaired people require spaces that allow them."

Techniques for Ideation

The complexities and magnitude of some interior environments—particularly large-scale interiors, such as office buildings—often demand more design expertise, time, and idea generation than one designer can offer. In these cases designers may form design teams or use various types of focus groups to tackle a project. Today, focus groups are often online or set up in video conferencing. Decisions are made to ensure that all team members and aspects of the problem are represented. Any conflicting views or opinions must be worked through before proceeding to the next step of implementing.

In his book *Methods of Architectural Programming*, Henry Sanoff[2] describes the following five group decision-making strategies that are helpful in generating ideas (Figure 6.19).

ROLE-PLAYING In role-playing, a group gets together to generate ideas, and designers simulate client or user situations in an unrehearsed scenario. Team members assume a designated role and give input from the point of view of that client (or user). The intent is to stimulate the designers to look into new attitudes and biases about the project that will ultimately affect the use of the spaces. The designers try to understand how others would perceive the problems at hand.

BRAINSTORMING Brainstorming is an idea-generating process whereby designers express their thoughts in a freewheeling, informal way, to produce as many ideas and alternatives as possible. Spontaneity and innovation, as well as fantasizing about the relationships of the problem, are encouraged. It is desirable for sessions to be rapid-fire to stimulate group enthusiasm and release ideas that individuals may be holding back or subconsciously censoring. This censorship might inhibit them from reaching a unique solution to the problem. The group should strive for quantity, as the more ideas, the better the options. In these sessions, designers also use sketches and graphics to communicate their ideas (Figure 6.20).

BUZZ SESSIONS A fast-moving but directed group activity, buzz sessions discuss a specific topic and propose alternatives for design strategies. The goal is to have a body of people critically analyze ideas related to the specific problem within a designated time limit. These groups promote understanding of all the participants' viewpoints but seek to arrive at a consensus on specific points.

DISCUSSION GROUPS In small discussion groups, participants share knowledge, develop new attitudes, and attempt to arrive at well-thought-out decisions. Unlike quick buzz sessions, these sessions are held over a prolonged time period and are closely coordinated by a group leader who guides the participants through to a decision-making process. This technique is sometimes used by a design team in solving a complicated client problem with many variables.

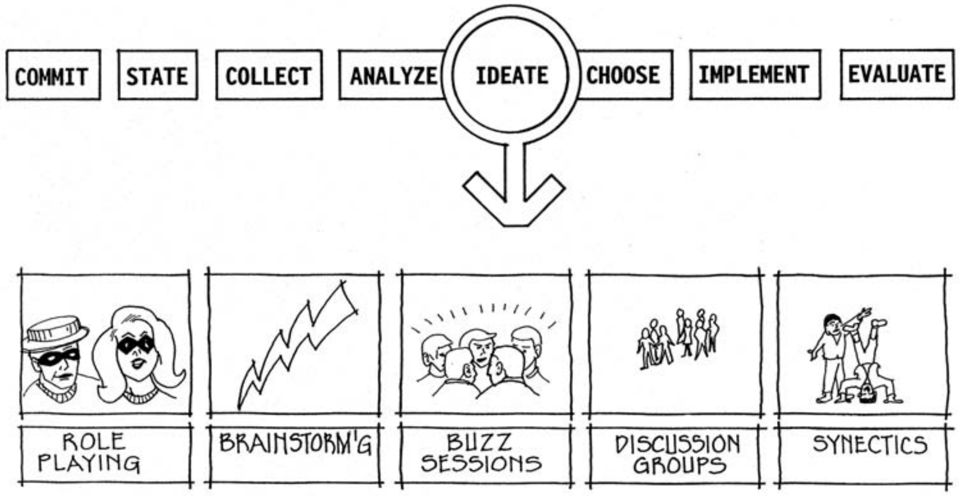


FIGURE 6.19 Techniques for ideating can be done through role-playing, brainstorming, buzz sessions, discussion groups, and synectics.

FIGURE 6.20 This small room serves as a collaborative workspace for these designers to informally meet and propose alternatives for design strategies on a particular project.
Courtesy of Perkins + Will; photograph by Steve Hall. © Hedrich Blessing

SYNECTICS Synectics involves a group activity that attempts to make the unfamiliar look familiar and the familiar appear unfamiliar. This fresh way of looking at a problem increases the probability of a creative and unique solution. Symbolic and fantasy analogies are utilized to delve into the project to allow team members to interact creatively and achieve a novel solution that is not possible by using other methods.

Choose (Select the Best Option)

Some designers find the selection stage of the design process difficult (Figure 6.21). However, if the established goals, objectives, and problem-solving methods have been defined, this step can be fairly clear-cut. The designer chooses the most appropriate or "best" option by going back to see how the selected concept fits the client's budget, needs, objectives, and desires. If the selected option satisfies the criteria, has a creative approach, and

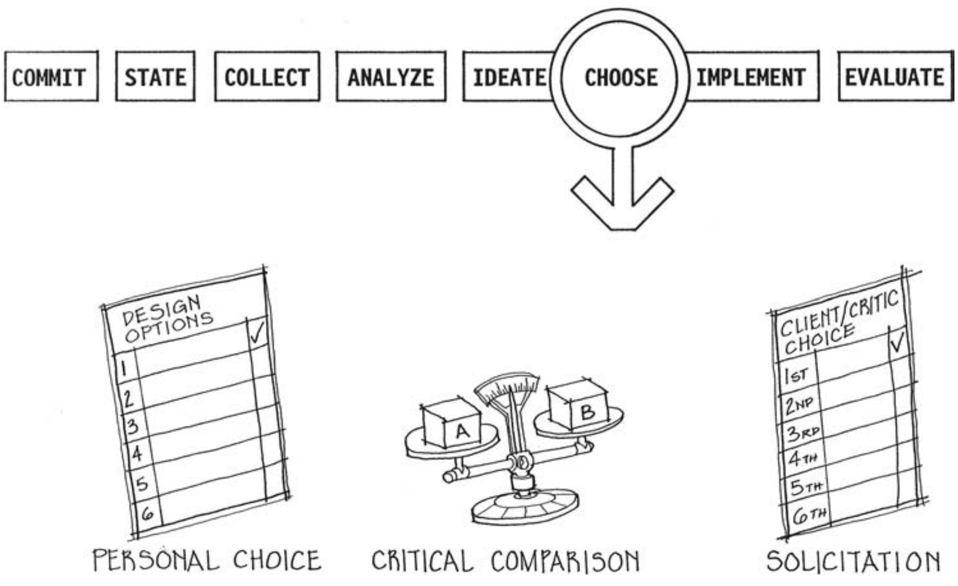


FIGURE 6.21 Techniques for selecting the best solution include personal judgment, comparison, and soliciting a consultant.

produces a functional and exciting solution to the problem, it is the right choice. If it does not, the designer should reevaluate the alternatives and select another option. After all the schematic drawing options have been explored and one has been selected, the designer begins preliminary drawings.

Preliminary Drawings

The schematics are refined in scale and proportion to represent the actual square footages of the spaces. Details begin to evolve, showing walls, circulation routes (corridors), views (windows), and the usage of the spaces. Sometimes at this stage, furniture, equipment, and built-ins (such as cabinets) are indicated (Figure 6.22). The drawing is still fairly sketchy and may have been drawn freehand. The designer is still refining details and does not want to laboriously make very accurate drawings at this time. These preliminaries are generally presented to the client for feedback and then revised or further developed into the next phase of design drawings. At the same time that the preliminary plan is being developed, designers are also preparing preliminaries or building sections and elevations to indicate vertical spaces (Figure 6.23). (See Chapter 18 for further discussion of communicating in design.)

Techniques for Decision Making

PERSONAL JUDGMENT Most designers make decisions based on personal judgment. They carefully compare each choice against the others and decide which option satisfies the problem objectives. This is a decision-making process in which the designer relies on his or her past experiences and confidence in making proper choices. But today, most designers need input from others as the world has become interlinked, and diversity and interaction with others are more in demand. Designers don't just work in a vacuum.

COMPARATIVE ANALYSIS Although the personal judgment method is effective, decision making can be improved by carefully itemizing, ranking, and weighing the options in a hierarchical manner to determine why one solution is better than the other. Criteria are carefully listed for each idea and weighed against other options. Judgment can then be made, based upon a total point or weighing system of pros and cons, rather than by "feeling" which decisions might be best, based on a personal bias.

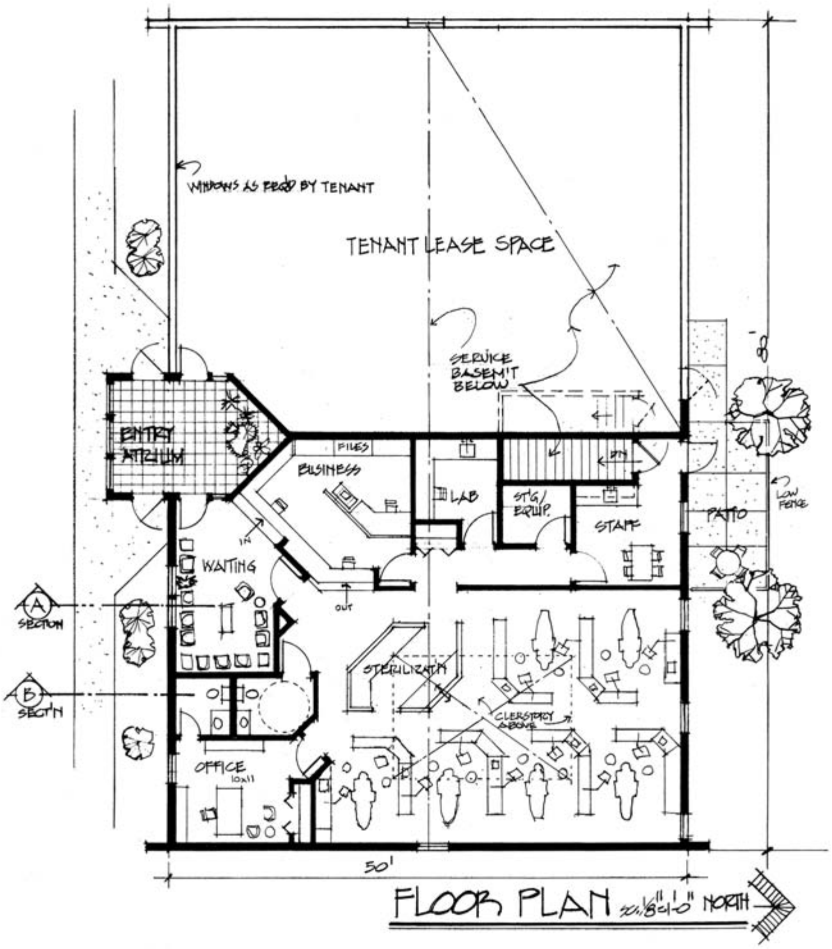


FIGURE 6.22 Preliminary floor plan of a dental office within a small medical building. At this stage, drawings can indicate walls, openings, spaces, furniture, and other details.

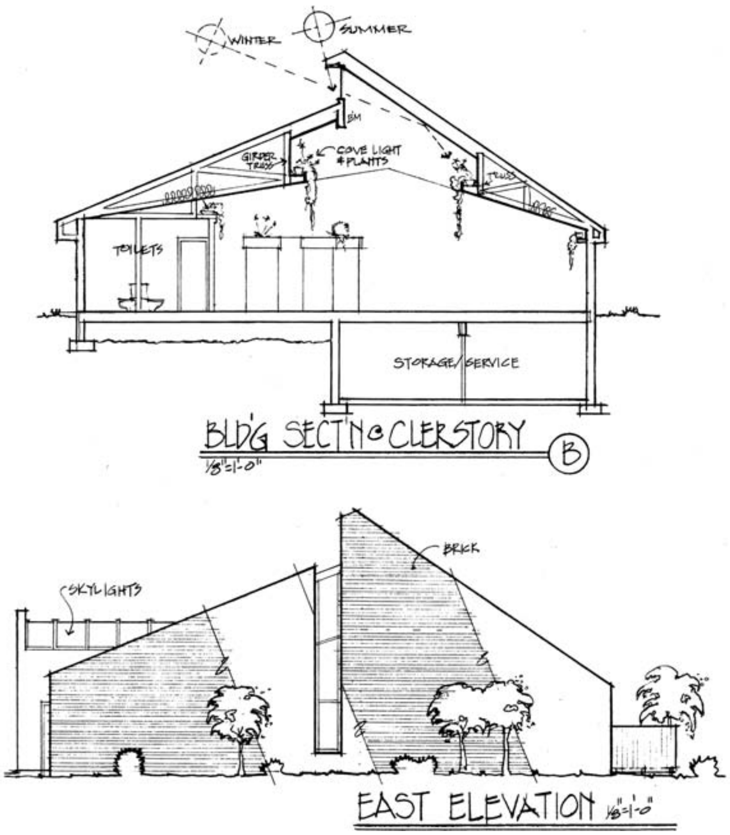


FIGURE 6.23 Preliminary building sections and elevations can be sketched to define the verticality of spaces and explore other details.

CONSULTANT OR USER DECISION Another method is to let the clients, consultants, or users make the decisions. Often the people who are going to utilize the solution are asked for their input or decision; this is called user selection. However, users' decisions might be biased because of the way they perceive the solution, so the designer should always structure the alternatives for the users and suggest implications each choice might present.

Implement (Take Action)

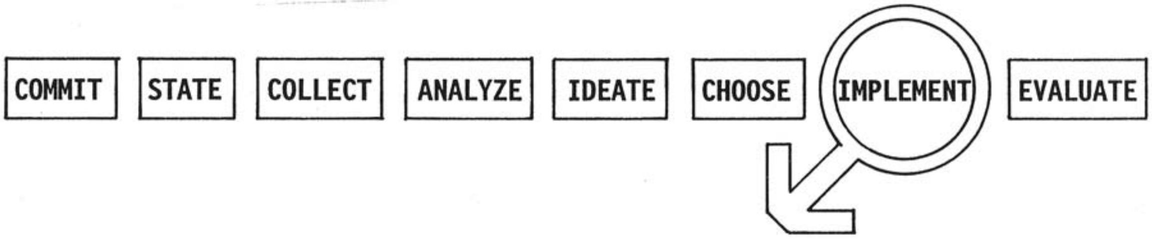
Implementation refers to executing or taking action on the selected idea and giving it physical form (Figure 6.24). This step communicates the idea through final drawings, plans, renderings, and other forms of presentation to the client. The design process does not stop with a creative idea or solution but continues in this action stage to bring the ideas into reality. To the student in the classroom, this step might involve executing final presentation drawings, renderings, and so forth for presentation and evaluation by the instructor(s) (Figure 6.25). To a professional designer, this step involves the strategy of getting final approval from the client.

Techniques for Implementation and Communication

FINAL DESIGN DRAWINGS At this time the preliminary drawings are further developed into final design drawings, including plans, sections, elevations, and other details. (See Chapter 18 for examples of more detailed drawing types.) The final plan is drawn to scale and depicts all spaces and objects, including architectural details, such as doors, windows, and built-in cabinetry. Once these drawings are approved, construction drawings must be made, a contractor must be hired, and workers have to be supervised before the client can eventually move in.

TIME SCHEDULES To move ahead effectively on the chosen idea, it is best to have a clear view of the major tasks, activities, people, materials, and time involved to execute the idea. The designer can simply list all these or can develop time schedules, calendars, graphs, and other charts to assist in methodically moving ahead on the project

BUDGETS Designers often have creative and exciting designs. Some are easily done, and others might be very expensive to implement. In the architectural and interior design fields, early discovery and compliance to a client's



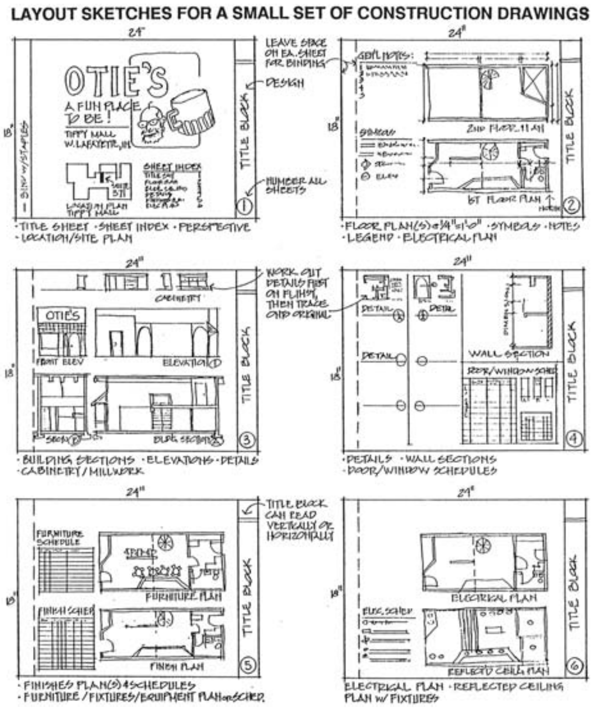


FIGURE 6.24 Techniques for implementation can include various drawings and schedules, such as finish and furniture schedules.

monetary budget is often a controlling factor in the outcome of a project. Preliminary cost estimates and final budget numbers are compiled throughout the design and sequential stages in a project.

In addition to the construction budget, the design firm also estimates their time and fees on a project from the initial planning, subsequent stages, and the time that might be required to oversee the construction phase (Figure 6.27). This is discussed in more detail in Chapter 19.

CONSTRUCTION DRAWINGS Construction drawings, sometimes called working drawings, are prepared to detail all the particulars of a project. First, a preliminary layout of all the sheets that are required should be prepared. They are then drafted to scale, to show what is to be constructed (or supplied), where it is to be placed, and how it relates to other parts of the project. These drawings include scaled plans, elevations, sections, details, notes, schedules, and other directives that will guide contractors who do the work. (See Chapter 18 for detailed descriptions and examples of these drawings.) Careful coordination is needed between the structural, architectural, mechanical, electrical, finish, and furniture drawings to ensure that the project is completed correctly and in a coordinated effort by the workers.

In some cases, "as-built" drawings must first be prepared if none is available for an existing facility. The designer measures all the physical features of the built environment and prepares scaled drawings to show what exists. See Chapter 18 for examples.

SPECIFICATIONS Specifications are written instructions to the general contractor and vendors for the materials, performance standards, and method of construction or installation to be utilized. Specifications are written in technical terms and usually include what is to be done, how it is to be done, who is to do it, and the standards of materials and performance to be met. In the design field, these specifications, the accompanying construction

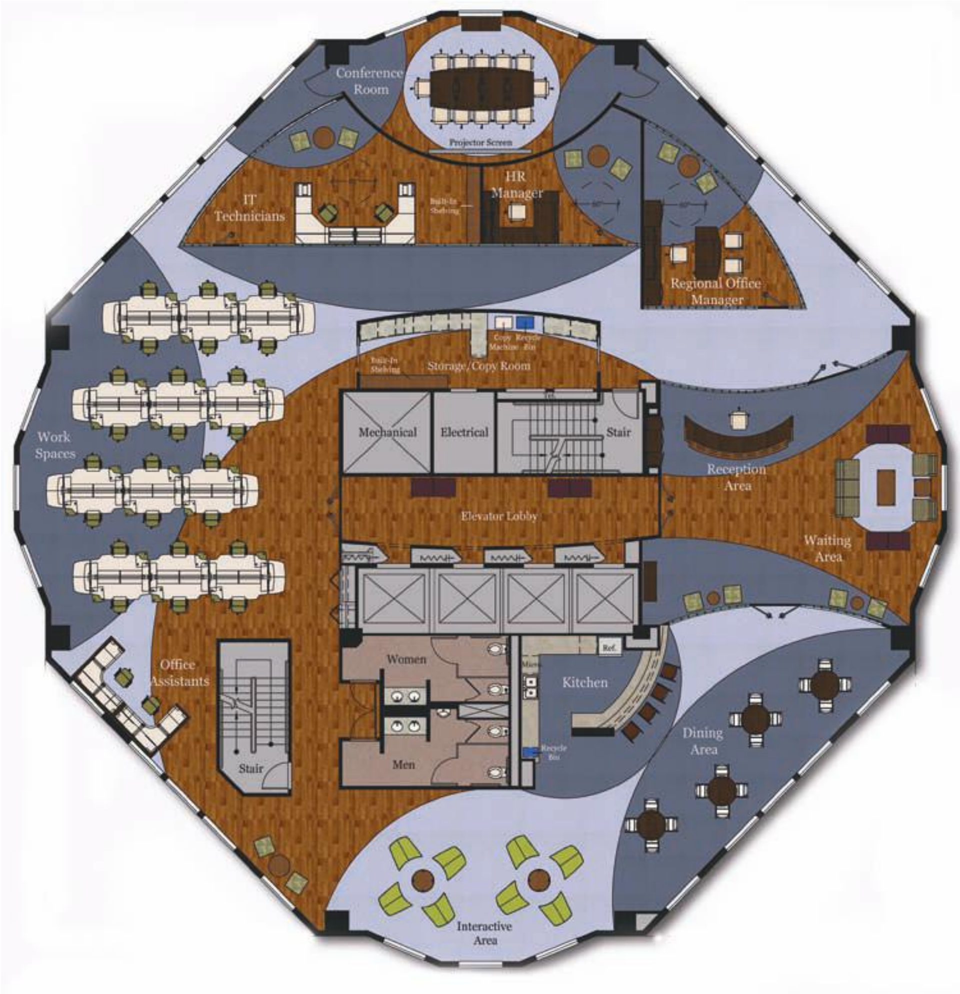


FIGURE 6.25 Final presentation floor plan of an office is drawn to scale with furniture and floor textures added.

drawings, and various legal contracts direct the various parties in implementing the solution into physical reality. More discussion is to be found in Chapter 18.

CONTRACT ADMINISTRATION The designer or a representative often has to oversee the implementation of ideas from conception to physical reality. In interiors, this means overseeing the project to be constructed or installed. The designer assists the client in the administration of the contract to implement the designer's solution. These stages of implementation are usually broken down into the following steps:

1. *Contractor Selection.* Contractors are selected to execute the work. In some instances, just one contractor is negotiated with, but usually bids are received from several contractors interested in doing the project. The bids are based on the designer's drawings and specifications. The designer and the owner select a contractor on the basis of the estimated cost and the reputation of the builder.
2. *Observation.* During the construction process, the designer checks on a regular basis for quality, to be sure the budget is being met, to make certain the time schedule is being followed, and to check subcontractors' shop drawings for conformity with the designer's drawings. There is a distinction between observation and supervision (a term sometimes used by designers); the designer observes construction and does not directly supervise the workers.
3. *Move-in or Occupancy.* The designer assists the owner and the contractor in coordinating the move-in and the installation of furniture, furnishings, and equipment. (See Chapter 19 for further explanation.)
4. *Punch List.* The designer develops a list of substandard or incomplete items that must be corrected by the contractor. Although it is preferable to do this step before move-in, it often occurs during or after this process, at the time when the owner is ready to occupy the project. See Chapter 19 for more information.

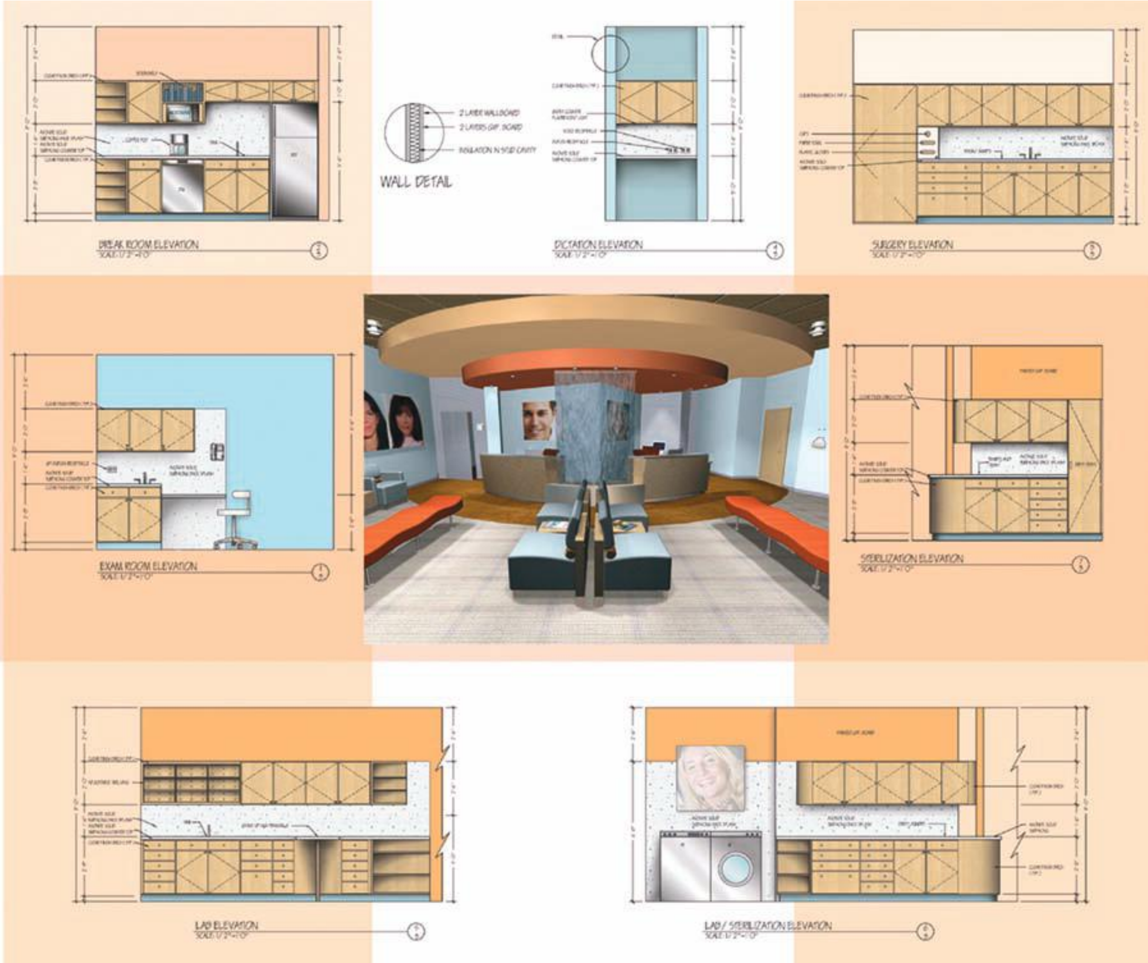


FIGURE 6.26 This presentation board (2 of 5) details the interior elevations and includes a rendering of the reception desk.

ESTIMATED CONSTRUCTION DOCUMENTS & ADMINISTRATION COSTS FOR SAXTON RESIDENCE

SHEET	DESCRIPTION	RESPONSIBILITY	HOURS	× $100	SUB TOTAL	DRAFT'G HOURS	× $45	SUB TOTAL	TOTAL
1	SITE PLAN	Kilmer	5	$ 100.00	$ 500.00	3	$ 45.00	$ 135.00	$ 635.00
2,3	SEPTIC SYSTEM	Good	2	$ 75.00	$ 150.00	2	$ 45.00	$ 90.00	$ 240.00
4	FOUNDATION/FOOTING PLAN	Good	2	$ 75.00	$ 150.00	2	$ 45.00	$ 90.00	$ 240.00
5	LOWER LEVEL FLOOR PLAN	Kilmer	6	$ 75.00	$ 450.00	8	$ 45.00	$ 360.00	$ 810.00
6	1ST FLOOR PLAN	Kilmer	10	$ 75.00	$ 750.00	6	$ 45.00	$ 270.00	$ 1,020.00
7	2ND FLOOR PLAN	Kilmer	5	$ 75.00	$ 375.00	6	$ 45.00	$ 270.00	$ 645.00
8,9	BUILDING SECTIONS	Kilmer/Good	6	$ 75.00	$ 450.00	4	$ 45.00	$ 180.00	$ 630.00
10,11	EXTERIOR ELEVATIONS	Kilmer/Good	6	$ 75.00	$ 450.00	8	$ 45.00	$ 360.00	$ 810.00
	STUDY MODEL	Kilmer/Good	4	$ 75.00	$ 300.00	8	$ 45.00	$ 360.00	$ 660.00
12,13	INTERIOR ELEVATIONS	Kilmer	2	$ 75.00	$ 150.00	3	$ 45.00	$ 135.00	$ 285.00
14,15,16	FRAM'G & ROOF PLANS	Good	3	$ 75.00	$ 225.00	4	$ 45.00	$ 180.00	$ 405.00
17,18,19	ELECTRICAL PLANS	Kilmer	2	$ 75.00	$ 150.00	1	$ 45.00	$ 45.00	$ 195.00
20	PLUMBING SCHEMATICS	Good	2	$ 75.00	$ 150.00	2	$ 45.00	$ 90.00	$ 240.00
21,22	MECHANICAL SCHEMATICS	Good	3	$ 75.00	$ 225.00	2	$ 45.00	$ 90.00	$ 315.00
23	INTERIOR FINISHES	R. Kilmer	22	$ 75.00	$ 1,650.00	8	$ 45.00	$ 360.00	$ 2,010.00
24	INTERIOR EQUIPMENT	R. Kilmer	20	$ 75.00	$ 1,500.00	4	$ 45.00	$ 180.00	$ 1,680.00
25	INTERIOR FURNISHINGS	R. Kilmer	12	$ 75.00	$ 900.00	5	$ 45.00	$ 225.00	$ 1,125.00
	ADMINISTRATIVE (typing,etc.)	Staff	6	$ 75.00	$ 450.00	18	$ 28.00	$ 504.00	**$ 954.00**
TOTALS			**118**		**$ 8,975.00**	94		**$3,924.00**	**$ 12,899.00**
SITE INSPECTIONS									
1hr. Every 2 weeks x 6 months		Good	24	$ 100.00	$ 2,400.00				**$ 2,400.00**
						TOTAL FEES			**$ 15,299.00**

FIGURE 6.27 A spreadsheet is used to estimate the number of personnel hours and responsibilities for the construction document phase of a new residence.

Evaluate (Critically Review)

The evaluation stage (Figure 6.28) of the design process reviews and makes critical assessment of what has been achieved to see if it does indeed solve the original problem. The evaluation stage is also a review to see what was learned or gained from the experience and what the effects or results of the design activity were. This stage is also part of the self-improvement of the designer and the design process used and is intended to achieve closure on a problem.

It is important for the interior designer to work continually to understand and improve his or her own method for arriving at solutions. This can be difficult, but it is imperative for all designers to look back to see how they got to the end of the problem and to attempt to assign a value to the results achieved. They can then refine their methods for application to future situations.

Techniques for Evaluation

There are many forms of evaluation that measure the quality and quantity of design decisions. They all attempt to measure the effectiveness of the design solution and the designer's process of designing; evaluation serves as a learning tool for future problem solving.

SELF-ANALYSIS Designers often measure their achievements in terms compared to the initial objectives. To accomplish this, they evaluate themselves and their actions honestly and critically.

SOLICITED OPINIONS Another method involves evaluation by an outside, independent source. They might be other designers, immediate supervisors, consultants, users, and so forth. These outside judgments can assist the designer in seeing the solution to the problem from another viewpoint. This can provide valuable insight for the designer to measure the effectiveness of his or her own proposals and the way others perceive those proposals. However, these opinions must be scrutinized to determine whether they are an accurate assessment of the situation and are indeed aimed at helping the designer improve the design process.

STUDIO CRITICISM In the classroom, a common form of evaluation is the studio criticism, or the "critique." This is an evaluation of the project and the student's performance. These critiques can be done periodically or as a final at the end of the project. They might be done individually by the instructor or in conjunction with a peer review "jury" where the student presents his or her designs before the instructor, class, and invited critics (often professional designers or clients with experience in the project types).

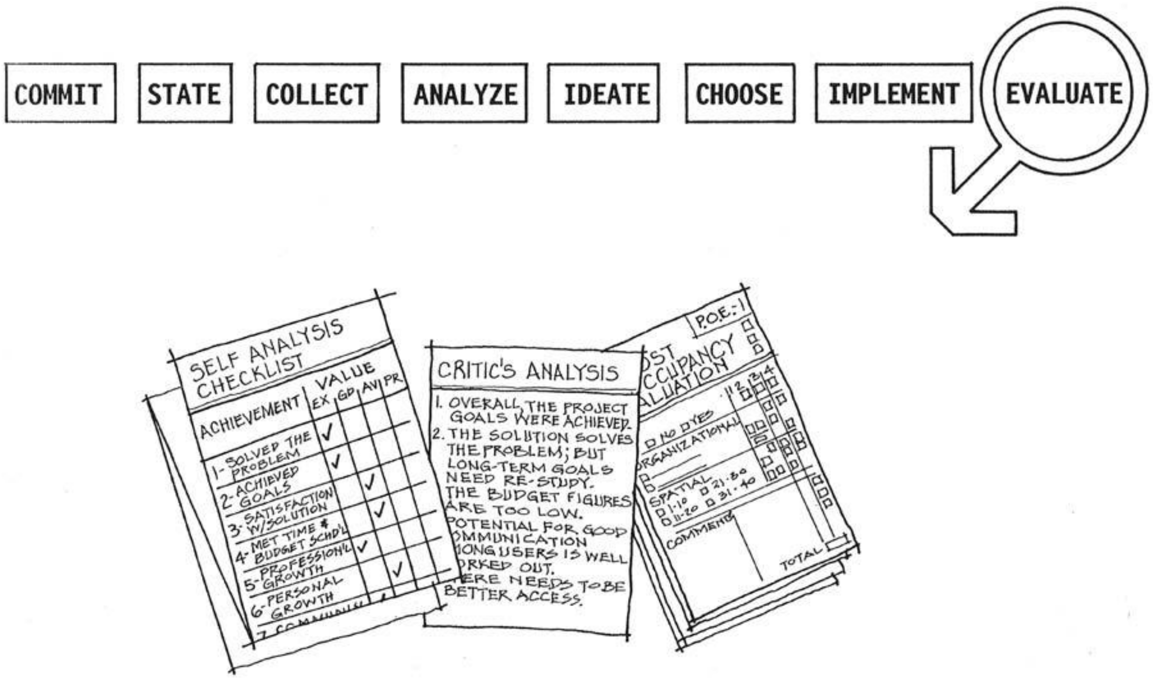


FIGURE 6.28 Techniques for evaluating a design solution can include a variety of methodologies.

Critique sessions provide an excellent form of critical evaluations and are most effective when the communication is two-sided—that is, with questions and explanations flowing freely between the student, instructor, and others who might be participating. Students should be aware that instructors are providing "constructive" criticism, not "destructive" criticism. Design is often a trial-and-error process in which learning occurs from making mistakes. A student should realize this and build from the critique, creating better design results and methods.

POSTOCCUPANCY Many interior designers use an evaluation technique termed postoccupancy evaluation, which is a formal process to determine whether the designer's solutions did indeed solve the client's problem. This analysis seeks to find out how well the interior environment satisfies the performance, behavior, and psychological needs of the users. Does the final design satisfy the original program requirements? By going back to a project later and carefully examining everything, the designer can learn what worked and what did not. The designer can then improve ideas and problem-solving processes on the next project. These postoccupancy evaluations are often done as a walk-through observation and/or through a questionnaire answered by the users of the facilities.

Feedback

Feedback is the term many designers use for the systematic evaluation at each step of the design process, using former, or previous, steps. It includes looking back, after the process is completed, to the very first step to compare what resulted with what was in place when the project began. It is characteristic of the design process that the entire operation is cyclic—it keeps repeating itself, looping back to former stages, as illustrated in Figures 6.2 to 6.4. If feedback is used after each step and the information gained is fed to the former step, the new inputs might produce some new results. In other words, if the output of each step is fed to the input of the former step, the information gained can often change the current step's results.

NOTES

1. Don Koberg and Jim Bagnall, *The Revised All New Universal Traveler.* Los Altos, Calif.: William Kaufmann, Inc., 1981.
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7

Programming Interior Spaces

To design requires talent, but to program requires genius.

– Le Corbusier, *The Radiant City*

Before a designer can actually design a space for someone, he or she must anticipate how that person will function in the space. Knowing the user's present and future needs, activities, conditions, equipment, special allocations, and other particulars makes the organization and design of space an easier task. Background information must not only be organized and planned but gathered in a systematic manner. This methodology consists of planning or establishing a plan of action. Often referred to as "programming" in the design profession, it is the "collect" or "research" step (Figure 7.1) in the design process, as discussed in Chapter 6.

Many designers and other professionals use the terms *programming* and *program* in several different ways. In the design field, a program generally takes the form of a written or graphic document that presents a structured research and problem-solving process used to identify, examine, and elaborate upon the various elements and needs of a design project. The program contains background information, analysis of facts, evaluation, goals, and conclusions relevant to the problem, which are documented and presented in a clear, organized manner, facilitating communication between user and designer. The program establishes the basic goals and objectives for the designer during the initial design phase.

Programming is not a totally separate profession, but rather a part of the overall process for designing and building environments; it establishes the initial steps in designing for the built environment (Figure 7.2). Programming can be thought of as the predecessor to examining or analyzing the problem, whereas designing can be thought of as solving or synthesizing the problem from the program specifics (Figure 7.3). To analyze means to dissect the parts of a problem to discover the interrelationships; to synthesize means to pull all the parts into an integral and meaningful whole, to develop a design solution. As William Pena summarized it, "Programming is problem seeking, and design is problem solving."[1]

The specific content and format of a program may change from project to project, depending on the scope and complexity of the problem. For example, the same program cannot always be used for every restaurant. However, some critical issues to be addressed in a program may be the same, such as: specific use(s) of the space; number of occupants; activities of occupants; functional and spatial relationships between spaces and activities; furnishings, fixtures, and equipment needs to support the occupants' activities; site selection and site characteristics; cultural, social, and community context; building codes, laws, and ordinances; and economic issues (budget, restrictions, fees, etc.).

The program serves as a tool for recording client and user needs, expectations, and decisions. It establishes specifics to be met in the design stages before the actual construction begins. The designer continually looks back to the program to ensure that the designs will satisfy all the stated specifics.

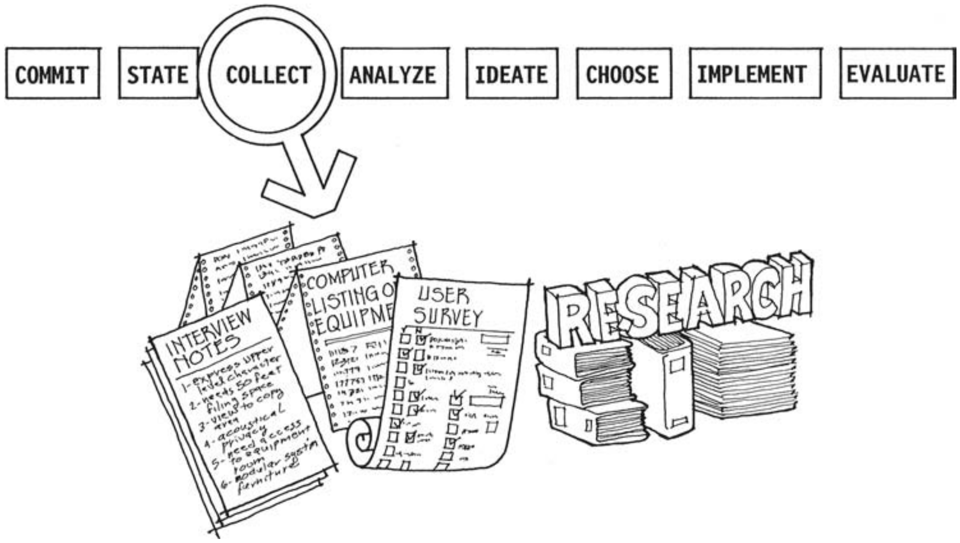

FIGURE 7.1 Programming in the design profession is the "research" step in the overall design process. The collection of background information and facts is then organized in a systematic manner.

Programs are recognized today as an essential part of the planning process for most design situations in architecture and interior design. Interior designers are being required to take more responsibility for detailed programming and planning before the design and sketching process begins. Designers are often faced with the task of designing environments that accommodate functions and activities that they know little about; thus, a program becomes a key to the design phase. More is also being demanded of interior environments in terms of performance and operations. A program might be developed for a physical change in a new or

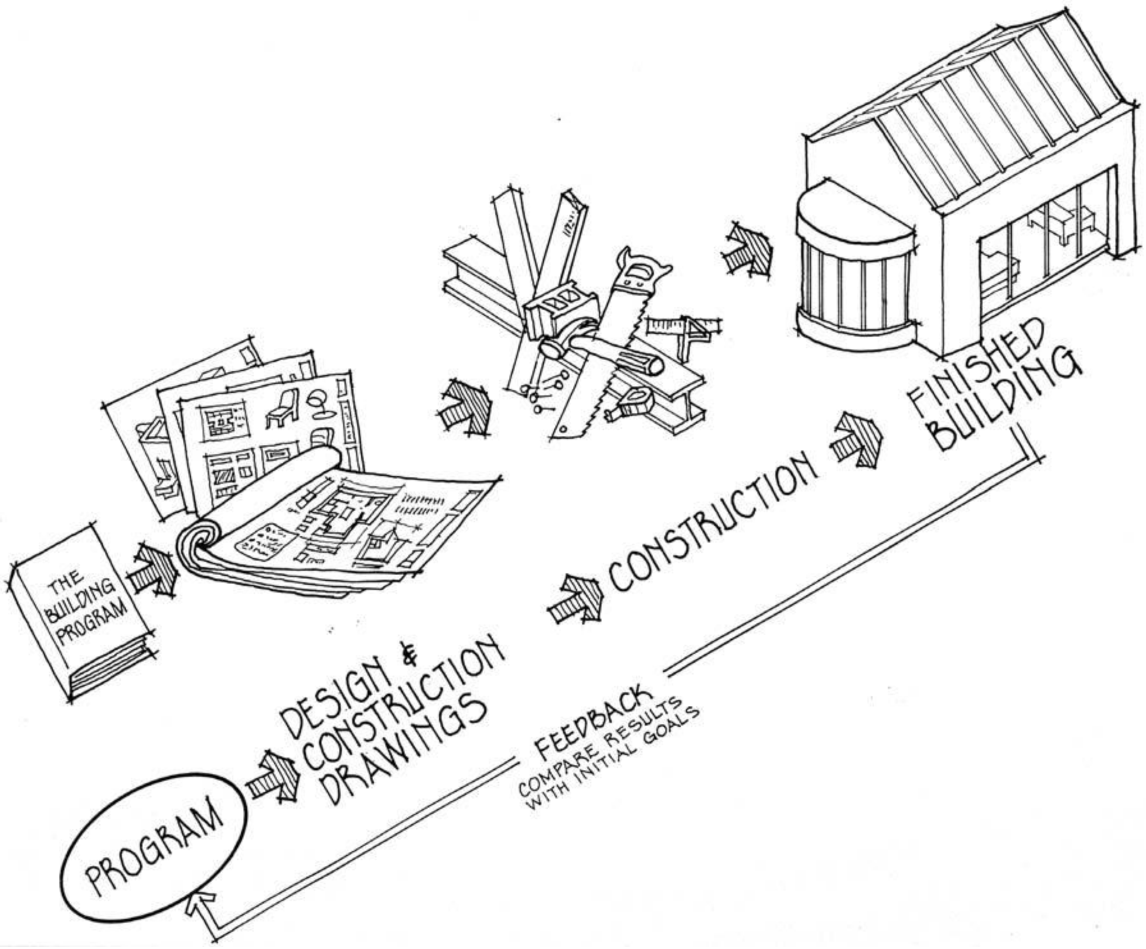

FIGURE 7.2 Programming is the initial step in planning, designing, and constructing interiors and architecture.

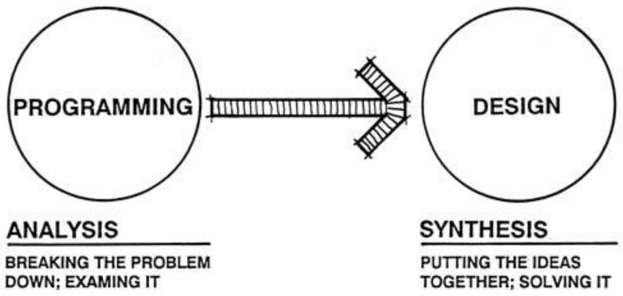

FIGURE 7.3 Programming is an integral part of the overall design process, but can be seen as a separate phase preceding the design phase.

an existing building or for a nonphysical change, such as improving operational efficiency within an established organization. Merely gaining a "pleasing" environment is no longer sufficient justification for a client to incur design, construction, and maintenance costs. The programming phase is crucial to the interior designer as the initial step in ensuring that the environment "performs" as it is designed to, serving the client's needs, goals, and aspirations. Programming is done by a design professional, such as an interior designer or architect, or by a team of professionals. This professional or team is referred to as the programmer in this chapter.

When a large amount of information must be programmed, a model, or paradigm, is an effective method for organizing, analyzing, and presenting this information. Whether for the most complex office environment or a small house, a programming paradigm generally consists of six basic steps: establishing goals, gathering and analyzing facts, specifying needs, evaluating, organizing, and presenting conclusions relevant to the problem (Figure 7.4). This paradigm process is simple enough to be generally repeatable and applied to different types of facilities, yet comprehensive enough to cover the wide range of factors and details that influence the design of complex buildings or interior environments.

VALUES IN PROGRAMMING

It is important to understand that the programmer interjects into the program certain values and attitudes that in turn will influence the problem solution.

The programmer must seek and carefully state the values of the user, client, and society, and of their interrelationships. A point of view is based on an individual's value system. However, the programmer's point of view may differ from the client's and/or user's value system. Values not only affect the decisions we make but also how we interpret the information we gather prior to making a decision. Programmers must be careful to assume a neutral position and listen to the clients' and/or users' values and not interject their own values unless it affects the overall design solution. In turn, the resulting program statements and performance criteria should clearly direct the designer toward creating a viable environment that not only responds to the client/user needs but establishes the resulting environment as a space promoting the healthy existence of those people and their functions in the overall society. Interior designers should be aware of environmental issues and be responsible for protecting the health, safety, and welfare of the public as well as for preserving global life.

Throughout the programming process (and into the design phase), to establish the "quality" toward which the program will direct the resulting designs, a conscious effort must be made to understand the meanings or values of the information gathered on user needs, goals, space requirements, and so forth. Recognizing and stating values will ensure a smooth transition from the program goals to the resulting solution.

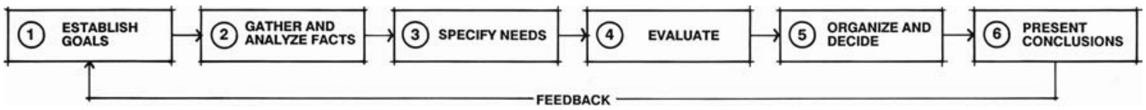

FIGURE 7.4 Programming has six distinct steps that are sequential.

THE PROGRAMMING PROCESS: THE SEQUENTIAL STEPS

Establish the Goals

Goals are the desired result of what is to be achieved (Figure 7.5). They could also be termed the mission, aspirations, or purpose of the project. The goals of a project state what the client wants to accomplish and why; they involve trying to ascertain the client's values and needs, including physical, social, economic, and psychological.

Design is a difficult process because it often attempts to satisfy several goals simultaneously. Goals for a particular problem may include creating a space that is safe and healthy, enables users to perform their functions without causing discomfort, and is aesthetically pleasing, all at the same time. However, these goals are not equal and must be tested for usefulness, integrity, and relevance to the problem. The programmer or designer should set priorities, specifying those goals believed to be most crucial. The goals must also be measurable or able to be tested for usefulness.

Understanding the relationship between goals and objectives (called concepts in design projects) will help determine their relevance to the overall program. A goal is a broad generalization; an objective or concept is a more detailed description of how to achieve the goal. Goals indicate what the client wants to achieve; concepts indicate how to achieve the goals. The designer should state the goals and concepts in his or her own words to ensure that there is a clear understanding of the situation. For example, if a client's goal is to increase the number of customer transactions in a banking facility, a design concept could be to add tellers (or lengthen the bank's operating hours).

Research, Gather, and Analyze Facts

Research and Gather Facts

Facts are existing or actual conditions and are gained by the designer by doing research (Figure 7.6). They are pieces of information that have reality or truth. A design solution is based on high-quality research. An approach that designers take to achieve the highest quality of research, leading to the best design solutions, is called evidence-based design (EBD). EBD is a process for collecting the best evidence from research and practice in order to make critical decisions about the design of each individual project. EBD involves both quantitative and qualitative research. The designer should collect and categorize only facts that are pertinent to the goals of the specific problem. Important facts and

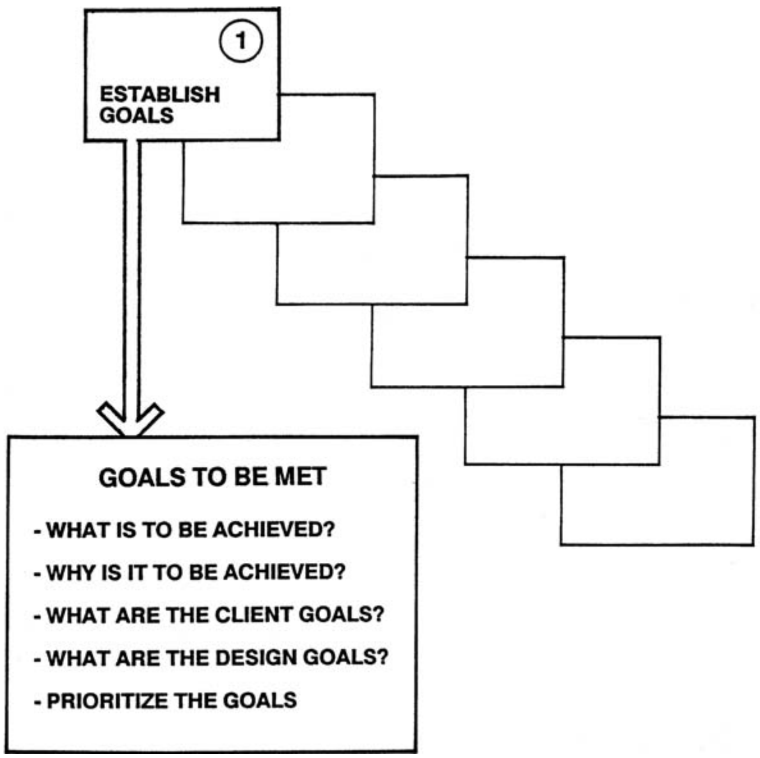

FIGURE 7.5 The first step in programming is to establish the goals.

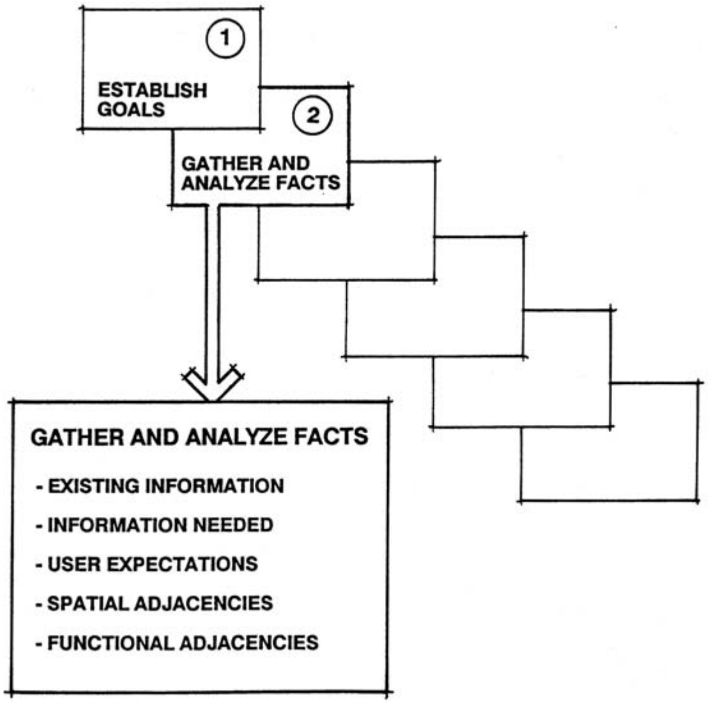

FIGURE 7.6 The second step in programming is to research, gather, and analyze facts.

research in a program include descriptions of user characteristics, economic data, and statistical projections. Other research might include local, state, or federal regulations concerning deed restrictions, zoning, and health, safety, fire, and building codes. Facts also generally involve numbers, for example, how many people will occupy the space and the space requirement per person, such as 15 square feet (1,393 square millimeters) per dining seat or 1,000 seats in a movie theater.

After researching and collecting the necessary facts, the designer can apply the findings to the design solution. Systematic research not only creates knowledge but provides solutions to design problems.

INTERVIEWS OF USERS To elicit information that is perhaps intimately known only by the users of a space, product, or system, the programmer may find it necessary to interview those people. This direct method encourages the users to describe and to demonstrate any aspects of their activities that are important to them (Figure 7.7). The interviewer should record critical, factual, and circumstantial information to identify the users' relevant needs and attitudes. Users can add some very important information in an interview, including their biases—which may not be the same impressions the designer or the co-users have. A potential problem arises in that some people do not say exactly what they mean. In these cases, the interviewer should carefully scrutinize their comments to determine the users' meaning. Interviews are one method of gathering information for evidence-based design solutions.

The interviewer can solicit information from several users who represent different norms and compare their comments to see if they all agree. For example, an interview with managers and executives can be compared to those with office workers. Sometimes the results are the same, but sometimes the interviews can provide a startling contrast between the impressions and data furnished by each group.

USER SURVEY Another useful tool in gathering data to support evidence-based design is the user survey or written questionnaire to determine the needs and desires of those who will occupy or use the space. The development of user surveys and questionnaires and the programmer's analysis of the replies are very important and must be designed very carefully in order to be useful to the problem solution. The documents should attempt to identify the real needs of the user by asking the "right" questions. An example of a questionnaire can be seen in Figure 7.8.

SITUATIONAL RESEARCH The programmer might consult available publications and other professionals, including experts who have dealt with similar problems to find out how those problems have been solved. Sources such as magazines, books, and other research material can provide considerable data, including pictures, about similar

FIGURE 7.7 Notes are made of the programmer's interview with a client, generally referred to as a "user needs analysis."

PROJECT Dr. Smith's Clinic | PAGE 7 of 21 | DATE 3.13

SPACE Dr. Smith's office | USER Dr. Smith / interview

ACTIVITIES	FURNISHINGS AND EQUIPMENT	SPACE NEEDED	ADJACENCIES	COMMENTS
· Consults with patients · Meet with staff · Meet with doctors, other professionals	· chair · Seating for 2 patients · Desk · Bookshelf · Coat Closet · Telephone · Computer Console	· approx. 120 separate feet · View to the outside · accoustical privacy	· exam rooms · nurse station · private entry (not thru patient area) · private toilet	· wants low lighting except at work area · furniture scaled to make patients comfortable

GENERAL REMARKS
wants to display some of his Kachina doll collection

INTERVIEW QUESTIONNAIRE Page 1 of 3 Date ________

Company ________________ Department ________________

Person Interviewed ________________ Title ________________

Job Description ________________________________

Telephone No. __________ Supervisor ________________

Interviewed by ________________ Reviewed by ________________

1. Briefly describe the functions of your department.
2. Briefly outline the flow of work through your department.
3. List (in order of importance) the departments with which you have frequent contact: both physical and work flow.
4. Describe any conferencing facilities needed by your department. List types, frequency, length, and number of people involved in these.
5. List other people, their titles, and functions in your department.
6. Describe your current work surface (size) and equipment needed. Do you anticipate any changes?
7. List the files/storage/supplies you need to perform your tasks. Are they needed at your station or in a central location?
8. What furniture (desks, chairs, etc.) do you have to perform your work? Any changes needed?
9. Describe any special equipment/needs required for your tasks.

FIGURE 7.8 Example of a written questionnaire that is filled out by a user

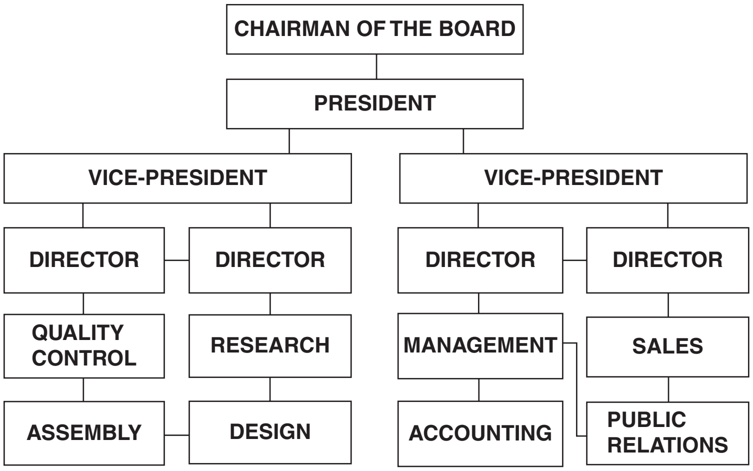

FIGURE 7.9 Example of a company's organizational chart.

situations and their relationship to the current problem. We can learn a great deal from history, rather than "reinvent the wheel" for every new problem or situation that arises.

ORGANIZATIONAL PROFILES Most companies have some form of hierarchical organizational profile or chart showing the relationships of the employees and their functions (Figure 7.9). It can be a very simple chart for a small company with a few employees or a complex graphic analysis of a large company with hundreds of employees. The programmer utilizes these organizational profiles to gain a clear understanding of the working relationships of the company, its communication procedures, its departments, and the interrelationships among them. If no hierarchical chart exists, the programmer works with the administrative unit of the organization to develop one.

An informal structure that often does not agree with the official formal chart may also exist. The informal structure may be more representative of how the organization really functions—with its allowances for the peculiarities of personnel, functions, abilities, and communication networks. It is necessary for both the programmer and the client to recognize this informal structure in the program.

COMMUNICATION MODES It is essential for the programmer to scrutinize the way the organization communicates as work is being performed. The communication patterns may be in the form of paper transactions, telephone systems, computers, or face-to-face meetings. These interactions can occur between staff members or between visitors and the staff. They may be formal or informal, which could influence the physical arrangement of interior space, to maximize layouts to improve communications and workflow efficiency. For example, a space might be used as a touch-down area for two or three employees to meet informally to discuss a situation on a project (Figure 7.10).

FUNCTIONAL ADJACENCIES The programmer should analyze the organization in terms of both how it operates and the physical proximity of its parts. The functional relationships are defined in terms of the physical and spatial needs of each individual and of each group (or department), as well as the interactions of the whole organization. How much space each individual needs to perform assigned tasks is determined, as is the necessary proximity to coworkers. Then the groups or departments are diagrammed according to their functional and adjacency needs (Figure 7.11).

FURNITURE, FURNISHINGS, AND EQUIPMENT INVENTORY Whether the space to be designed is new or is to be remodeled, the furniture, furnishings, and equipment must be efficiently and aesthetically integrated into the future plans. The programmer must consider whether the client is reusing existing items, purchasing new ones, planning to replace them in the near future, or using a combination of these. A careful inventory must be made of existing items, indicating their type, size, color, finish, and physical condition, if they are to be reused. (Refer to Chapters 16 and 17 for more specific information.)

In this inventory, *furniture* includes the typical support items, such as desks, chairs, tables, sofas, and credenzas, found in workspaces. *Equipment* is primarily the nonfurniture items, such as telephones, computers, video equipment, copy machines, and kitchen equipment, needed to execute the work. All other items, such as plants, rugs, privacy screens, and artwork, are classified as furnishings.

FIGURE 7.10 This touch-down area serves as a collaborative workspace for designers to informally meet and discuss a project. *Courtesy of Allsteel Office*

Analyze Facts

To analyze facts means to take the research information, facts, and ideas that have been gathered and break them down into categories identifiable by similar attributes. This allows the programmer to scrutinize these groupings rather than try to look at all the information at one time. The data might be categorized into groups such as physical, social, psychological, and economic, allowing the programmer to organize them for careful

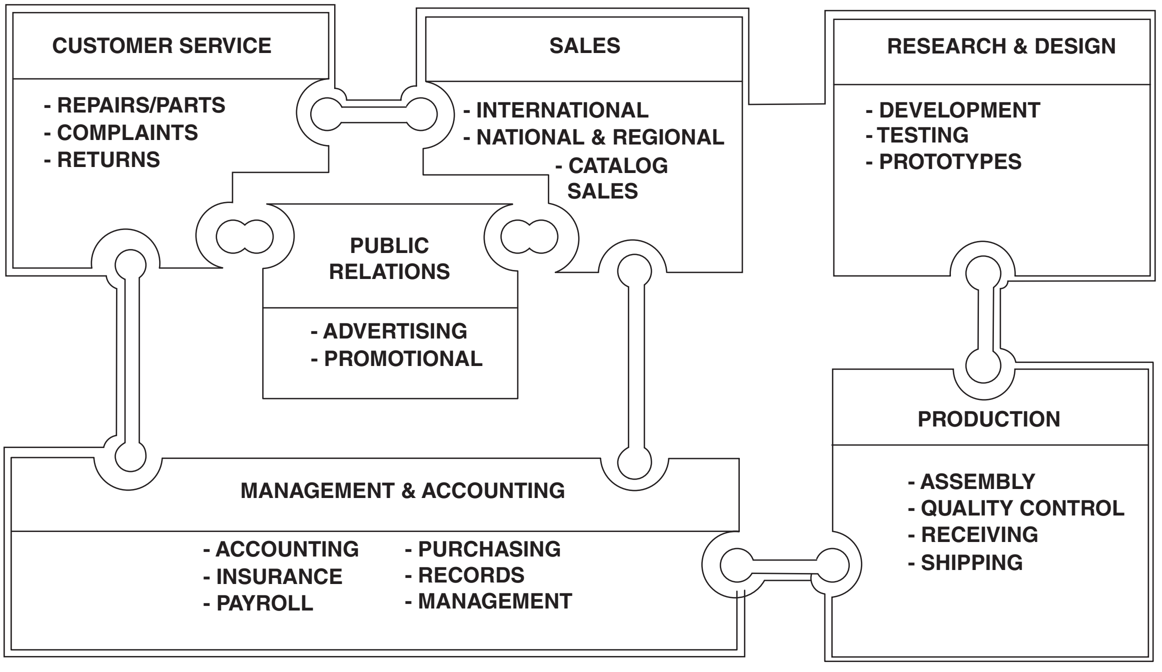

FIGURE 7.11 Functional adjacency diagram of departments within a company

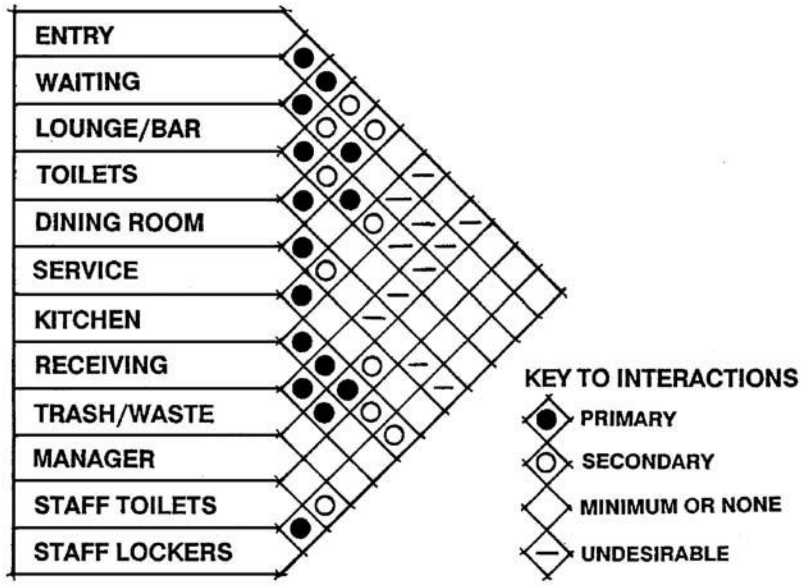

FIGURE 7.12 Example of a programming matrix for a restaurant

analysis. This information can be in the form of written documentation or visual charts. The programmer compares the collected groupings of facts to the stated goals, refining those that meet the criteria and rejecting those that do not.

CHARTS AND MATRICES Among the many ways to research, examine, and classify materials about the problem or situation being investigated is simply to list all the questions that can be generated about the problem and seek information that may address these inquiries.

A chart or matrix is an effective way of studying interrelationships. In the matrix form, elements or components are listed in a grid, and the relationships are determined by a dot or preset value mode. The matrix helps clarify and make simpler the complexity of all areas/components and their relationships. See Figure 7.12 for a typical interior design problem stated in a visual matrix form for analysis.

PATTERN SEARCHING Pattern searching scrutinizes individual parts of a problem to see if some components have similar characteristics or connections. These identified small subsets of patterns are then grouped into larger bodies and in turn are analyzed to see if larger patterns might exist. In this way, the programmer seeks to relate smaller parts of a problem to larger components. For example, a programmer analyzing a bank lobby to be redesigned might observe and record the pattern a bank teller goes through while performing daily work tasks and compare this pattern to that of other tellers to discover common movements among all tellers. This analysis would then enable the designer to plan traffic patterns accurately.

Specify Needs

Some of the needs of the problem are fairly simple to define, such as the amount of money the client wants to spend on the project (Figure 7.13). Other needs, such as the psychological impact the resulting environment may have, can be more difficult to determine. Therefore, in the programming phase, the designer tries to establish the "real" needs of the problem. The program then serves as a guide for both the designer and the client (or user) for the situations addressed in the design phase that follows.

Although the program specifies the needs of the problem, these needs can be dynamic and can change. The users of the space may change, as may the original purpose of the space. For example, as people grow older and experience some physical changes, their individual needs may change. Likewise, as time passes, the usage of a space or building may also change. If some changes can be anticipated, such as the client's need for additional space at a future date, the program should address those issues.

In trying to determine the needs of a problem, four areas should be considered: user needs, structural needs of the space, contextual needs, and economic needs.

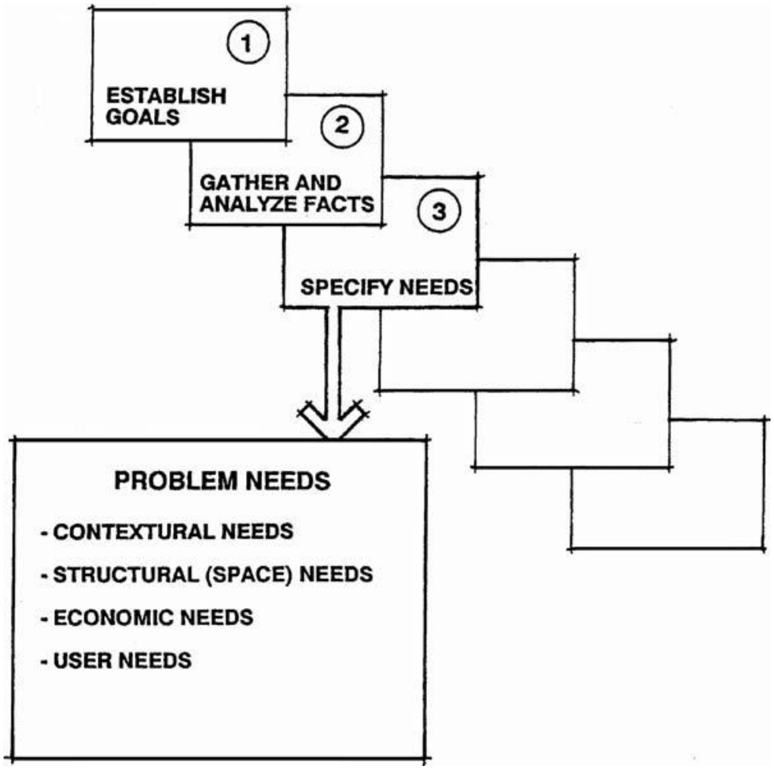

FIGURE 7.13 The third step in programming is to specify the needs.

User Needs

The program defines the needs of the people who will ultimately use the space. Although we tend to consider the client to be the user of the final design, there may be "intermediaries" between program and user, who either have hired the designer or will make the final decision for the user. Business executives might in a sense be the user by virtue of being a client for a new office space, but these individuals rarely if ever use a workstation in the secretarial pool. Likewise, developers and managers of mass housing units are not really the end users. The programmer should attempt to address the needs of the people who will indeed be the "real" users. To do so, the programmer must consider physiological, psychological, and sociological needs, as well as structural, contextual, and economic needs (Figure 7.14).

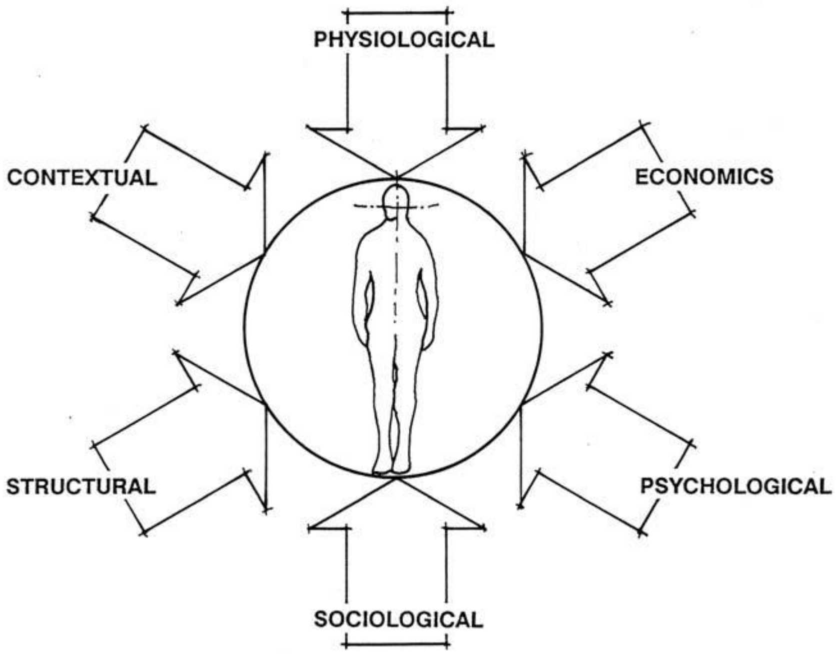

FIGURE 7.14 People have many specific needs that must be met when designing environments for them.

PHYSIOLOGICAL Physiological needs are physical in nature and relate to human and bodily requirements. Physiological planned spaces must support basic human physical functions. The planned spaces must also be designed for comfort in terms of things the body senses, such as noise, light, temperature, humidity, and ventilation. Physiological spaces relate to human scale—thus the need for an environment to be designed to fit a person, not an insect or an elephant. This may seem obvious, but how many spaces or objects have you encountered that seemed too small or too large?

Winston Churchill once noted that we build our buildings first, then they shape our lives. It is actually the converse of this statement that should be the guiding principle in planning interior space for human habitation. Ideally, interior spaces should reflect and fulfill rather than control the functions enclosed. Our lives should shape the buildings, not be shaped by them.

Anthropometrics. The measurement of the size and proportions of the human body is called anthropometrics (Figure 7.15). This discipline is involved with measuring the physical requirements of human beings as users. Over the years, a large quantity of anthropometric data has been gathered, on body sizes as related to gender, age, race, occupational groups, and socioeconomic influences. Today many publications supply this information.

It is, of course, not enough merely to obtain the data on the human body; the importance is in understanding the field and the complexities of applying these facts to design situations. The data often represent averages, norms, and ranges of human bodies, not exact dimensions. Also, consideration must be given to the body in motion in interior spaces, because its proportions and needs can change or be variable. The designer should be aware of the specific situation he or she is designing for, and use some common sense in applying anthropometric data.

Ergonomics. The study of the relationships between human beings and their functions in the environment is termed *ergonomics.* It is the applying of anthropometrics for optimum human/environment interaction. The thrust of most of the previous work in ergonomics, or human engineering, was associated with complex technological situations and machine interactions, such as in aircraft cockpits, space capsules, and military applications. Now, however, many of these studies of human factors are applied to automobile design, electronic/computer applications, and furniture design, involving the human body as a user of equipment and environments. The designer should be aware of the specific situation when applying ergonomics, since needs may vary considerably depending upon the application; that is, the needs of a population of users that is numerous and mixed will be quite different from those of a specific single user.

PSYCHOLOGICAL AND SOCIOLOGICAL We have discussed some of the physiological needs, which are basically measurable components that can be programmed rather easily since they are physical in nature. Bodies and their functions can be measured and studied so that appropriate furniture and spaces for circulating can be designed. But such physical data do not take into consideration the user's feelings and interactions with other users.

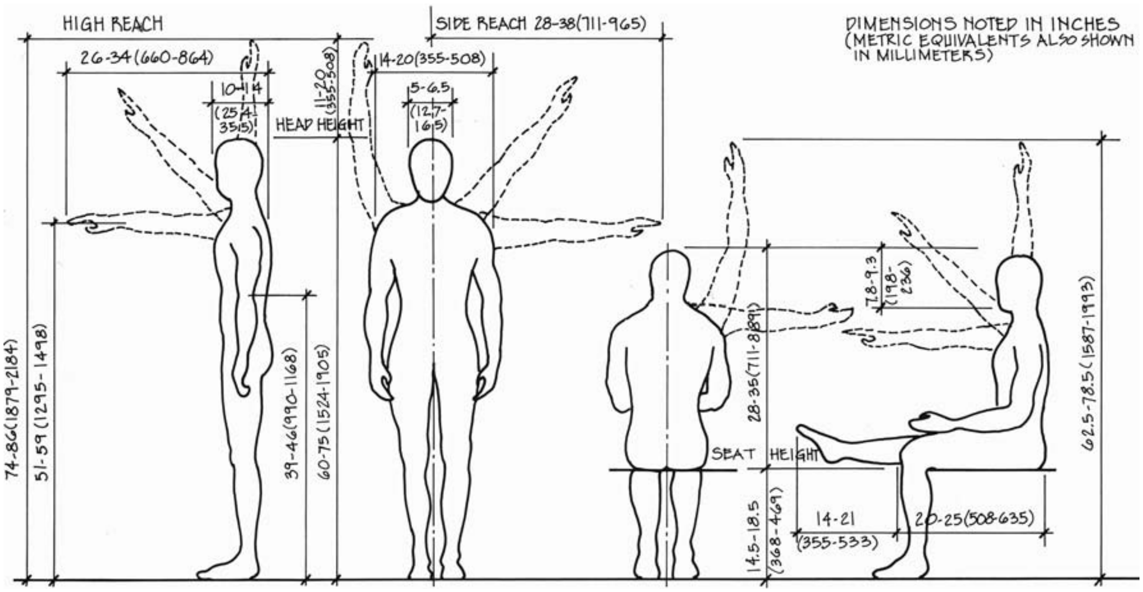

FIGURE 7.15 Anthropometrics is involved with body measurements that are useful to the interior designer.

People need a certain amount of psychological space surrounding them, which we call personal space. It can be thought of as a bubble that can vary in size and shape depending on the user's psychological makeup and the activity the user is trying to perform. Good friends engaged in a conversation may be within touching distance, but this would be too close for two business associates conducting a formal meeting. A classic example of personal space "bubbles" can be seen when people ride in an elevator of a high-rise building. Many of them go through all sorts of postures and efforts not to touch one another, speak, or break into others' personal spaces. At such a close distance, most of these people will attempt to stand perfectly still and stare into blank space. Psychologically, they need more space. Designers must be aware of these personal space bubbles when designing interiors. Consequently, the program should attempt to state the individual's psychological needs and the relationships between those needs.

Proxemics. In his book *The Hidden Dimension*, Edward T. Hall[2] (1914–2009) discusses the interrelations, use, and perceptions of space. The term coined to describe these theories of man's spatial relationships is "proxemics." Hall divides this spatial territory into four zones: the intimate, personal, social, and public (Figure 7.16). These zones specify distances that govern activity and the relations formed during that activity, and these facts can be useful guidelines for the interior designer.

The "intimate" zones allow actual physical contact and generally exist from skin surface to a distance of approximately 1½ feet (457 mm). If a stranger penetrates an individual's intimate zone, actual discomfort may be experienced—sometimes by both parties.

From approximately 1½ feet to 4 feet (457 mm to 1.2 m) is the area defined as the "personal zone." This space allows friends of an individual to come close to, but not to penetrate, the inner limit. If they do penetrate this zone, it is only briefly, such as for a handshake or a passing social contact. This distance also allows conversations to take place at a little below a normal voice level.

The "social zone" ranges from about 4 feet to 12 feet (1.2 m to 3.6 m) and is the spatial zone conducive to informal, social, and business transactions. Voice levels range from the normal level within the 4-foot (1.2-m) distance to a raised level near the outer limits of 12 feet (3.6 m). The arrangement and placement of furniture within this social distance can also affect relationships of people in the space. For example, a visitor's chair placed across from a desk generally places the visitor approximately 9 feet (2.75 m) from the person behind the desk and creates a more formal atmosphere. In contrast, a chair at the side of the same desk places the visitor about 4 feet (1.2 m) away and appears to be more conducive to an informal meeting, as illustrated in Figure 7.17.

The space that extends beyond the 12-foot (3.65-m) limit of the social zone is the "public zone." This distance tends to stimulate formal behavior and hierarchical relationships. Individuals of prominence or status within this zone tend to automatically have approximately 30 feet (9,144 mm) around them. Voice levels become generally louder, and enunciation is clearer and more formal, within this zone.

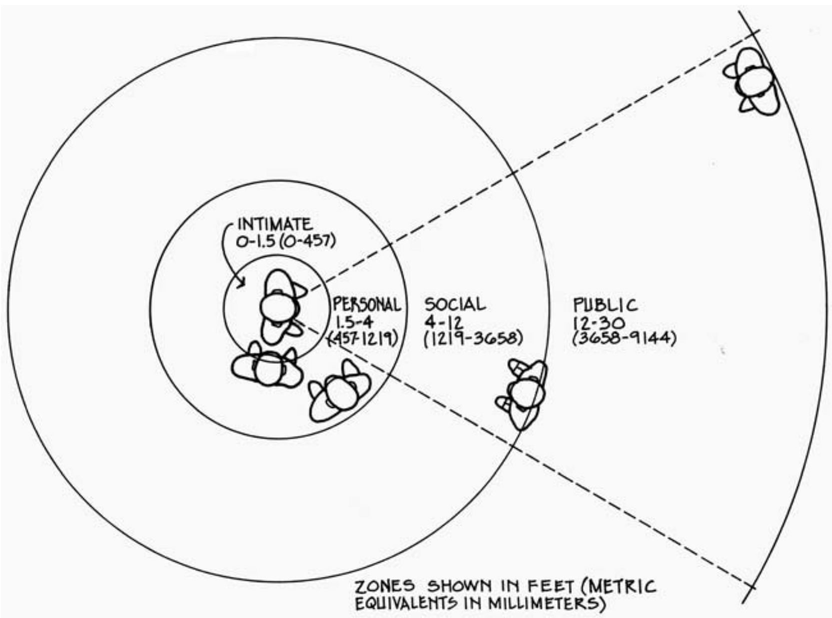

FIGURE 7.16 The four zones of proxemics

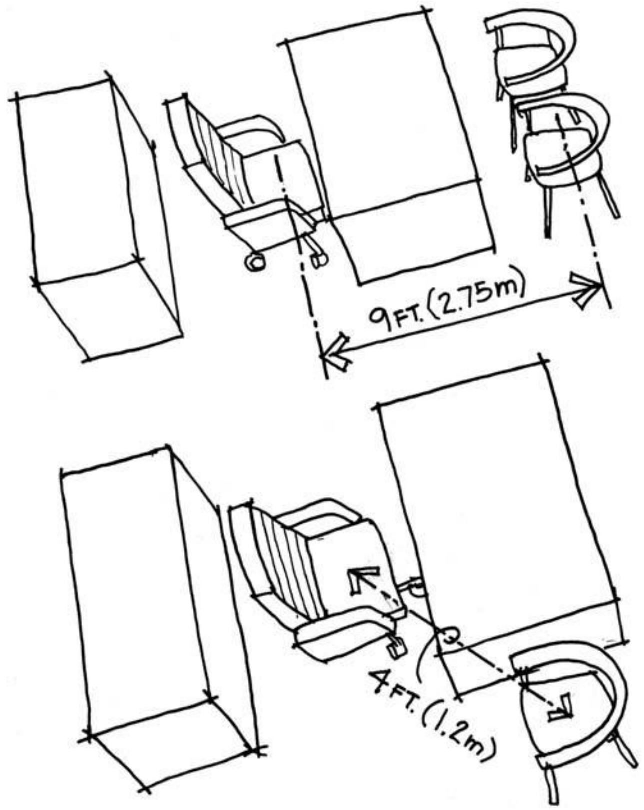

FIGURE 7.17 Chairs placed across a desk create a more formal distance between the parties, as opposed to the chairs placed next to one another, creating a more informal arrangement.

Proxemics is also concerned with individual differences and perceptions of space as applied to specific groups and cultures. Hall further notes that proxemic classifications are indeed approximate and applicable only to the group of individuals studied. People's perceptions and uses of space vary from culture to culture, and therefore their proxemic patterns also vary. It is important to recognize that even though general zone patterns exist, the interior designer must be cognizant that personal space requirements differ. Designers must also understand the cultural background of the client and the ultimate users of the space.

Emotions can also be affected by spaces of unusual proportions or spaces to which one is not accustomed. Large spaces with very high ceilings may create a feeling of awe or make some people feel insignificant or threatened. Yet in some public environments—such as cathedrals, with their soaring, uplifting spaces—we can appreciate and even desire high vertical spaces. In contrast, small spaces may cause a feeling of discomfort due to a cramped feeling (claustrophobia).

Much of our daily life depends on interaction and cooperation between individuals—in the neighborhood, on the streets, and in the workplace. If in designing spaces the designer takes into account characteristics that make cooperation convenient and easy for the users, they can function more effectively and congenially.

We are increasingly finding that limiting our space to some degree is essential, since space is fast becoming a precious commodity. The economy affects our ability to build new living and working environments, transportation systems (highways, airports, and the like), and recreational areas because of rising costs of materials and labor. Population growth and a finite limit to available land also create the necessity to conserve on space usage.

Structural Needs

Structural needs of a planned space must be considered in terms of protection, health, safety, and welfare and must be documented in the program. These areas are covered in various building and related codes, and must be considered during the programming phase of a project. Protection of both the occupants and the contents must be specific in terms of weather, including water, cold, heat, high wind, earthquakes, and fire. (See Chapters 10 and 11 for specific information.) The arrangement of the space must allow for logical and convenient entrance and exit of both people and objects. The program must also define needs for the distribution of energy, information, equipment, and materials. The space must be structurally sound—that is, designed and engineered to stand up under its own weight—and must accommodate objects and people placed in it. The space must have structural considerations, such as walls, floors, and ceilings, to hold it together. If an existing space is being designed, structural elements must be noted, because they might influence the new design. For example, an existing stairway location could affect the design concepts and may have to be removed or brought up to new code standards. Environmental comfort of the immediate space must be maintained through appropriate lighting, comfortable air temperature and humidity, and adequate air circulation, with energy conservation in mind.

Contextual Needs

A building or space within a building is not an island isolated from its surroundings. If it does not work in harmony with the surroundings, it will work against the environment. Among the programming contextual needs of the space (and its inhabitants) are the cultural aspects of the immediate area, along with its historical, religious, and political elements. Physical contextual concerns that also need to be addressed in the program include how outside systems—such as electric power sources, communication modes, and water, sewer, and transportation units—are linked to the environmental situation. After the contextual needs are determined and listed, the programming process projects into the future to determine how those needs might change in years to come.

Economic Needs

In terms of the client's budget, the major design considerations are that the space must be economically feasible to construct, must serve the needs of the users, and must take maintenance costs into account. These maintenance costs are projected over the expected life of the project to determine what is called life-cycle costs. (See Chapter 16 for a more detailed explanation.) Most people (and clients) cannot afford to do everything they desire. It is important for the programmer to distinguish between the needs and the wants of a client. What a wealthy person considers necessities, someone else would see as luxuries. Clients often desire more from an interior environment than they can actually afford. The programmer and the client have to come to an agreement concerning how much money is to be spent for the quantity and quality of construction, furniture, and equipment. This agreement must be stated in the program. This phase of determining economic needs defines the amount and kinds of funds the client has to work with, and whether his or her expectations match this amount. Preliminary cost estimates and project budgets are generally set in the programming phase, to be adhered to in the design phase that follows.

Evaluate

The evaluation stage of the program attempts to determine the relative importance, and to appraise the value, of the program (Figure 7.18). Evaluation can actually occur at various stages throughout the programming process,

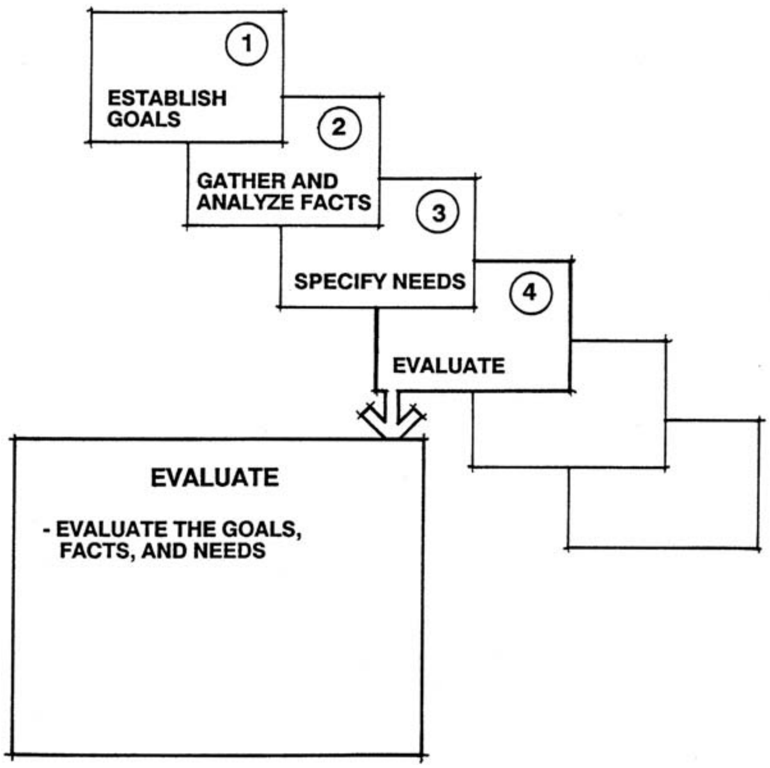

FIGURE 7.18 The fourth step in programming is the evaluation stage.

since the programmer can evaluate the whole or its parts. In either case, the programmer must have some criteria for judging the relative importance of the data to this point. The whole program might be judged by totally different criteria than a part would be.

The programmer makes evaluations not only about objects but about their "value" in relation to the goals to be achieved. Using question sets as evaluative criteria is a good way to see if the original goals are being met. Some questions that should be asked include:

What are the important issues?

What value will you assign the various data?

What alternatives should be pursued further?

Have the goals been met?

The evaluation step offers feedback immediately about decisions that may affect the whole process. In a complex situation involving a large number of facts, it sometimes helps to assign numerical ratings to the criteria for evaluation and to express the relative importance of the facts in the form of a hierarchy. This will help to clarify, in the feedback to the client and in the communication to the designer, the value range assigned to problem determinants. A good program format for evaluating a design will also be a good design tool. Another tool is postoccupancy evaluation, which is discussed in Chapter 6.

Organize and Decide

The organizational and decision-making process in programming occurs after, and builds upon, the analysis and evaluation stage (Figure 7.19). Although organization takes place throughout the whole programming process, it is defined here as a formal step that generally occurs after the goals have been established and the data have been collected, analyzed, and evaluated.

The organization step is the facet of the program in which the client's needs and their relationship to the overall information collected, analyzed, and evaluated are translated into a format that the designer can utilize to reach decisions.

The organizational step begins to formulate the decision-making stage in programming, which in turn leads to conclusions. Commitments about relationships and priorities begin to be made. Conclusions, alternatives, and

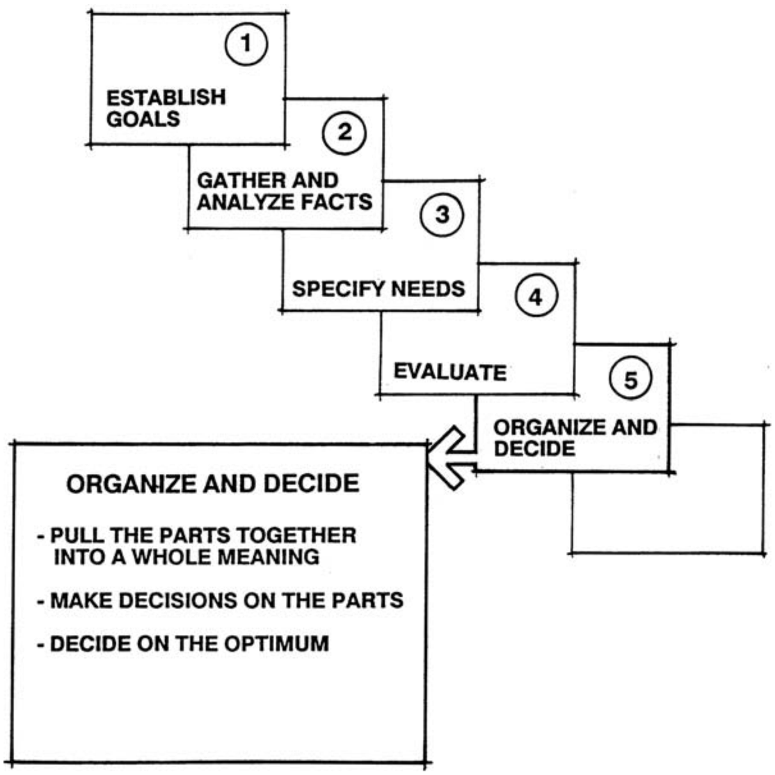

FIGURE 7.19 The fifth step in programming is to organize all of the parts into a whole meaning and form conclusions.

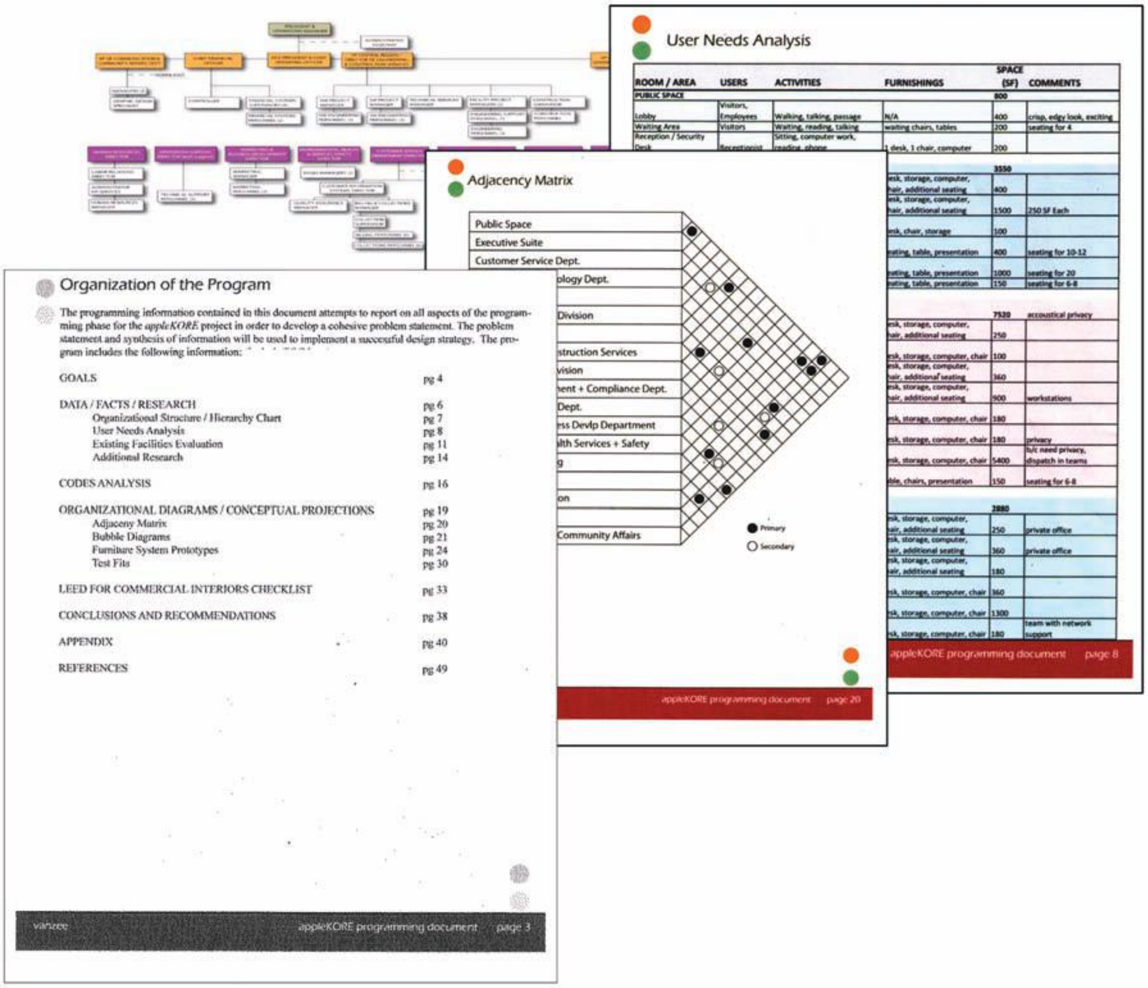

FIGURE 7.20 Several sheets from a programming document for a new office.
Courtesy of Lisa VanZee

recommendations are developed about what should be achieved in the design process and what the result should be. Projection of future circumstances and how they might be achieved should also be stated.

The conclusions and recommendations should be presented in as graphic and diagrammatic a form as possible. Diagrams often have direct implications for physical form or suggest obvious pattern relationships. The programmer's ability to organize visual, graphic, and verbal data will help translate programming facts into the formation of a physical space.

To be an effective guide, the order of the program and the form in which it is presented must relate to the way the designer will use the program. Its format must be well organized, have established priorities, and state recommendations, as shown in Figure 7.20.

Present Conclusions

The last step of the programming process is to present or communicate the findings to the client and other parties involved in the situation (Figure 7.21). An end product or document, usually in the form of a printed publication containing both written and graphic information, must evolve from the programming process for the ideas to become reality. Although some programmers tend to rely on written presentation, a program should also seek to communicate data graphically. The finished program can be one sheet or a bound publication of many pages, or it can assume a different visual mode, presenting the program as a continuing process, not a final conclusion. For example, the designer might use a kinetic programming or active feedback system that allows and encourages participants at

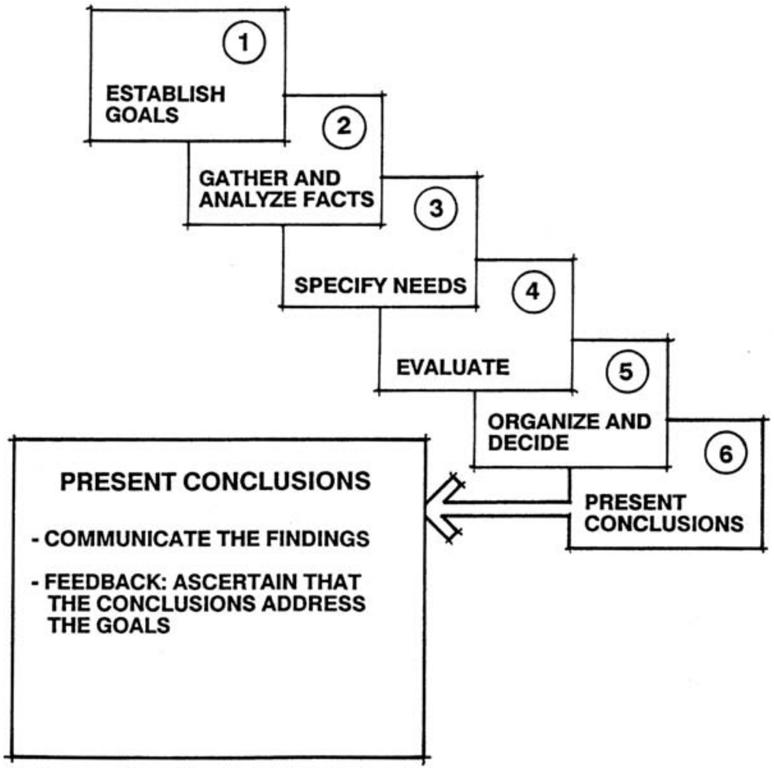

FIGURE 7.21 The sixth step of programming is to present the conclusions.

the presentation to modify the conclusions. This might include the "storyboard" technique developed by the motion picture industry for developing movies and cartoons (Figure 7.22), or might use a series of large worksheets pinned to the walls. Both of these formats place all the information in view of many participants at one time, to encourage immediate responses.

No matter in what form the program is presented, the intent is the same. A program is an effective design tool that finds, organizes, selects, and sets goals into a written and/or graphic document that in turn will be used by a designer. Figure 7.23 shows a fairly standard outline for a programming report that serves as a general guide for

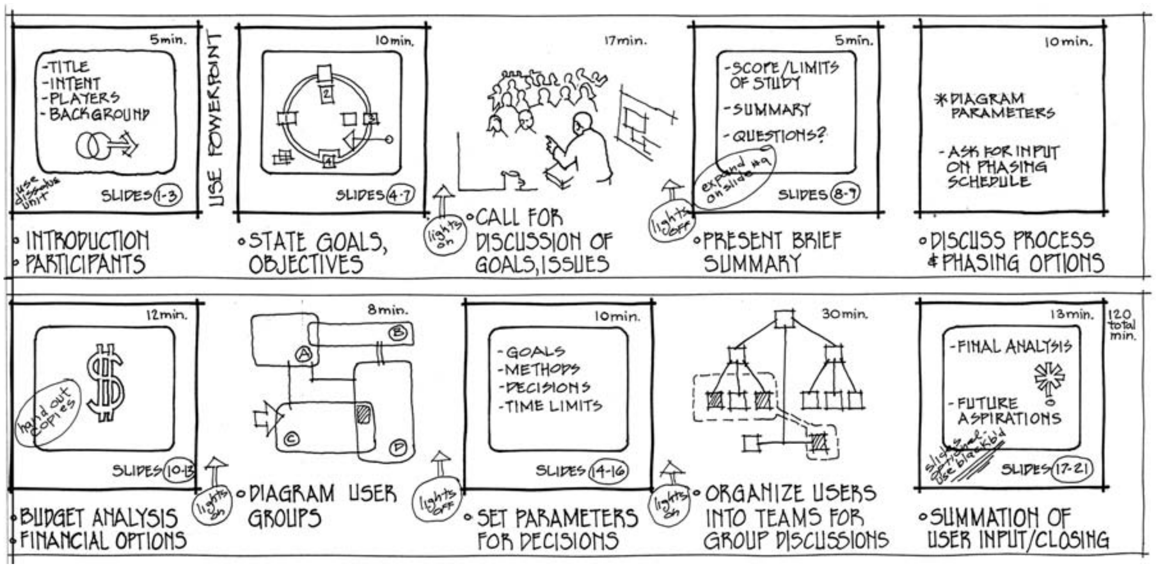

FIGURE 7.22 Using the storyboard technique can be an effective method for visually organizing information and involving participants.

1. PREFACE
   - Introduction
   - Participants/Clients/Stakeholders
   - Acknowledgments
   - Table of Contents
2. SCOPE OF THE PROJECT
   - Limits of Study
   - Philosophy/Purpose/Values
   - Summary
3. GOALS
   - Client and Operational Goals
   - Project Goals
   - Programming Goals
   - Programming Methodology
   - Client Background and Information
4. RESEARCH AND GATHER DATA
   - Assumption/Givens
   - Client Organizational Structure
   - Existing Conditions/Structural Needs
   - User Needs/Descriptions
   - Summaries of Projections
5. CODES ANALYSIS
   - Means of Egress
   - ADA Requirements
6. ECONOMIC NEEDS AND SCHEDULES
   - Budget Analysis
   - Phasing of Project
   - Time Schedules
7. CONCLUSIONS
   - Spatial Needs/Requirements
   - Test Fits
   - Recommendations
8. APPENDIX
   - Detailed Statistical Data
   - Exhibits
   - Bibliography

FIGURE 7.23 Typical outline for a program report

the presentation of material. The outline shown here can vary according to the complexity of the situation and the uniqueness of the problem; however, it contains certain basic categories applicable to most programs.

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2. Edward T. Hall, *The Hidden Dimension.* New York: Doubleday, 1966.

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Space Planning of Residential Interiors

8

INTRODUCTION TO SPACE PLANNING

Once the building program has been established, presented, and approved by the client, the interior designer develops the concepts and information into physical reality. The designer now has the goals, data, objectives, and other pertinent guidelines to proceed with creating spatial concepts and interrelationships that will be responsive to the users' needs.

This phase of the design process is space planning, which means arranging the spaces to satisfy the program and the needs/desires of the client. We speak of "planning" the space rather than "designing" the space since the primary concern at this point is solving the functional, physical, and psychological needs of the client. This phase goes beyond addressing the aesthetic or visual issues of texture, color, or fabric. Although it is difficult to shape and manipulate spatial concepts for use by human beings without thinking of all the elements in a holistic "design" sense, this first stage of the design process is intended to establish order and functional relationships of the space and its inhabitants.

Space Planners and Interior Design

Space planning based on building programs can deal with small, simple spaces or large, complex ones. In fact, large-scale space planning of office interiors in large buildings has become so complex and such a lengthy process that many interior designers (and others) call themselves space planners. This title usually connotes that they are planning specialists who work primarily in this phase of the design process in commercial interiors, often office spaces. They might work from a program established by another firm or generate the program as part of their own services. Space planning implies an ordered, methodological approach that a designer employs to create an interior environment responsive to and in harmony with its users. Although the term *space planning* is almost exclusively applied by designers to office planning, in the true sense it can be applied to the planning of all spaces, whether they are in offices, residences, factories, retail stores, or institutions. All interior designers are space planners.

Space planning involves developing concepts in three dimensions and communicating in two-dimensional plan drawings and other sketches to explain basic relationships (Figure 8.1). Other graphic material, such as equipment lists, flow diagrams, analysis, circulation, and horizontal (and vertical) relationships, is added to assist in presenting the designer's basic premises for solving the problem.

These schematics are refined through bubble diagrams (Chapter 6, Figure 6.13), preliminary floor plans, and final design plans (Figure 8.2). From these drawings, more detailed studies and construction drawings are made to direct contractors in building the designs. (See Chapter 18 for a more in-depth description of the types of drawings used in these processes.)

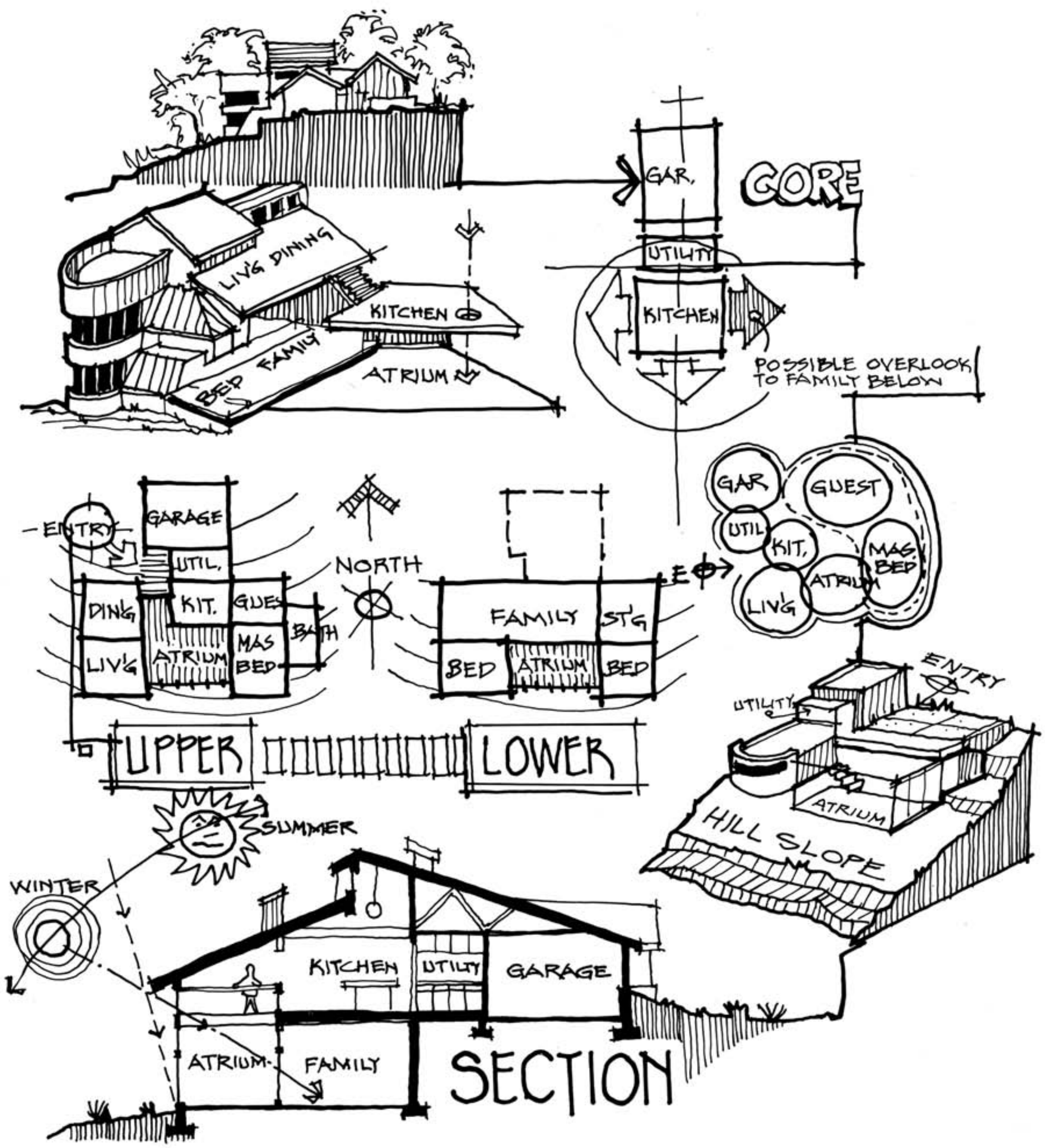


FIGURE 8.1 A designer's sketches for space planning explore basic concepts and relationships in a variety of drawing techniques.

Categories of Interior Spaces

Interior environments are very important because we spend the major part of our lives inside a variety of artificial or man-made interior spaces. We experience and talk about the natural environment, but many people have little or no direct contact with it on a hourly or even daily basis. For most of us, our immediate space is man-made. How this interior space is created, is shaped, and functions becomes crucial to our existence and psychological well-being.

Residential and Nonresidential Design

Some designers, design schools, and the general public separate the field of interior design into two distinct categories: residential and nonresidential, or commercial (Figure 8.3). The practice of interior design is also categorized by the particular kind of space, such as work space, living space, institutional space, special purpose space, and

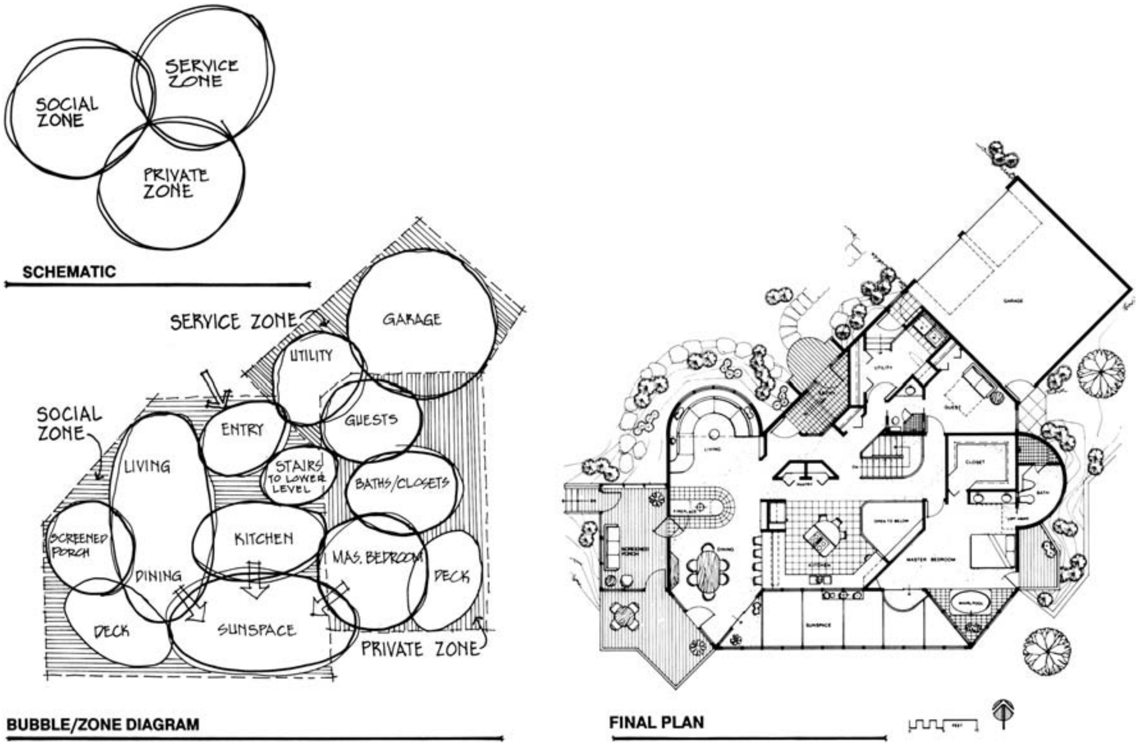


FIGURE 8.2 Space planning evolves from basic schematics and bubble diagrams to final design plans.

FIGURE 8.3 Interior design is often categorized into two distinct areas: residential and nonresidential.

RESIDENTIAL

ENVIRONMENTS FOR LIVING, OR WHAT IS GENERALLY CALLED "HOME"

A. SINGLE-FAMILY OR MULTIFAMILY

1. Detached houses
2. Apartments, townhouses
3. Condominiums, dormitories
4. Manufactured housing units
5. Mobile homes (trailers)
6. Specialized

NONRESIDENTIAL (sometimes called contract or commercial)

ENVIRONMENTS THAT ARE RELATED TO THE BUSINESS WORLD, ENTERPRISES, PUBLIC DOMAIN, OR SPECIAL PURPOSES. NOT DIRECTLY RELATED TO LIVING QUARTERS.

A. OFFICES

B. FINANCIAL INSTITUTIONS

Banks, Savings & Loan, Credit Unions, Trading Centers

C. RETAIL

Stores, Shops, Shopping Malls, Showrooms, Galleries

D. HOSPITALITY (AND ENTERTAINMENT)

Restaurants, Eateries, Hotels, Motels, Inns, Resorts, Clubs, Theaters, Concert Halls, Auditoriums, Arenas, Convention Centers

E. RECREATIONAL

Gymnasiums, Bowling Alleys, Swimming Pools, Health and Sports Centers

F. HEALTH CARE

Hospitals, Clinics, Nursing Homes, Doctors' Offices

G. INSTITUTIONAL

Schools, Colleges, Universities

H. PUBLIC AND GOVERNMENT

Libraries, Museums, City Halls, Courthouses, Legislative, Post Offices

I. TRANSPORTATION

Airports, Terminals, Airplanes, Space Vehicles, Cars, Buses, Trains, Boats, Ships, RVs

J. INDUSTRIAL

Factories, Manufacturing, Laboratories, Garages, Warehouses, Workshops

K. SPECIALIZED

Set Design for TV/Theater/Film, Studios, Exhibition Design, Kiosks other spaces being planned. This categorization is really involved more with defining the specialty of practice or expertise of an interior designer than with the type of spaces people occupy. Although interior designers work with many different kinds of space, some specialize in either the residential or the nonresidential area.

Although we categorize types of interior spaces, it does not necessarily follow that total environments are specifically of one category or the other. Living and work spaces can be and often are combined in the same interior environment. In fact, they can be within the same "room" or space—not divided by conventional means of walls or doors. This multiuse of space is becoming more apparent as computerization and technological advances create additional options for people to work and live in the same environments (Figure 8.4). The name given to the space is not necessarily the definer of that type of space—the inhabitants (or users) of the space and what they do or how they interact with the space give the space its name. The physical makeup of the space may be constantly changed to reflect the occupant's performance, thus theoretically changing the space's usage and resultant category.

The distinction between residential and nonresidential spaces is often not very distinct. The theories and practice of interior design are utilized in all areas, not just in residential or nonresidential spaces. Interior design is a holistic approach to creating all environments—not a specialty of interests or places.

It is not the authors' intent to distinctly categorize every kind of interior space or to create new niches for defining types of interiors. The categories presented in Figure 8.3 will serve to illustrate that indeed interior spaces can basically be called either residential or nonresidential. Under nonresidential, it is further possible to list spaces under general headings of office, retail, hospitality, institutional, and so on. The specifics categorized here are generally accepted by most designers; however, some individuals will take exception where the authors have listed types of space. So be it; interior design, like other professions, is composed of individuals—designers, educators, and students—who have different points of view and interpretations that provide a healthy forum in which creative people can interact.

FIGURE 8.4 This small residence serves as a workspace and living environment.
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

PLANNING RESIDENTIAL SPACES

Civilization has evolved from a simple society where residential activities, such as eating, socializing, sleeping, and playing, took place in one area of space. We now have a very complex society in which we perform different activities in many different physical buildings or spaces.

In its broadest sense, "living space" now refers to any shelter built for human habitation. People today tend to refer to residences rather than living spaces. The term *residential* is generally accepted to mean an environment to "house" an individual or a social set formed by a family (or group of unrelated people living together who form a congenial unit). This "living environment" is a space that has great influence on our interaction and relationships with one another and that reflects our personalities and our life goals.

We might also classify apartments, condominiums, and retirement homes as part of residential design, defining them simply as any place where one spends one or more nights. We could expand this theory to any place one dwells in for an extended amount of time or that a person calls his or her residence, such as a trailer, recreational vehicle, or yacht (Figure 8.5) that moves from port to port. No matter what form living spaces take, what they might be called, or where they might be located, the importance in designing them is to meet the needs of the people who will use them as a living environment.

Whether one is designing a single detached home or an attached dwelling in a multifamily complex, many of the design decisions are very similar, if not the same. Interior spaces, arrangements, and user needs are similar whether they be for a single-family residence or an apartment. Primarily, amenities such as entry location, parking, patios, decks, and available exterior views (from the interiors) might be the differences. But basic human needs and aspirations are the same in all residences.

FIGURE 8.5 A residence might be a yacht that people use as their home while traveling throughout the vast oceans and seas.

© TheYachtPhoto / imagebr / age fotostock

Planning Guidelines

In planning a new residence or remodeling an existing one, the designer should address certain basic issues. These are usually provided in the program, as outlined in Chapter 7. These issues for design decisions include:

- The users' needs, characteristics, aspirations, and activities
- The context of the residence: location, orientation, and relationship to the physical and societal patterns
- The economics or budgeted money for the project
- The aesthetic influences with respect to beauty and character that the designer and the client exert
- Sustainability, energy conservation, and environmental concerns
- Possible long-term use or flexibility of the residence for changes such as children growing up, moving out, or aging-in-place users

With the economic need to conserve land, building materials, and square footage in our living environments, designers have also made more economical and creative use of vertical spaces and stacking of floors. Exciting and dramatic spaces are created by high, sloping ceilings with mezzanine or balcony effects. The use of vertical space allows a departure from the standard eight-foot (2,438 mm) ceiling and helps to alleviate our feeling of constriction and our awareness of smaller floor area (Figure 8.6). On a larger housing design scale, utilizing vertical space planning in multileveled plans allows the opportunity to design well-separated zones of activity over a relatively small land area, thus economically and effectively saving our precious resource, land. Population growth in this country and others has created the need for more and more housing, but less space for it. We designers are faced with the necessity to do more with less space.

Buckminster Fuller's Dymaxion House (see Figure 3.22) was a concept for designing a living environment in a very limited space. His concept is similar to today's "compact" house, in which spaces are shared for a variety of activities, and the mechanical areas and support spaces are grouped together to maximize efficiency in the use of

FIGURE 8.6 Designers often create overlooks between floor levels, accenting the spatial relationships and features that can be shared by more than one level.

Courtesy of Paul de Ruiter Architects. Photographer: Peter Lipton

FIGURE 8.7 This small 1,000-square-foot house incorporates food preparation, dining, and a living area within one multipurpose space.
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

space, materials, maintenance, and operating costs. The arrangement, quality, and use of space (or space planning) have become much more important than the quantity of space. Multipurpose areas have solved the problem of limited space (Figure 8.7).

Residential design today often encompasses flexibility and adaptability for tomorrow. For example, as children grow up and move out of a family home, their space may be used only occasionally on their return visit to the home. The room(s) might be designed for this change and incorporate a future office, study, or hobby activity, instead of remaining a bedroom.

Designing for a residence involves planning for human needs and life experiences by dividing the space for specific or numerous activities and defining these with elements such as walls, doors, windows, other openings, or furniture. A floor plan is the end result of space planning and indicates the location, size, and shape of the various spaces and often the ways in which the furnishings might be arranged. This overall floor plan evolves from the program and translates user needs and desires into areas of specific sizes, shapes, and functions. Living patterns and circulation then become expressed through the placement of areas, doors, windows, walls, different floor levels, and materials (Figure 8.8).

Economic factors are often a driving force for the design of a residence. It will govern the choices of the location, type, size, and quality of the structure and interiors. Designers not only work with upper-income people and their housing needs, but also may be involved with work on what the United States Census Bureau classifies as substandard housing, minimal housing, and adequate housing.

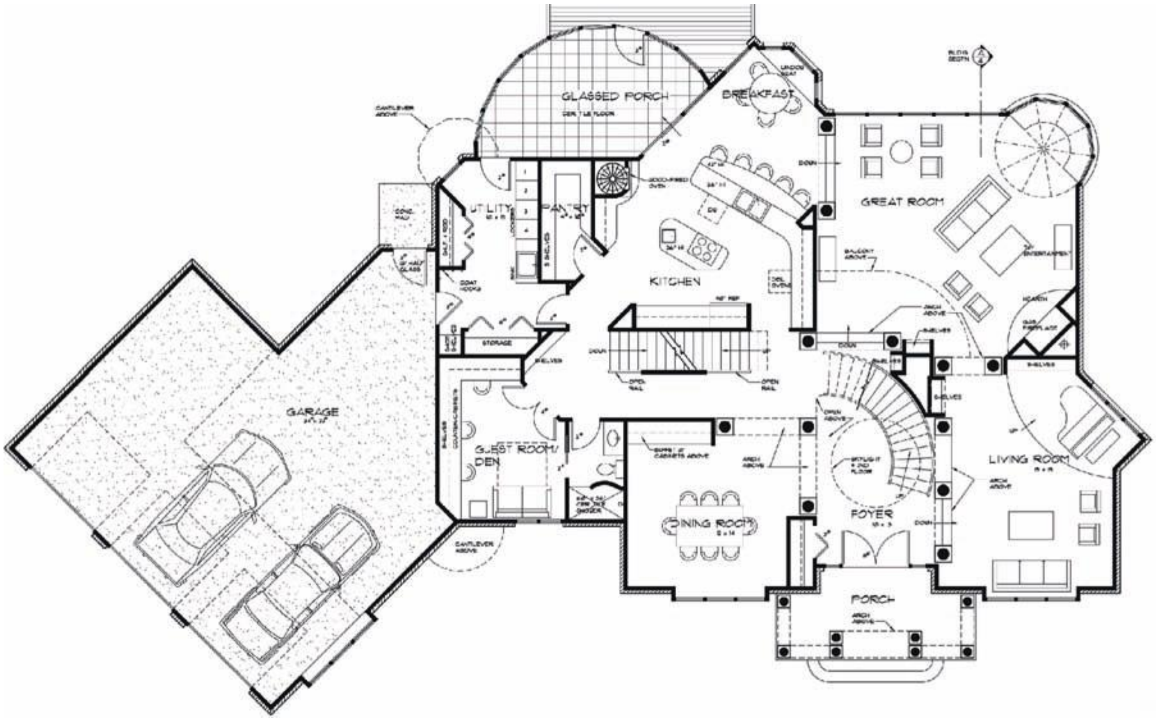


FIGURE 8.8 The first floor plan of this residence offers a number of spaces, levels, and features the clients desired for their home and living preferences.

SPACE ORGANIZATION

There are two design approaches to spatial organization and planning for activities within an interior environment, whether we are discussing residential or nonresidential design. They are commonly called the closed and the open plan concepts. Each derives its name from the organization and creation of spaces within spaces—as defined primarily in plan arrangement.

Closed Planning

About the beginning of the nineteenth century, floor plans for housing began to reflect particular activities and were labeled accordingly, with, for example, a music room, sitting room, library, card room, and drawing room. This concept, called the "closed plan," led to compartmentalization of specific spaces, with separate rooms often being joined by hallways. Many houses continue to have spaces labeled kitchen, bedroom, living room, and so on, to reflect the living patterns and lifestyles of the occupants. Today, however, primarily because of economic considerations, we see smaller residential units that utilize spaces for multipurpose activities.

Changing lifestyles have influenced a corresponding trend reflected in homes where there are fewer "formal" rooms strictly for socializing. Although we still see many formal living rooms, they are often smaller than their predecessors. Living patterns have also transformed kitchens and formal dining rooms into combined areas that accommodate both functions in a more informal atmosphere.

Closed plans have some distinct features and advantages not possible in the open plan concept. The use of walls and doors provides visual and acoustical privacy for the occupants. This type of planning also allows for varying types of activities that ordinarily might be in conflict to occur simultaneously (Figure 8.9). For example, with proper acoustic control of walls, a game room and a library might be placed side by side for simultaneous use in the closed plan, whereas an open plan would not permit this. Many people, particularly families, often prefer the closed plan, which allows segregation or control of various family activities by generations, such as children's sleeping areas being undisturbed while the parents or older children are engaged in other activities.

Closed plans produce some distinct physical disadvantages as compared to open plans. For example, climate control by heating, ventilating, or air-conditioning becomes more involved, with extra ducting or conveyances being needed for each room or space. On the other hand, special mechanical systems can provide more control of

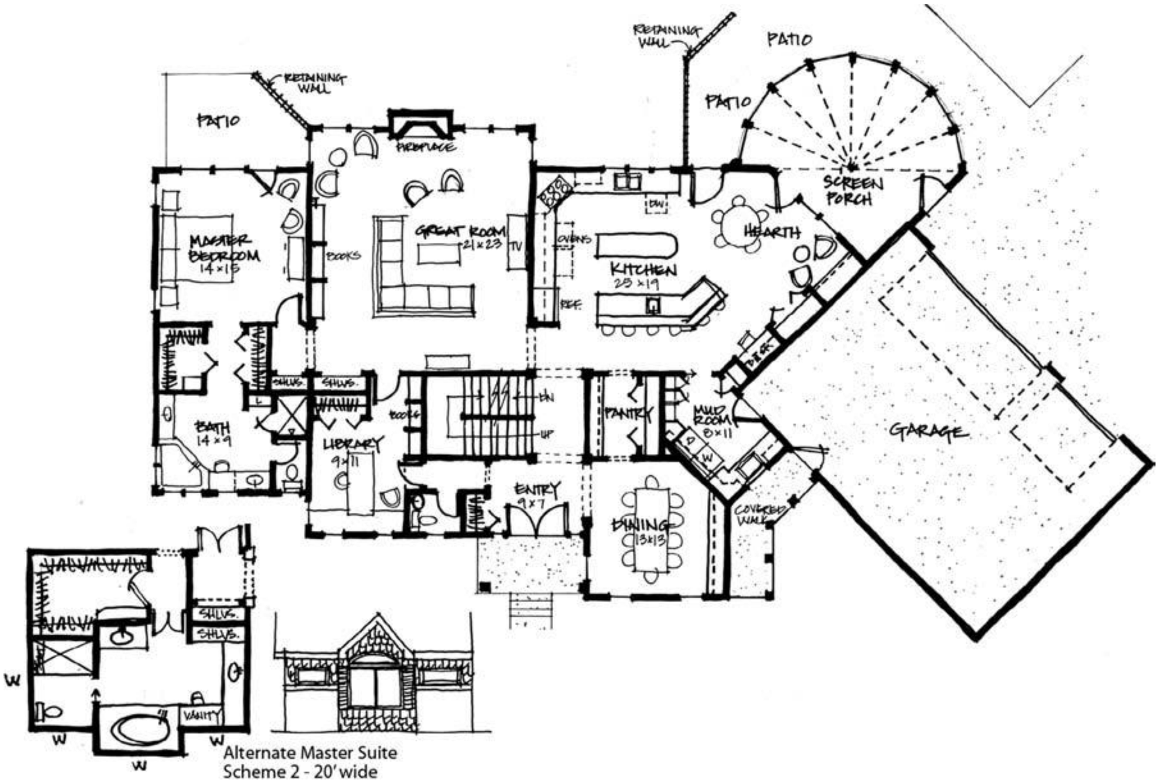


FIGURE 8.9 This "closed plan" sketch of a new home arranges the homeowners' functions into separated rooms for the various activities.

separate rooms by zoning the microclimate of specific rooms to meet each occupant's needs. Closed planning can offer some energy saving alternatives in that portions of a home that are not in use can be zoned off and not heated or cooled.

Open Planning

Some of our residential design and planning has cycled from the open plans of early civilization through the closed planning of the nineteenth and twentieth centuries and seemingly back to the open plans once again.

Some houses are designed with one central space or with fewer spaces that flow or combine into other spaces and eliminate the "physical" segregation of activities (Figure 8.10). Changing lifestyles of families, away from formalized social activities, have created the demand for more spaces with multipurpose functions. The open plan might have spaces, such as an entertaining area or a great room, that are derived from a combination of activities.

The open plan as we know it today was influenced by Frank Lloyd Wright with his prairie house designs and by the innovations of Le Corbusier and Ludwig Mies van der Rohe. Their contributions to residential design emphasized greater flexibility in the use of space through planning, volume, lightness, and an open, informal integration with the immediate environment.

The designs of modern furniture and equipment that are modular, compact, and even portable have also added to the multiuse of spaces for different activities. Overall, open plans exhibit a minimum of spatial separation or compartmentalization. Segregation of activities can be accomplished by furniture arrangement, level changes, and partial walls or screens. Interaction of activities and groups between spaces is often encouraged, as is the use of adjacent spaces to flow into one another for flexibility.

In residential design, the open plan offers some cost savings in the reduction of interior walls. Also, in passive solar design, the open spaces encourage natural heating of all the space, rather than using ducting systems to circulate warm or cool air to individual rooms (Figure 8.11).

FIGURE 8.10 Some classic houses are designed as open plan interiors, which incorporate spaces that flow into one another, without doors and individual rooms.
© bobboz / age fotostock

FIGURE 8.11 In passive solar design, interior spaces are often open to one another to encourage the natural flow of heat throughout the building.
Courtesy of Dennis Holloway, architect

INTERIOR ZONING

In residential design, spatial organization should be viewed as a whole. Its elements, products, procedures, equipment, people relationships, and environmental aspects are interdependent and should be planned integrally. Space planning begins with an analysis of the activities to take place within the environment, the furnishings and equipment needed to carry out those activities, the relationship to adjacent activities, and the spatial and structural needs to accommodate those activities and accompanying furnishings.

Activities can be grouped into zones according to their similarity in function and the degree of privacy or interaction required. Although designers tend to look at space organization as a flat graphic (often represented in plan view), they also see the designs in their mind as three-dimensional relationships. These are termed group (or social) zones, private zones, and service (or support) zones (Figure 8.12). The designer should refer to the program for specific user needs to be met and activities to be accommodated.

Group/Social Spaces

The group, or social, spaces within a living environment are areas where family members, friends, and guests gather for activities such as conversing, watching television, listening to music, playing games, and entertaining in general. These spaces should provide an atmosphere conducive to the occupants' lifestyle and values. The group/social areas of a residential environment have been traditionally identified as the living, dining, and family areas (Figure 8.13). The number and the size of these areas are determined by specific user needs and resources, and can vary widely from a multiuse studio apartment to a large, formal space. In some residences, two or more separate living spaces, such as a formal living room for adult conversation and entertainment and an informal recreation room for family and/or children's activities, are needed. In others, a large space, sometimes referred to as a great room, accommodates several activity areas. These areas might be subdivided by changing the floor levels, furniture arrangements, or floor coverings to create visual rather than physical wall separations.

The relationship of one area to another influences the way space will function. Group spaces should be located for easy access for both occupants and guests from the primary entrance or parking facilities. Since group conversation is often accompanied by serving meals, eating areas should be adjacent or close to the living area for entertainment and multi-activity purposes. These eating areas can be planned as either one area or two or more separate spaces, such as a dining room and a breakfast area. Of course, the eating area or areas should also be adjacent to the food preparation area (Figure 8.14), with the location of the main eating area (where the meals are served most frequently) taking precedence over that of secondary dining areas (where an occasional meal is served).

Living Areas

When designing a new residence, the designer should not be limited by the tradition that the living area must always be at the front of the house. Some sites are actually more conducive to having the living area open onto

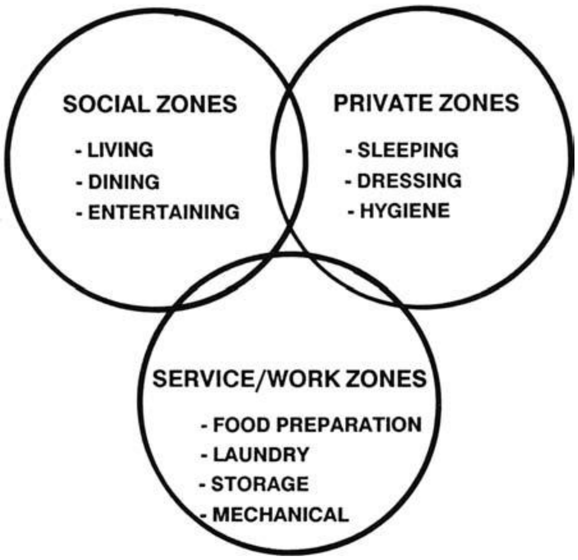


FIGURE 8.12 Typical activity zones of a residence

FIGURE 8.13 The dining and kitchen areas in this residence are not separate rooms, but open to each other for social interaction.
Courtesy of Kohler Co.

FIGURE 8.14 This kitchen incorporates an eating counter for convenience and to facilitate social interaction with the food preparation activities.
Courtesy of National Kitchen & Bath Association

FIGURE 8.15 The living area in this residence has primary views and access to the backyard.
Courtesy of Andersen Windows.

the back or side yard (Figure 8.15). This might be more desirable than to have the living area overlook the street or the neighbors' houses.

Even the smallest of living areas benefits by having the spaces separated into sections for different activities. Within the living space, three activity areas might be: a primary seating/conversation area, a secondary seating group, and an entertainment center. The functions of these areas can also overlap rather than being distinctly separated.

The primary seating area is usually the major conversation space, with the furniture grouping or a focal point (such as a fireplace or television) being the dominant element. In many arrangements, a coffee table or similar piece is placed in front of a seat or between groupings, about 18 inches in front of the seat (Figure 8.16).

One of the arrangements most conducive to conversation is a grouping that places a maximum distance of about 8 to 10 feet (2,438 to 3,048 mm) between people. This distance allows people easily to see facial expressions and body language and to hear. To interact comfortably, people generally prefer to sit opposite each other or at a slight angle. If there is too much distance between them, they will then tend to sit side by side. There are four basic furniture groupings for conversation arrangements (Figure 8.17). Well-planned seating areas avoid having traffic pass directly through. Doorways or entries should be grouped in a corner or be located across from each other to avoid cross-circulation problems (Figure 8.18). Generally, at least 3 feet (914 mm) should be allowed for traffic lanes in the space.

If space permits, additional seating areas can be planned within the living area to accommodate one to four people for a secondary conversation area or for reading, games, or music activities. This secondary area could be in the form of a window seat, game table with chairs, or large lounge chair. Furniture used in living areas is categorized as either built-in (or fixed) or movable. Much of the movable furniture on the market today is modular and encourages rearrangement.

The electronic entertainment center has evolved from spaces (referred to as dens in the 1950s) that primarily featured a TV console. A decade later this became the family room, with a color TV and a hi-fi system. The 1970s brought a space called the media center, which contained both visual and audio electronic equipment. Today, this home entertainment center is often integrated into the overall design of the living environment for entertaining,

FIGURE 8.16 The fireplace in this living room is the main focal point for the primary seating group, while a secondary conversation group faces the opposite direction.
Courtesy of Knoll, Inc. / Bruno Augsburger

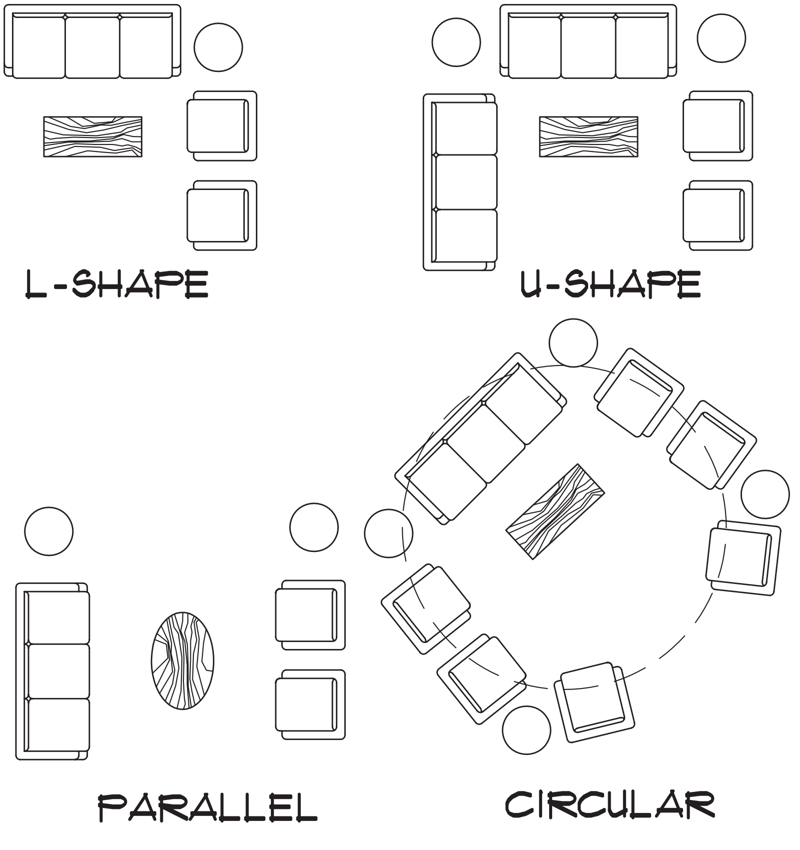


FIGURE 8.17 There are four basic arrangements of furniture that are conducive to conversation groupings.

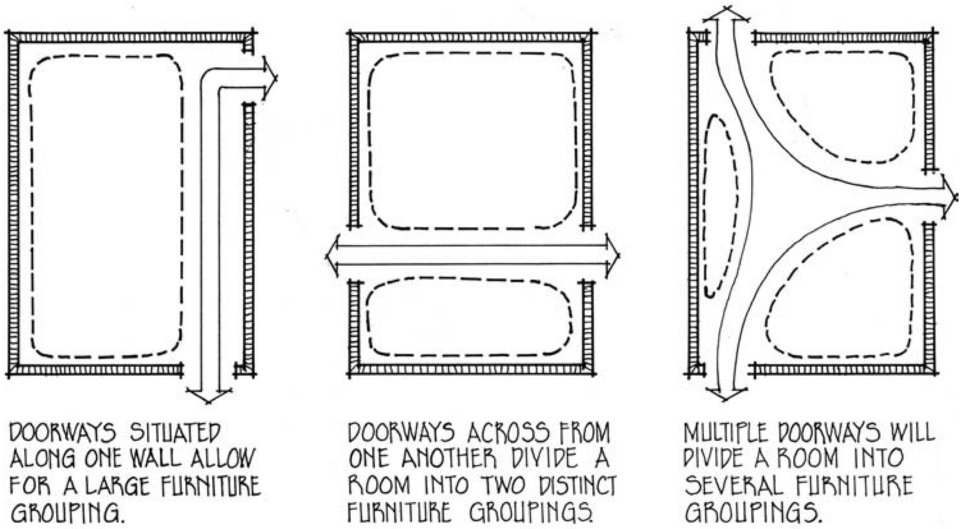


FIGURE 8.18 Doorways and entries into a space should be placed in a manner that avoids traffic patterns through the center, which could disrupt the effective use of the space.

information, comfort, and aesthetics. It includes everything from a flat screen TV, video recorders, and total sound system to a computer and related equipment. The placement and the design of these entertainment centers depend on the lifestyle of each family. For instance, some clients feel that televisions are too conspicuous or not very attractive, and hence want to hide them behind cabinet doors or place them on portable carts.

A media wall or center provides a good solution for incorporating audiovisual equipment by making the area easily accessible, as well as making a strong design statement (Figure 8.19). The entertainment center should be

FIGURE 8.19 This media room is designed with a reference to art deco and incorporates many electronic features, as well as a variety of seating preferences.

Courtesy of National Kitchen & Bath Association

located so it is convenient to the primary and secondary seating groups, especially if it includes a TV. Major concerns in locating the entertainment center are good seating and viewing angles, as well as light and sound control.

As personal computers become common household items, they are incorporated within almost any area, depending on the users' needs. Whatever the location, adequate space for a keyboard, video display terminal, printer, other hardware, and software is important if the units are dedicated equipment, as opposed to a laptop that might be wirelessly connected to devices within the space or other remote locations. Proper height of the keyboard, angle of the screen, adjustable seating, and good lighting are also important for the comfort of the users.

Permanently placed musical instruments, such as pianos, need enough open space around them for effective acoustics and for a small audience to gather. Upright pianos can be placed flat against a wall or sometimes used as a room divider to partition off an area. Grand pianos are usually placed so the curvilinear side faces into a room for the best sound dissemination. Pianos should not be placed in areas that might subject them to significant temperature, direct sunlight, and humidity changes.

Eating Areas

To some people, eating is merely a necessary function to replenish the body. To others, it may be a time of social pleasures and communicating with family or friends. The ways, times, and locations where people eat in a residence can vary according to the personal values of the occupants, their lifestyles, and the available space. People eat just about everywhere—the kitchen, the family room, outdoors, in front of the television, and even in bedrooms. The designer should analyze the particular situation to determine users' needs.

As people become busier with work and activities outside the residence, eating areas are often less formal and more flexible to serve other activities. Also, because we are more aware of the need to conserve space, we tend not to set aside an enclosed space that will be used only approximately three hours a day for the specific activity of eating. Instead of one isolated dining room, we often see two or more eating areas that merge into other areas, such as a kitchen and living space that can be planned and used as circumstances dictate (Figure 8.20). Breakfast areas or eating counters, which can be designed in a number of ways within the kitchen, are also very popular, primarily for quick meals (Figure 8.21). The occupants' living patterns should dictate whether the eating areas will be formal or informal, how much space should be made available, the type of equipment to be utilized, and what furniture to select. For instance, dining tables and chairs are of various sizes and shapes and can be arranged in many ways (Figure 8.22).

FIGURE 8.20 This house does not have a dedicated dining room, which provides flexibility in arrangement and size between the living and dining functions.

Photo by Guy Wilkinson

FIGURE 8.21 Eating counters adjacent to or within kitchen areas are popular for breakfast, quick meals, and social interaction with the cook(s).
Courtesy of National Kitchen & Bath Association

Private Zones

Sleeping Spaces

In addition to allowing us to meet the basic biological necessity of sleeping, the bedroom provides a place for quiet meditation or rest, for retreating from the pressures of everyday life—work, the outside world, and even family interactions. The space is often used for reading, contemplating, and sexual expression. The bedroom has further become a very personal or private area where people keep their intimate or personal items, such as jewelry,

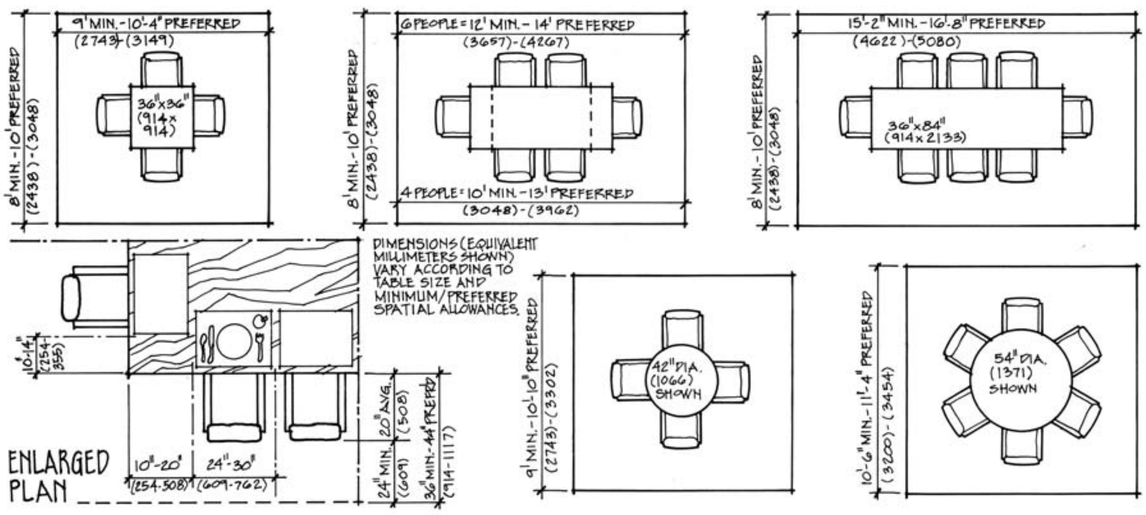


FIGURE 8.22 Various sizes, shapes, arrangements, and clearances for dining spaces.

FIGURE 8.23 This master suite includes a sitting area with a view to the exterior.
Courtesy of Andersen Windows.

important papers, money, and other valuable or memorable keepsakes. In fact, the bedroom (along with adjacent dressing/bathing areas) has become a "retreat" to many people because of its furnishings, size, and separation from the rest of the house. It might be a master suite with a dedicated bathroom, closet(s), dressing area, and sitting area (Figure 8.23). This is not the case, however, in many other cultures and other parts of the world, where the sleeping area is an integral part of the living spaces. In Japan, for instance, many families roll out mats on the floor for sleeping, roll them up in the morning, and store them out of the way so that other activities can take place in the same space.

The bedroom has undergone many changes throughout history. The sleeping platform, or bed, has actually been around since Egyptian times. Since then, the bed has taken almost every shape, style, dimension, and importance imaginable. During some periods, such as the fifteenth and seventeenth centuries, beds were not only very elaborate but were also used by the host or owner to receive guests and even conduct business. Now we have beds filled with water, air, foam, and springs. We also now have available specific types of standardized beds, such as adult beds, children's beds, bunk beds, cribs, daybeds, convertible beds, and even beds built into the structure of a room.

Bedrooms or sleeping areas are often isolated from the rest of the house or zoned into "quiet" areas to maximize privacy and the needs associated with sleeping. Residences are usually classified as one, two, three, or more "bedrooms," denoting the number of sleeping spaces the structure has. Some dwelling units have no "formal" bedrooms but instead have designated sleeping areas, such as lofts. Other small dwellings may have convertible beds, such as the Murphy bed, that are pulled out specifically for sleeping and put away when other activities are taking place (Figure 8.24).

Sleeping spaces have some basic requirements. Physically, the sleeping area, including the bed and related furniture, should be comfortable for the specific activity of sleeping and should be conducive to relaxation. Sometimes, the room needs to take on an almost opposite character in the morning, when the occupant is ready to rise and "jump out of bed" to start the day, perhaps by performing calisthenics. The visual makeup of the room and even its outside views (where possible) should be restful/peaceful to the eye or controllable. It should have the appropriate environmental controls for isolating noise, temperature, and light, both natural and artificial. Psychologically,

FIGURE 8.24 This fold-up bed provides additional floor space in a small house when it is put away.

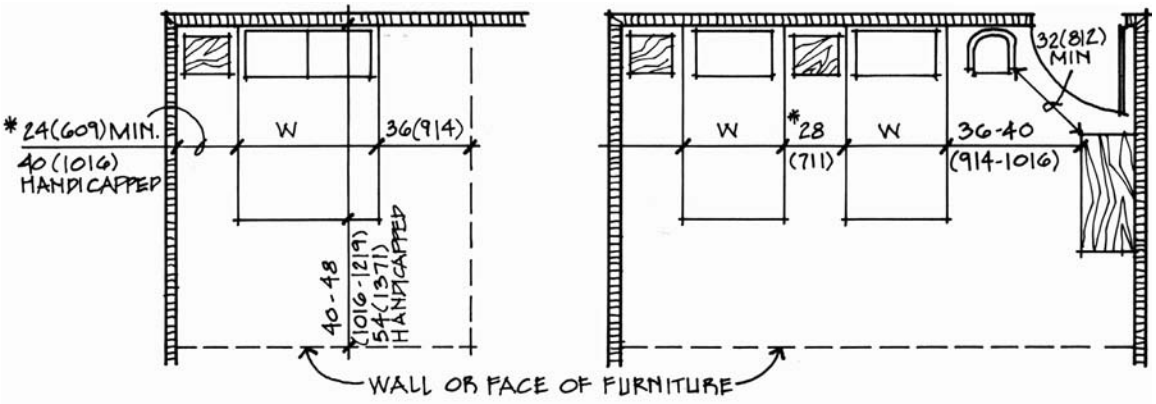
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

the sleeping area can take on other attributes, such as providing us with intimate privacy and even individualistic expression (Figure 8.25). It is important to realize that a client may select interior furnishings that seem quite irrational or very different from what the designer proposes; this is often a result of a person's individualistic desires and private sleep-related needs or routines.

Bedrooms or sleeping areas can vary in size and physical layout. Consideration should be given to the number of people, their ages, and the various functions the space will serve other than just sleeping. Today's trends toward smaller dwellings, more efficient use of space, and modular furniture have influenced a move toward smaller bedrooms. Several housing and government authorities have specified minimum sizes for bedrooms; however, it is not the size of the space that is important but how effectively it is planned. In general, the area or room should be large enough for the bed, circulation around it, making the bed, and appropriate clearances for other furniture

FIGURE 8.25 This bedroom provides an intimate and peaceful setting by means of warm tones of wood and a low level of lighting.

Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon



BED SIZES*				
TYPE	WIDTH		LENGTH	
	IN	MM	IN	MM
CRIB	30	762	53	1346
DAYBED	30	762	75	1905
TWIN	39	990	82	2082
DOUBLE	54	1371	82	2082
QUEEN	60	1524	82	2082
KING	72	1828	84	2133

* DIMENSIONS GIVEN IN INCHES. (METRIC EQUIVALENTS SHOWN IN MILLIMETERS).

MATTRESS HEIGHT FROM FLOOR VARIES 14-18 INCHES (355-457 MM).

FIGURE 8.26 Minimum clearances recommended around bedroom furniture and standard bed sizes.

(Figure 8.26) and activities. Every sleeping room should have at least one window for fresh air and to be used as a fire escape. Most building codes require this for the health and safety of the occupant.

Bedrooms are also used as studies or small offices by some people. Inclusion of a working space with chairs and even a desk can make the bedroom more than just a sleeping space. We also find today's bedrooms serving a multitude of other functions, such as exercising or aerobic workouts. Or, semi-enclosed areas nearby might also serve an exercise function (Figure 8.27).

Dressing and Clothes Storage

Storage for clothing items is often located within a sleeping space or is readily available in an adjacent dressing area which also might contain lavatories. Typically, this storage is in a closet near the room entrance. Location of the closet needs to be convenient for all-day use.

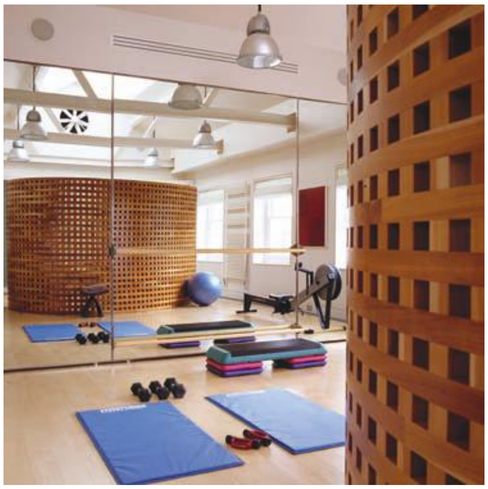


FIGURE 8.27 Many homes today have rooms or areas designated as exercise centers to support our needs for physical and mental well-being.
Andreas von Einsiedel / Alamy

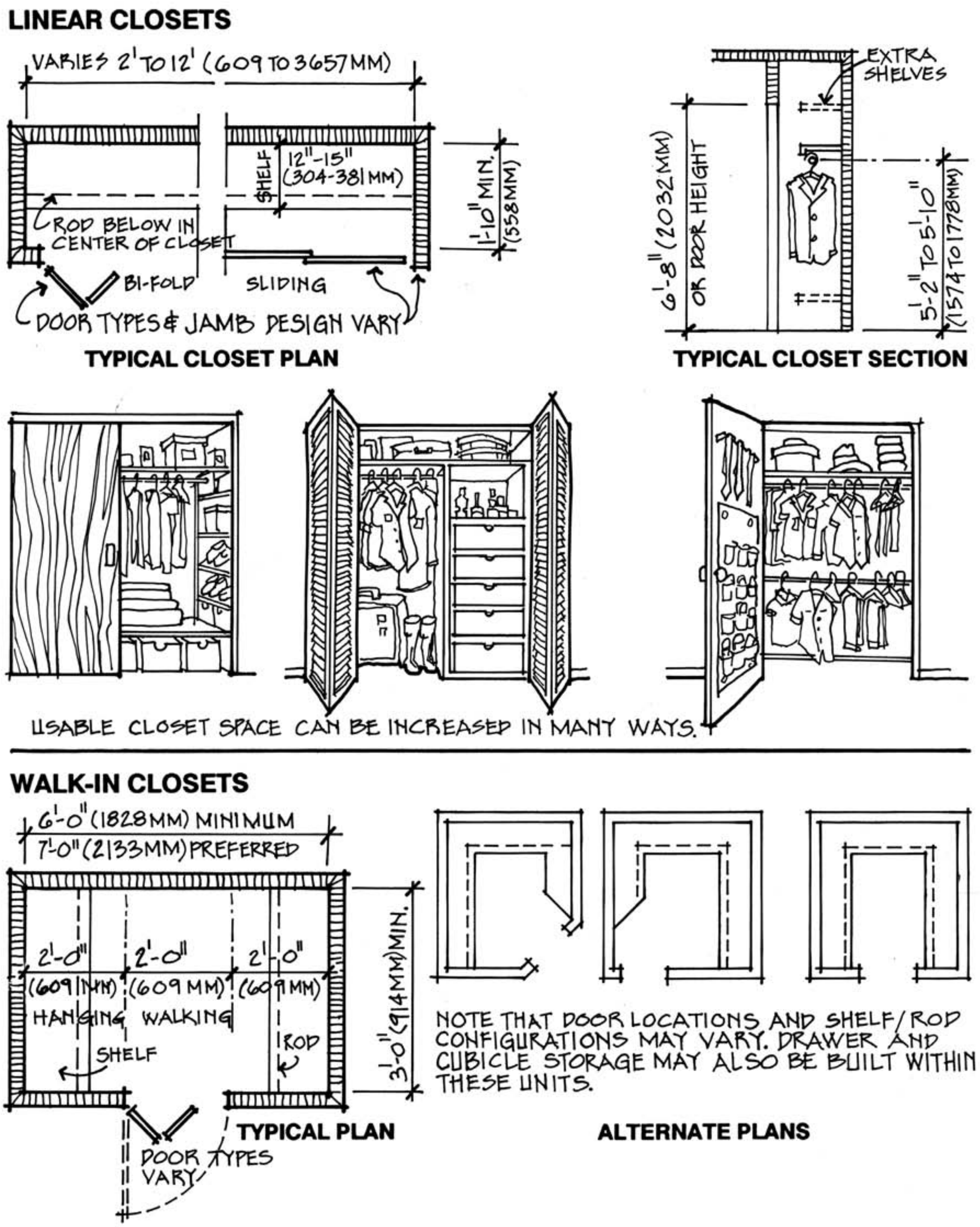


FIGURE 8.28 Closets can be designed as reach-in or walk-in enclosures and have many functional variations of shelving and hanging assemblies.

Clothing closets are usually designed as either the linear type or the walk-in type, although variations of these basic styles exist. Each type has some minimum size and layout standards (Figure 8.28). Unfortunately, a lot of closets in our dwellings are inefficiently designed and waste a lot of space by using just one hanging rod and a shelf. Closets should be designed to maximize storage from floor to ceiling. Such closets can be modified in many creative ways to better serve the users.

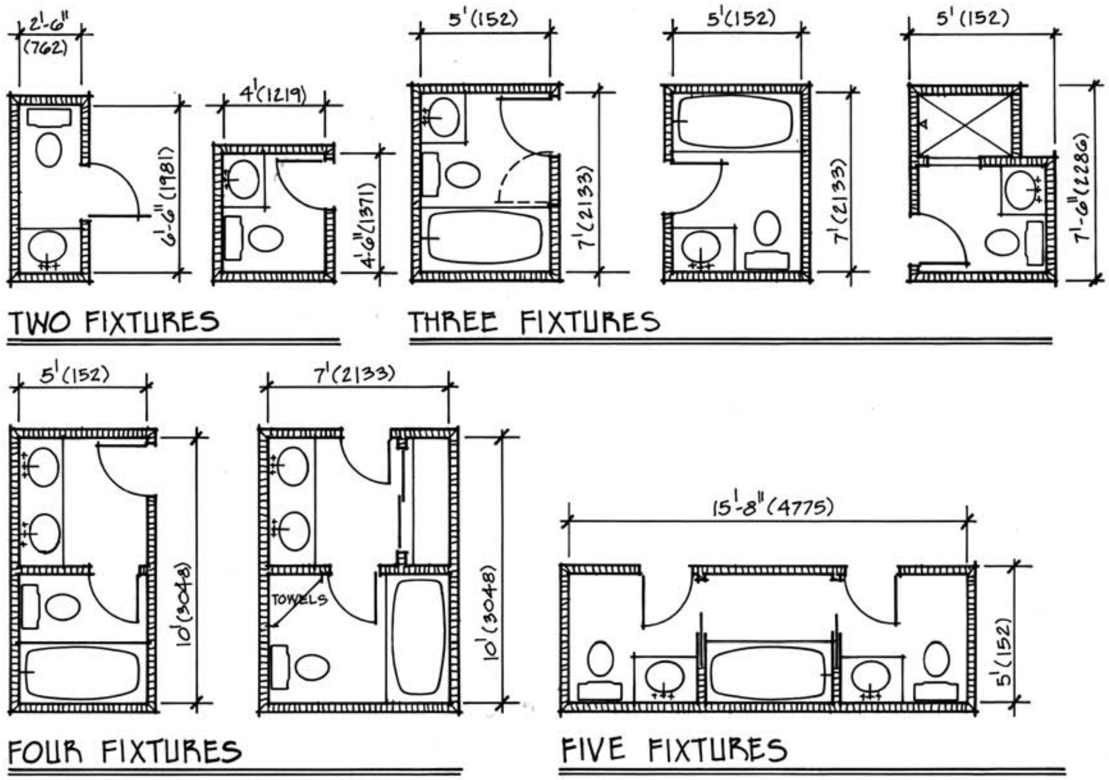
As noted, some sleeping spaces provide a separate or distinct clothes storage area and dressing space, but generally the space for a person to dress or undress is near the closet, or even in it. However, dressing is a distinct and separate activity that the designer should plan for—often in direct relation to the personal hygiene and grooming needs of an individual. The basic requirements of a dressing area are proper lighting, easy access to garments, space to dress either standing or sitting, and amenities related to dressing, such as mirrors, hooks, and a place to put on makeup or to wash. In fact, many master bedroom suites now place such importance upon dressing, grooming, and convenience of washing that these areas are often located in a distinct space between the sleeping area and the personal hygiene, or bathroom, space.

Another important factor when planning dressing areas and clothes storage is the distinction between soiled and cleaned clothes and the handling of them. Clean clothing is organized and placed for retrieval in various ways such as hanging, folded, rolled (socks), and bunched. Careful consideration should be given as to the user's preferences. Soiled items should be placed in a convenient storage area (often clothes hamper) or laundry chute for routine removal to the laundry area if on different floor levels.

Personal Hygiene: Bathrooms

Personal hygiene areas, or bathrooms, seem to have evolved more from an economic consideration than from psychological or anthropometric needs. However, now amenities for simple functions such as hand washing no longer just require an economical washbasin, but have evolved into art forms (Figure 8.29). For a long time, most dwellings had an economy bathroom with three fixtures: the lavatory (correct term for a bathroom sink), water closet (correct term for toilet), and bathing tub (or shower combination) in a room approximately five feet by seven feet (Figure 8.30). This classic example is still evident today in most dwellings, with the fixtures all on one wall (to save plumbing installation costs) or rearranged in several ways depending upon the relationship to and size of the dwelling. Today, many individuals are fascinated with adding whirlpool baths, steam showers, soaking tubs, hot tubs, saunas, and spas to their bathrooms, all of which encourage an appreciation of our bodies, the enjoyment of bathing, and the relaxation bathing can provide. Therefore in these instances, we find bathrooms being made larger to accommodate more than the basic hygiene needs (Figure 8.31). Also, bathroom design has become more flexible and can accommodate more than one person at a time by compartmentalization. Other amenities such as bidets, vanities for makeup (sitting or standing), and dedicated storage for towels and bath accessories might be included.

FIGURE 8.29 The lavatory in the bathroom is both a functional item and an art form.
Courtesy of National Kitchen & Bath Association



FIXTURE	SIZE		CLEARANCE	
	WIDTH(W)	DEPTH(D)	FRONT(F)	SPACE(S)
WATER CLOSET	19-21 (482-533)	27-30 (685-762)	18-36 (457-914)	30-40 (762-1016)
LAVATORY	17-30 (431-762)	16-22 (406-558)	20-36 (508-914)	24-40 (609-1016)
TUB/SHOWER	60-72 (1524-1828)	30-42 (762-1066)	20-36 (508-914)	60-72 (1524-1828
BIDET	14-16 (355-406)	25-28 (635-711)	18-36 (457-914)	30-40 (762-1016)
SHOWER	32-42 (812-1066)	32-48 (812-1219)	18-36 (457-914)	30-42 (762-1066)

DIMENSIONS SHOWN IN INCHES (AND MILLIMETERS)

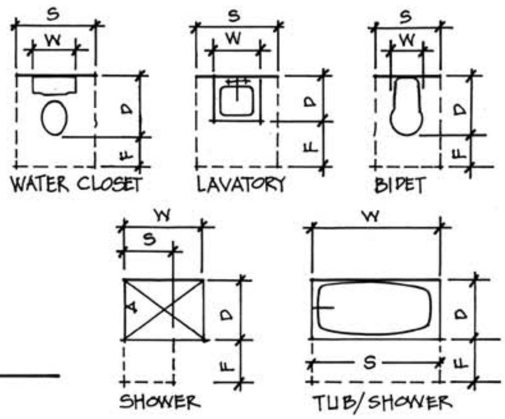


FIGURE 8.30 Basic bathroom and plumbing fixture arrangements

FIGURE 8.31 Today's bathrooms receive a lot more attention and design than just serving our bodily needs.

Courtesy of National Kitchen & Bath Association

FIGURE 8.32 This three-quarter bath (water closet, lavatory, and shower) is designed for "aging in place," as it incorporates accessible features and fixtures.
Courtesy of Kohler Co.

If a dwelling is to have only one bath, it is customary to locate it between group and private zones so that it can be reached from either area with a minimum of disruption. Most dwellings, however, have two or more bathrooms. The number of people occupying the dwelling and economic considerations vary the number. Some have half-baths or three-quarter baths, which have two or three fixtures (substituting a shower for a tub), and are used in areas other than bedroom suites (Figure 8.32). Moreover, a wide variety of fixture arrangements is used, depending upon the function of these baths within the dwelling and upon available space.

The doorway to the bathroom should be designed to visually shield the room if the door is left open. The room should have a window for natural light and ventilation; however, many building codes permit artificial light and mechanical exhaust fans if a window is not possible. Storage is also needed within the room for items related to grooming and hygiene. Bathroom fixtures are now made in all colors and shapes for individual preference.

Support/Service Areas

The support and service areas are the work areas of a residence. These areas supply the utilitarian and functional aspects of the home. They are designed for food preparation, general storage, clothing care, and mechanical equipment storage. These areas are usually called the kitchen, laundry facilities, mechanical space (for heating and cooling equipment), and utility or storage space. The amount of space designated for these functions seems to have been decreasing over the last few decades because of increased construction costs and new technological developments in equipment. Much of our support equipment today is smaller, quieter, and cleaner than in the past. We can even find a laundry area that is similar to a closet and centrally located. The heating and air-conditioning equipment is also being put in a smaller space incorporated within the garage, crawl space, or unfinished basement.

ENERGY CONSERVATION, EFFICIENCY, AND RECYCLING Of paramount importance in today's society and environments are the needs of energy conservation, efficiency, and recycling. Adding insulation to prevent heat loss and designing with energy-efficient heating and cooling systems can aid in reducing the amount of energy expenditure. The use of energy-efficient appliances and the recycling of food, packaging, and other "waste" materials can help preserve the environment and protect our future resources.

The support and service areas within residences can be designed and utilized to aid in the harmonious relationship with our micro- and macro-environments. For example, today's utility areas and kitchens can be planned to include recycling bins and other features to help with the use and reuse of materials that can be effectively and efficiently recycled (Figure 8.33).

Because of increased construction and energy costs, service areas should be centrally located and grouped, if possible. Plumbing fixtures for kitchens, baths, and laundry facilities should be placed back-to-back or stacked

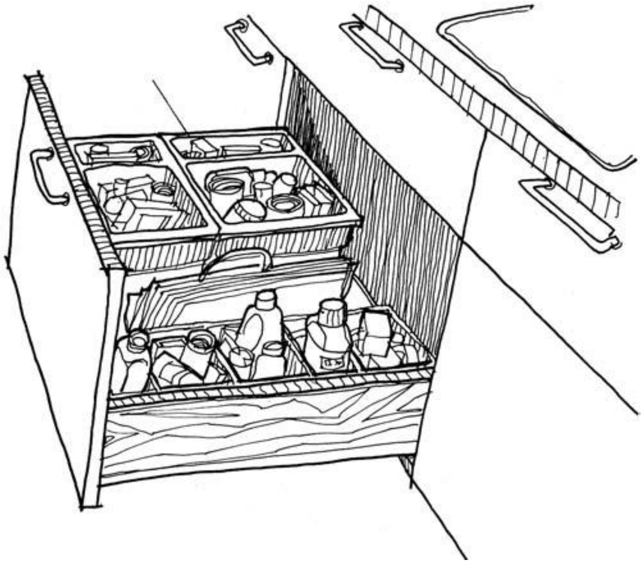


FIGURE 8.33 This kitchen cabinetry contains pull out drawers with plastic bins of various sizes for recycling materials.

in multistory units whenever possible. It is also energy efficient to locate hot-water-producing areas close to the hot-water supply, since the shorter the run of piping, the more economically and the faster hot water is produced. On-demand (tankless or instantaneous) water heaters provide hot water at the point of use, instead of using a centralized water heater, thus avoiding heat loss through the long runs of piping associated with those systems. These facilities are often grouped into a utility core. In some manufactured housing modules, the utility core contains all the equipment necessary to support the functions of cooking, bathing, laundry, heating, air-conditioning, and water heating. These modules are produced in standard sizes, shipped to the site in one unit, and installed.

LAUNDRY The laundry area is sometimes placed close to the source of soiled pieces and the storage of clean ones. For this reason, some people prefer the laundry on an upper floor and near the bedrooms, if it is a multilevel structure. However, it should be located where it is most convenient for the user to do the work during normal routines, which might be near the kitchen or combined with a "mudroom" that contains closets or lockers for coats and other seasonal items.

The laundry area should be designed with convenient and functional space for the washer and dryer, if so equipped. It is ideal to provide a sink, counter space for folding clothes, and storage cabinets for detergents and miscellaneous items. Many laundries also serve a number of other activities, such as ironing and sewing (Figure 8.34).

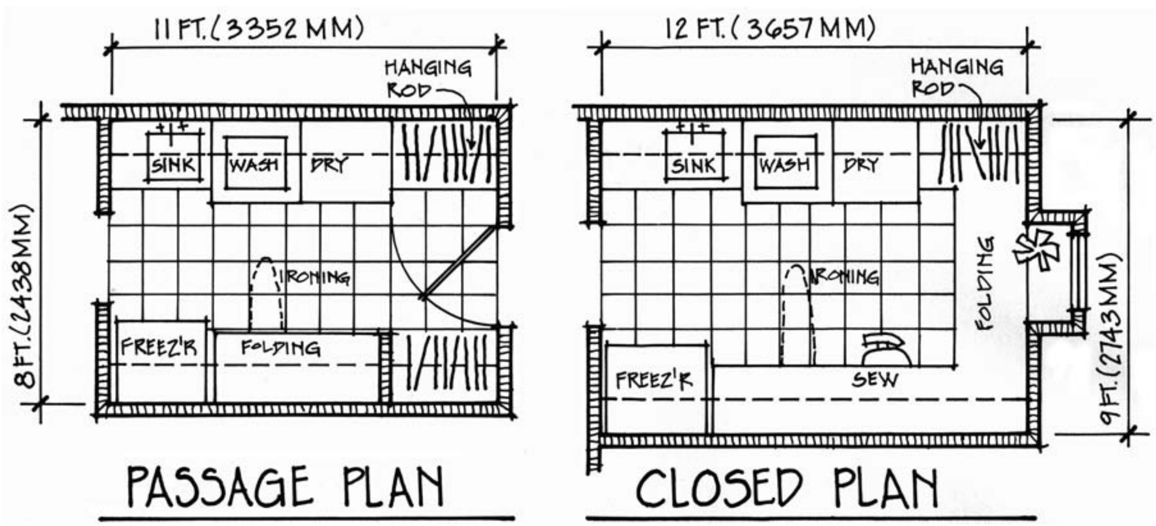


FIGURE 8.34 Laundry rooms can serve more functions than their name implies. Ironing, sewing, and storage can also be incorporated into this space.

FOOD PREPARATION AREA (KITCHEN) Although the food preparation area, or kitchen, is listed in the support/service area, it can serve as one of the primary social zones, as it is often the "nerve center" of a residence.

In its earlier development, the purpose of a kitchen was for the preparation of food and for family members to keep warm in front of a big open fire during winters. The kitchen often served as the center of family life, accommodating family gatherings and being used for entertaining visitors and other activities.

With technological advancements, different sources of heat for the entire house were developed, and new heat sources were created solely for the preparation of meals. The kitchen then became an isolated room designed for the specific function of preparing food. In the eighteenth century, the kitchen stove was developed; it was the standard cooking mechanism until the arrival of the iron coal range. In the nineteenth century, the icebox and water pumps were placed inside, and by the end of the century the kitchen was generally located at the back of the house. During this time the kitchen was generally considered a place that only the food preparer or servants used, and it was to be sheltered from the view of guests and even the owners.

In 1841, Catherine Beecher published a study on domestic kitchen planning in which she pointed out that domestic services should be compacted to utility cores for convenience and time-saving efficiency. From this point on, the kitchen developed into the center of family activities—efficient, an electric powerhouse, and a status symbol that many homeowners are proud to show. Most kitchens today are large enough to accommodate two or more cooks at one time so that food preparation duties can be shared. Manufacturers are continually redesigning kitchen appliances and equipment to make them more efficient and attractive (Figure 8.35). Studies have also been conducted on tasks performed in the kitchen, as well as on the location of work centers, their design, and their relation to changing lifestyles. A well-planned kitchen can save time and energy and enhance the value of a house.

The kitchen should be located near the areas where food may be served. The kitchen should also be accessible from the service entry, parking area, or garage for the convenience of transporting food items to and from the area.

FIGURE 8.35 This kitchen incorporates a number of commercial style features and appliances for cooking and entertaining.
Courtesy of National Kitchen & Bath Association

ACTIVITY CENTERS How efficiently a kitchen functions depends on the placement of its activity centers. These centers are governed by the activities that are to take place and the major appliance that will be utilized in the task. Activity centers used to be confined to the sink/clean-up center, the cooking center, the cold storage center, and the mixing center. With technological developments (along with changes in living patterns), the design and functions of the kitchen have changed drastically. For example, with the popularity of microwave ovens, cooktops, and double ovens, there may be several cooking centers instead of just one. Although we discuss the need for storage of cookbooks, recipes, and other printed materials, today's kitchen often has this information stored digitally and accessible through the use of computers and personal electronic devices.

The *refrigerator/food storage center* (Figure 8.36) is generally both the first and the last in the food preparation sequence; that is, perishable food is taken out of the refrigerator or storage center first and is put back in during the cleanup task. Packaged foods and related items are found in the food storage center, as provided in four basic ways: walk-in or reach-in pantry, full-height pantry cabinetry, base cabinets, or upper (wall) cabinets. Walk-in pantries offer abundant storage of items that are in full view when the space is entered, as do reach-in pantries, when their doors allow full view of and access to the shelves. Pantry cabinets are more compact than custom-built walk-in pantries, and often match the kitchen base and wall cabinets.

In addition to the refrigerator (and freezer), this center requires at least 18 inches (457 mm) of counter space on the latch side of the refrigerator door for placing food items, if it is a single-door operation. With today's side-by-side units or French-style doors, a countertop should be provided nearby for loading and unloading items. If a freezer is incorporated within the kitchen, it would also be located in the refrigerator center. Generally, however, large freezers are placed in a storage or utility room, basement, or garage, since they may not be used on a daily basis and can occupy valuable space that could be more efficiently used.

The *sink center* is the area utilized for washing food and utensils and providing water. The sink center is usually placed between the cooking and the mixing centers. On the other hand, the sink center is also closely related to the refrigerator center, where fruits and vegetables are generally stored before being brought to the sink for

FIGURE 8.36 Ample counter space is provided between the refrigerator at the left and the sink in this kitchen to facilitate the food retrieval, preparation, and re-storage sequence.
Courtesy of National Kitchen & Bath Association

FIGURE 8.37 Two sink centers are provided in this kitchen for a number of cooks and activities.
Courtesy of National Kitchen & Bath Association

cleansing. It is important for the sink center to be close to the dish storage area for ease of putting dishes away. Because of all the activities related to the sink center, sometimes two sink centers are used (Figure 8.37). The needs of this center or these centers are:

- A sink or sinks, the design depending on the size and needs of the family and upon the available space. Sinks are available in single, double, or triple units, with a central compartment for the waste disposal equipment. If space is limited and a dishwasher is incorporated, a large single sink will usually suffice. Sinks are made of enameled metal (cast iron or steel), stainless steel, or composite materials (granite, quartz), or even cast as an integral part of a countertop.
- Counter space should be provided on both sides of the sink and be at least 18 inches (457 mm) wide in a small kitchen with limited space, although 24 to 36 inches (609 to 914 mm) would be more efficient.
- A dishwasher is almost as standard an item today as a sink. It should be located as close as possible to the existing water supply, drainage, and the sink and should be easily accessible to dish storage. Personal preference and space availability will dictate whether it is placed to the left or right of the sink. Some large kitchens might have two dishwashers, with one dedicated to washing delicate items such as wineglasses or other stemware.
- Storage space is also necessary for equipment such as cleaning, cutting, and peeling utensils. The storage space should also have provisions for dish storage nearby.
- Trash and garbage needs, including a waste disposal in one of the sink compartments and possibly a trash compactor or recycling bin, must also be considered.

The *cooking center* (Figure 8.38) is probably the most active center in the kitchen and should be located near the sink and mixing center and convenient to the eating area. With the development of new equipment, the cooking center has often expanded to two or more areas, such as a main cooking area where the *oven(s)* and surface cooktop are located, and another area that includes a microwave for quick cooking and/or thawing. In some

FIGURE 8.38 The cooking center in a kitchen should provide for a variety of surface, oven, and microwave cooking needs—as well as for adequate counter area and the exhaust/ventilation needs of the equipment.
Courtesy of National Kitchen & Bath Association

cooking arrangements, a bake center is created by separating the oven(s) from the cooktop. It might be created with its own storage for baking supplies and its own work surface. The cooking center(s) should include:

- Surface cooktop units, either incorporated into a range or installed separately. Cooktops are available with gas, electric, or magnetic induction burners. Developments in cooktops include a smooth, ceramic-like top with conventional electric resistance heat. Quick cleanup is an advantage to these units; spilled liquid or food is easily removed.
- Another development is the cooktop that incorporates a barbecue grill or a griddle. Two-, four-, and six-element units are available, along with useful extras, such as a rotisserie or a wok.
- An oven or ovens can either be incorporated below the surface units or separate from the cooking surface. Ovens can be built in over the cooking units or in the wall, to eliminate stooping. Convection cooking ovens, in which warm air is continually circulated around the food by a small air-moving device, offer the benefit of operating at a lower temperature.
- Microwave ovens are available in many forms and sizes and can be a portable unit that sits on the counter or on a cart, or can be built in as a wall unit. These ovens might even be incorporated within a conventional range/oven unit and located above the surface cooking units.
- Counter space for conventional ovens with surface units or separate surface cooktops should be 18 to 24 inches (457 to 609 mm) on each side. If a separate built-in wall oven(s) is incorporated with this center, 24 inches (609 mm) of counter space should be provided on at least one side.
- Adequate ventilation must be provided for the cooking surface, whether by an exhaust fan to the outdoors or by a recirculating/cleansing unit.

The *mixing center* consists primarily of counter space and storage space and could be located between the sink and refrigerator or adjacent to the cooking center (Figure 8.39). It should incorporate:

- Uninterrupted counter space at least 36 inches (914 mm) wide and from 30 to 36 inches (762 to 914 mm) high, depending on personal needs and physical limitations of the user(s) (Figure 8.40)
- Wall and base cabinets to provide storage for various packaged food, cookbooks, small tools, bowls, pans, and small appliances used in mixing

FIGURE 8.39 This kitchen provides an abundance of counter space and cabinets for working, and storage of equipment.
Courtesy of Kohler Co.

The *serving center* is often integrated with the cooking center and should be located near the eating area. The serving center consists mainly of storage and counter space, as follows:

- Ample cabinet space for items, such as dishes, flatware, and linen, that go directly to the eating area
- A 24-inch-wide (609-mm) counter to facilitate serving

In some cases, a separate serving center (often called a butler's pantry) is located in or near the dining area.

Other activities that may be incorporated within the kitchen (depending on personal needs, preference, and lifestyle) include a communication hub, planning, or study area. This area may need adequate storage space for

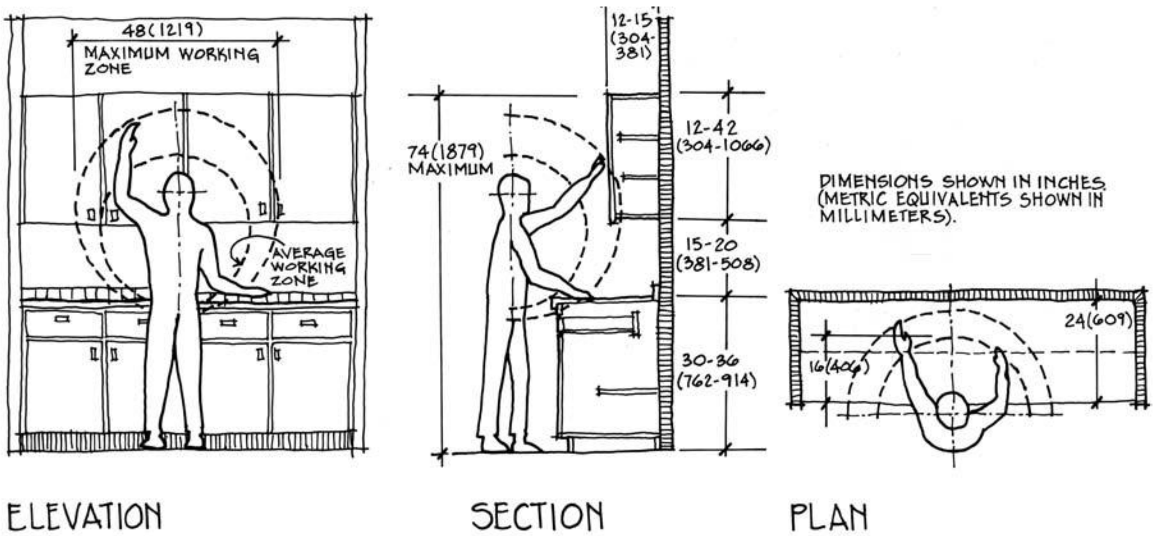


FIGURE 8.40 Dimensions within a kitchen are based on the height and reach of average-sized individuals who would use the room most frequently.

cookbooks, recipes, and perhaps even a personal computer, whether plugged in or wireless, connected to the Internet and other multiple devices.

ARRANGEMENTS AND LAYOUTS The most appropriate organization of the activity centers within a kitchen depends primarily on the work habits of those using it. However, some basic plans and guidelines have been developed and researched for efficiency and energy saving. An average meal generally requires six steps: planning, storage, preparation, cooking, serving, and cleanup. Back in the 1940s, the work triangle was developed to help plan a convenient and utilitarian layout (Figure 8.41) for meal preparation. It is an imaginary line drawn between the three main activity centers within the kitchen: refrigerator/food storage, sink/cleanup, and cooking. The triangle

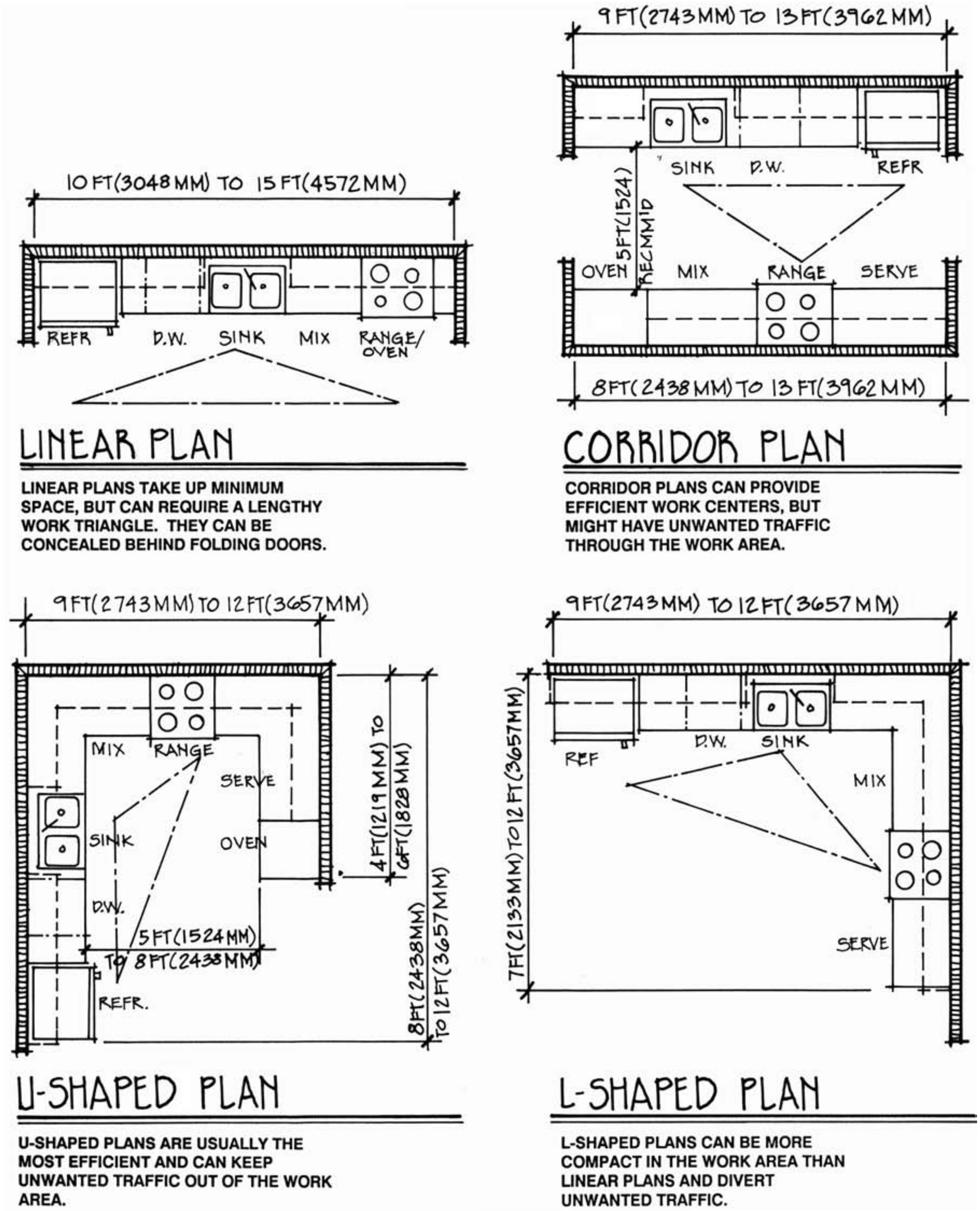


FIGURE 8.41 Of the four basic kitchen layouts, the U-shape is generally the most efficient and least disrupted by unwanted traffic into the workspace.

concept is meant to be used as a general planning guide, not a hard-and-fast rule. Studies have found that the most frequently traveled path is between the sink and the range. Therefore, it follows that this leg of the work triangle should be the shortest, from 4 to 6 feet (1,219 to 1,828 mm), to save time. The next most traveled path is between the refrigerator and the sink, and the least traveled path is between the range and the refrigerator; therefore, it is generally best to locate the sink between the range and the refrigerator. The built-in oven and microwave do not really fit within the work triangle. However, they should be located so that they are easily accessible to, and not too far away from, the cooking center. The basic kitchen arrangements are one-wall (or pullman), two-wall (or corridor), L-shape, and U-shape. Variations of these include the island and peninsula arrangements.

Distances between the activity centers should be kept short and as direct as possible so that time and energy spent while working will be minimized. The work triangle is recommended to be no more than 22 feet (6,700 mm) for the total of the three legs, with a maximum of 12 feet (3,655 mm) and a minimum of 4 feet (1,220 mm) per leg. Traffic (other than the cook or cooks) should be routed around or outside the work triangle. For this reason, the L-shaped and U-shaped arrangements are considered the most efficient.

Today, the work triangle still is a valid concept, but we often speak of kitchen zoning, which is similar to that found in commercial kitchens. As mentioned earlier, modern kitchens might include smaller secondary sinks, under-counter refrigerators, preparation areas, baking stations, and other specialized activities that are not always exactly in the work triangle, but overlap parts of the triangle's zones.

HUMAN PERFORMANCE SPACE If the quality of interface between the user and the components of the kitchen is to be adequate, the components must be responsive to the physical limitations of the human body. Of critical importance in work comfort are the height of a kitchen counter, the clearance between cabinets and appliances for use and circulation, the accessibility of overhead or under-counter storage, and proper visibility.

Standard manufactured cabinets with an attached countertop are usually 36 inches (914 mm) high, but this standard height is not necessarily comfortable for all users and all tasks. Some people may find the upper shelves in wall cabinets completely inaccessible, as they are not tall enough to easily reach them. Flexible or adjustable kitchen cabinets could be more usable not only for the shorter or the taller person, but also for the physically disabled and the elderly. Figure 8.42 shows how cabinetry can be universally designed to be more accessible within the kitchen.

FIGURE 8.42 One of the main features in this accessible kitchen is cabinets raised off the floor, with a deep toe-kick, to provide easy wheelchair access. Other features include a raised dishwasher and pull-out cabinets.
Courtesy of Masco Cabinetry LLC.

FIGURE 8.43 The entry to this home is defined by columns and leads into a foyer that expands to a vertical space and a cupola with windows above.

As discussed later in this chapter, most multifamily housing is now required to have one or more units either specifically designed for the physically disabled or built as "adaptable."

Transitional Spaces and Circulation

The entry into a residence is one of the transitional spaces that connects the outdoors to the indoors. This area can make a powerful statement about the architecture of the space and the inhabitant's values (Figure 8.43). Unfortunately, some residences tend to simply have a front door, which opens immediately into the living space and creates intrusion each time the door is opened. A properly designed entry should accommodate not only the inhabitants but friends and strangers (such as a delivery person).

Entry Areas

Entries are classified as primary (or, more commonly, front) and secondary. The primary entry is mostly for guests and strangers. In fact, it may be seldom used by the occupants, who might instead use a secondary entry from the side or garage. Generally, guests and visitors expect the entry and front door to a residence to be obvious when approaching the building, from a street, for instance. But, in some design arrangements, the entry door might be receded or moved where it is not clearly visible—for example, on a narrow lot where there is a large street-accessed garage, the door might be located within an entry court or found as a side entry.

To provide a sense of security and to prevent surprises, most entries have either a window or a peephole to peer out of. To conserve energy, many homes are being designed with an air lock or entry vestibule, to prevent the harsh winter cold or summer heat from entering the residence each time the door is opened (Figure 8.44). Either within these vestibules or close by, closet space and a settee can be made available as a place for outer garments such as winter coats in northern climates, and a settee to remove shoes.

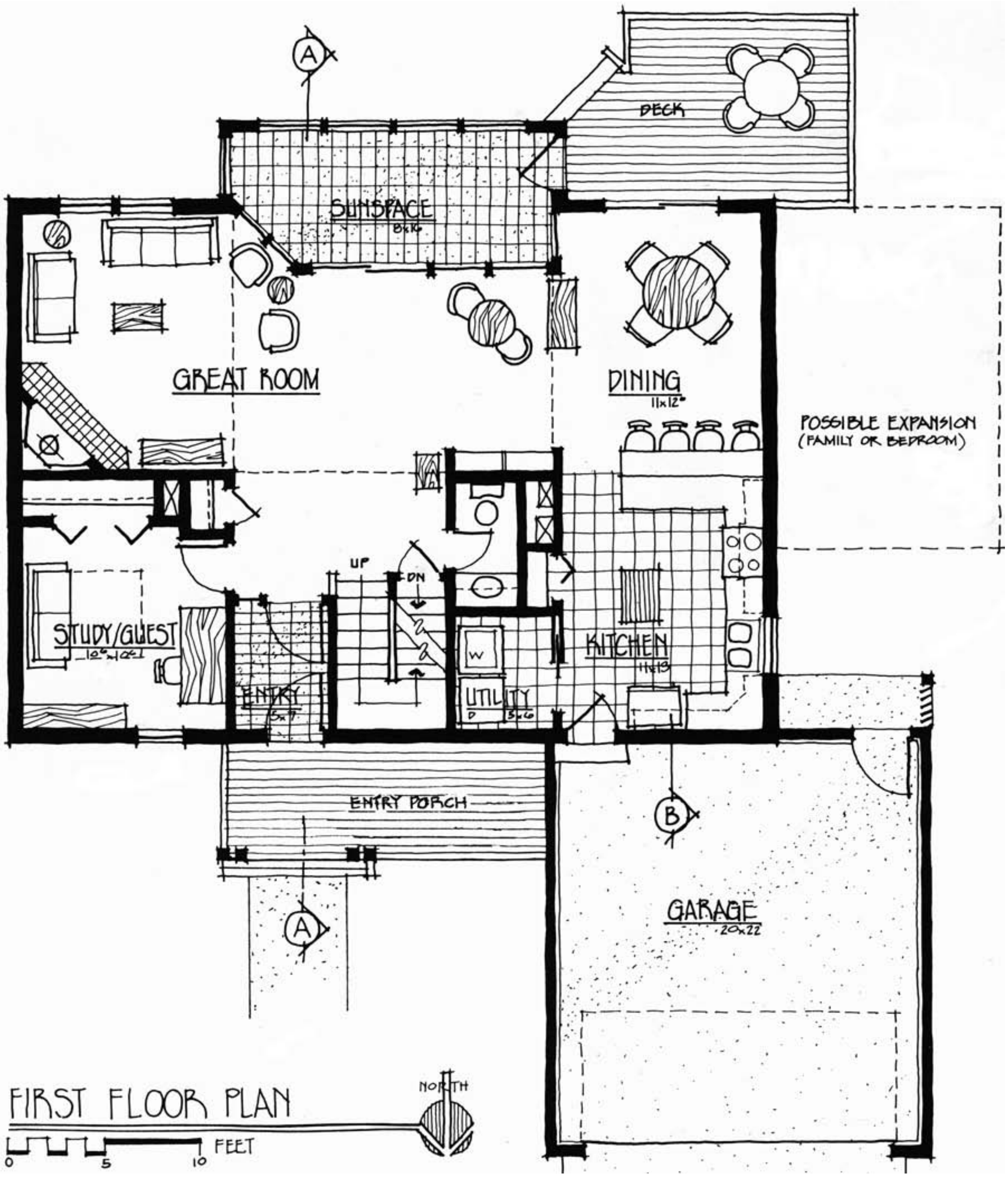


FIGURE 8.44 Energy-efficient homes are often designed with a vestibule (used as an air lock) to minimize heat transfer between the interior spaces and exterior each time the front door is opened.

Secondary entries are located to provide convenient access from support or work spaces. Formerly called service entrances because they were used primarily by servants, today, they might have a dual function as entry and utility or "mud room." Secondary exits can also double as emergency escape routes directly to outdoor areas.

Hallways and Stairs

Circulation between areas in a residence is accomplished in a number of ways. Hallways or corridors often function as horizontal connections between areas. In poorly designed floor plans, these become long, narrow avenues to go from one space to another. Many of these halls are created primarily because the designer has not solved the relationship of spaces. Hallways should not be added to solve a circulation problem; they are a distinct kind of space and should be treated as an experience to travel down—not as a tunnel leading to various spaces. The

FIGURE 8.45 The entry foyer in this house is also a corridor that connects several spaces. In addition to its function, it also incorporates many design features that make it a striking interior.

Photography: Emily J. Followill. Interior Designer: Beth Webb Interiors.

addition of windows, lights, ceiling changes, artwork, and even sitting areas can increase the pleasantness of a hallway (Figure 8.45). Although primarily a functional element for circulation between floor levels, a stairway can be designed to supplement the architecture and provide a visual accent (Figure 8.46). Stairway design is discussed in Chapter 15.

Ancillary Spaces

Many ancillary or specialized spaces in residences can be placed in the social, private, or service zones. Although these special-purpose areas are not a basic necessity to every residence and person, they can add to the quality of life and enhance the use of the residence. If a designer has not planned for them, many inhabitants will make space for them or create them within existing areas of dual-use spaces. They are categorized here and might include:

- Screened porches and sunspaces for relaxing or socializing (Figure 8.47). These might even incorporate hot tubs or spas.
- Hobby rooms or workshops. These come in every imaginable fashion, size, and location, depending on the occupants' needs.
- Game rooms for small or large groups. These can accommodate table tennis, billiards, other table games, and a variety of other activities.
- Garages for one or more vehicles. These spaces can also house bicycles, boats, snowmobiles, workbenches, and the like.
- Outdoor spaces. These can be as simple as an enclosed patio or balcony or as large as a backyard patio including a swimming pool (Figure 8.48).
- Home office. Sometimes a dedicated room or space is established as the work zone, but often the home dweller might use any space with access by a wireless computer or device.
- Home theater or media room, located and designed specifically for video enjoyment (television or projection devices), whether it be movies, entertainment, games, etc.
- Basements and "walk-out" lower levels for sloped sites.
- Attic storage is often requested when basements are not included as part of the residence. These might be above a garage or the house. Access can be by pull-down stairs or a dedicated staircase.

FIGURE 8.46 Stairways are primarily functional in nature but can also be a visual design statement within an interior.

Courtesy of Salter Spiral Stair

FIGURE 8.47 Sunspaces can be an effective way to extend interior spaces to the outdoors yet provide daylighting techniques and passive solar gains in the winter season.

FIGURE 8.48 The interiors of this residence open directly to a patio and swimming pool.
Photo by Philip Atherton

SPECIAL HOUSING NEEDS

Our discussion of space planning for residences has centered primarily around the "average" person. In today's society, we know that that person comes in many sizes, ages, and physical abilities. A concentrated effort is made to address the specific issues of designing for the physically impaired (including for individuals with temporary disabilities), the elderly, and other special populations. (See Chapter 10 for more specifics on barrier-free access.)

Many of the dimensions, spaces, floor changes, and materials we discussed do not serve all the needs of these special groups. For example, doors, hallways, and floor-level changes need to be designed to accommodate people in wheelchairs and other physically disabled people. Countertops need to be lowered (28 to 30 inches, or 710 to 760 mm) and clear space provided beneath them for wheelchairs or other seating units. Storage, light switches, and other items need to be lowered and specifically designed to match the physical ability or impairment of the user.

Accessibility and Adaptable Housing

Accessibility in housing and other buildings refers to the physical features that allow those structures to be accessible to and usable by people who have physical disabilities. Accessible buildings allow a physically impaired person to enter, use, and (in an emergency) escape from them, which requires special design considerations. Typically, accessible housing designed for the physically disabled person was constructed with all the dimensional and material requirements in place. To make a large-proportion or entire multifamily building in this manner could be limiting both in terms of economics and marketability. Today, we see many residential units designed as "adaptable" housing. These environments contain the mechanical and structural features that allow the units to be readily converted for use by disabled occupants, and converted back again if necessary.

Many adaptable and conventional housing units are similarly designed, making for a commonality that is easily marketable. The American National Standards Institute (ANSI) has produced publications that set residential and commercial standards for accessibility and usability, for the physically handicapped.

Housing for the Elderly

Housing for the elderly should be located where there is activity and in areas suitable for residences. In the past, too many of these facilities have been isolated or located in places not conducive to everyday activities for the elderly, such as shopping, walking, socializing, and other community involvement.

Many dwelling units for the elderly are designed to be accessible and are similar to environments for the physically disabled. Many elderly residents of housing projects have some degree of financial or physical inability to maintain a single-family home or to continue their daily routines without some assistance. Housing for the elderly ranges from full-care nursing homes to facilities that provide minimum monitoring or assistance, such as retirement homes.

FOR FURTHER READING

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9

Space Planning of Commercial Interiors

Space planning for both residential and nonresidential spaces is similar in process, but unique characteristics of planning are needed in each area.

Commercial spaces generally are defined as those that serve a user in carrying out a job or making a living. The commercial world is a complex place where people are employed in a variety of different kinds of work, often totally within interior spaces. These include office, banking, retail, hospitality, healthcare, institutional, and public spaces, as shown in Figure 8.3.

In discussing residential design (Chapter 8), we noted that the designer and the client, and/or end user, work closely to develop a personal environment that serves the functional needs and personal tastes of the occupant. In commercial design, the client may not necessarily be the user; executives, employees, and other workers utilize the space. Commercial interiors also tend to be larger and more complex—sometimes ranging to multi-levels and thousands of square feet or meters. It becomes very important, then, to plan these projects after a systematic and careful analysis of the users' needs and the creation of a design that, in turn, supports the business activity and "image" or "branding" of the client.

OFFICE DESIGN

Let's first select the area of office planning as a model to illustrate the steps in space planning. This is a good example to begin with, since more than half of interior design firms are involved in office planning and design, compared to those executing residential work. This trend will continue to grow as the need for office space increases along with growth in population and business activities.

Space planning for office design has become complex and is rapidly evolving, reflecting the changing relationships of the organization occupying the space and the technology used to carry out the work. When people hear the word *office*, no longer do they associate it with rows of private offices or the open bullpens of the past, with typewriters and telephones clattering throughout the spaces and desks lined up in seemingly endless rows. Today's office (Figure 9.1) is conceived as a total environment and is very different from past examples. As business is accelerating at a rapid pace and tasks have become more complex, collaboration and teamwork have become more important, and the walls that have separated us in the past have fallen in favor of the "open plan" office. We now find the office environment better designed, more efficient for faster communication, with unique arrangements consisting of low-partitioned workspaces or even completely open benching systems, as shown in Figure 9.2. Executives and managers might be found right out in the trenches with the rest of the employees, rather than in a private office suite. The restructuring of business organizations, concern for worker well-being, and digital technology have further changed the working and design of offices. The computer, with its ability to quickly process, store, and

FIGURE 9.1 Today's offices are designed not only to serve basic business functions but also to provide an environment that meets the users' human needs and aspirations.

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transmit information, has changed the way people do business—doubling and tripling their business transactions and productivity. More workers process information or provide services, rather than produce goods or products.

These rapid changes in work patterns and environments will present more complex situations to interior designers as they seek to provide well-designed work environments responsive to people and their technologies. As the automobile changed and shaped our cities and lives, so has the computer modified our offices.

Historical Development

Office planning has undergone several conceptual and physical changes in using interior space throughout history. At the beginning of the century, most management and executive offices were enclosed, with each accommodating one person. These individual offices multiplied throughout the industrial period to include staff and administrative people.

One of the most common historical concepts in office planning was the bullpen, or pooling effect, which centralized the work force. People were placed in rigid rows of identical desks in large, open spaces. This gave some sense of order to the staff and no doubt reflected the authoritarian control of business managers. Administrative personnel were segregated into closed offices with windows to the outside and even windows overlooking the bullpen areas for visual monitoring of the staff. This separation of management and staff has existed for a long time in the office environment, and we can still find examples of these arrangements.

About the mid-1950s, a concept emerged that reversed the typical approach that window status directly related to executive status. The administrators were shifted into offices near the center of the building (with windows facing the staff), and the other personnel were arranged in open spaces around the building's perimeter. This

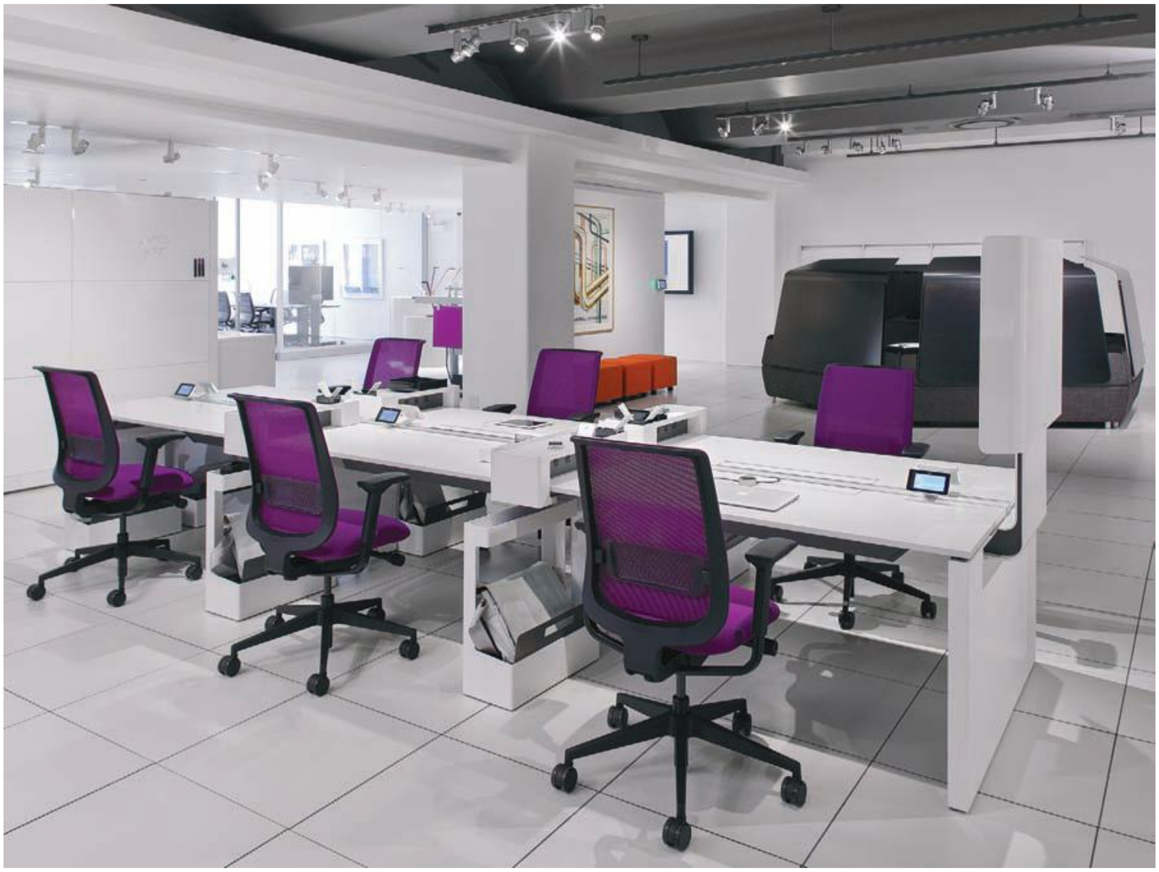

FIGURE 9.2 This benching system from Steelcase is a new-generation work setting. It fosters collaboration by eliminating barriers to teamwork, supports users who spend the majority of their day away from their workspace, and can be scaled to meet the needs of a variety of workers.

Courtesy of Steelcase Inc.

concept is still used today (Figure 9.3). This not only was a shift in planning to bring more light into the building but primarily was an attempt to elevate the status and well-being of the staff worker and temper the elitist perception of the administrative staff. At about the same time, modular panel wall construction was developed, allowing some degree of flexibility in relocating offices. Although entire walls and windows could be dismantled, moved, and reassembled in another location, that was not a quick and easy task to accomplish.

Open Planning

The next phase in office planning was taking away walled offices and placing executives and staff in an open plan, strategically scattered around the building floor. However, a lot of these plans fostered the reemergence of executive status, with executives usually occupying the areas closest to the windows or at the corners of the windowed building (Figure 9.4). The open plan developed with an increased use of partitions and modular furniture. These open arrangements offered two important changes over former closed office plans: (1) It was easier and cheaper to move furniture than to tear down private office walls and rebuild them, and (2) this flexibility in arrangement also allowed for easier managerial controls in personnel replacement or changes, or in regrouping workers periodically into "team" structures for increased work productivity.

Office Landscape Planning

Office "landscape planning" was a concept introduced about 1959 by a consulting firm in the Hamburg suburb of Quickborne, Germany. The Quickborner Team specialized in the organization of paper materials and of products such as filing systems and furniture. The team members studied the workings and interrelationships of offices. They realized that the elements and the performance of an office are interrelated and should be dealt with concurrently in office planning. Office landscape planning is an approach that encompasses an organization's elements, collaboration, and interrelationships, both physical and nonphysical. The Quickborner group theorized that the

FIGURE 9.3 Workstations are designed for office workers to maintain a link with the natural outdoor environment.
Courtesy of Allsteel Office

FIGURE 9.4 This office is located at the perimeter of the building and enclosed for privacy but incorporates glazing to permit exterior light to enter the building's center.
Courtesy of Perkins + Will; photograph by Nick Merrick. © Hedrich Blessing

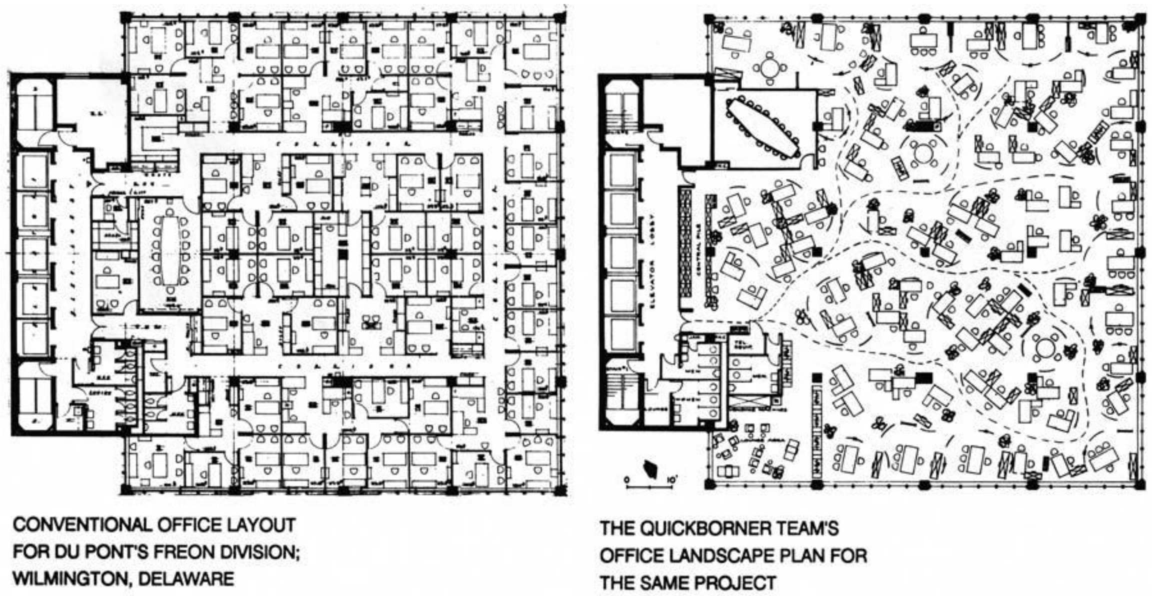

FIGURE 9.5 Comparison of a conventional closed office layout (left) and a landscape plan (right)

placement of workers and their furniture (including equipment) is dictated by the flow of all types of communication as the office carries on its business activities. They believed that communication among workers is easier in a physically open, partition-free space than in separate cubicles or offices. In turn, the decrease of emphasis on the status accruing to individual offices is said also to increase the overall office morale and provide a more human work environment.

Designers often interchange the concepts of the open plan office with those of the office landscape; however, landscape planning is distinctly different. Open planning stemmed from opening up the traditional office, whereas the landscape approach defines physical space and people as functions of the organization's workings.

Office landscape planning often takes place as an interdisciplinary team approach. A planning team of representatives/consultants of the disciplines involved, as well as the users of the space, is organized. Teamwork becomes a critical factor to ensure that the process runs smoothly and satisfies all the organization's needs.

The office landscape's physical layout can seem confusing when a person first experiences it (Figure 9.5). Furniture, privacy screens, and equipment appear to be randomly scattered throughout the interior, with no apparent visual order or geometric rhythm to the arrangement. Circulation paths seem to have no clear avenues from one point to another. However, upon closer scrutiny, it becomes apparent that there is indeed an underlying pattern relating directly to the communication flow within the office. As with the open plan, landscape planning's effectiveness is highly dependent upon the flexibility of the furniture for rearrangement, thus supporting changes. Landscape planning requires careful study by designers, since noisy machines (and people) and loss of privacy can create havoc. In fact, acoustical considerations are of paramount important in these environments and in open planning.

Office landscape planning had some acceptance by business organizations and designers. However, the introduction of the "action office" by the American researcher Robert Propst in the 1960s was probably more influential in creating the open plans we see today. His component system of writing surfaces, storage units, and other units replaced the traditional desks and credenzas. Later, office furniture manufacturers developed panel-hung systems, which then promoted office systems that are panel-hung and freestanding. However, in the 1980s, people began to think that maybe they shouldn't have to reconfigure their work spaces so much anymore, which led to "universal planning" whereby either an 8-foot by 8-foot (2.4-m by 2.4-m) or 8-foot by 12-foot (2.4-m by 3.6-m) space was assigned to each employee. This resulted in better use of the space and a cost savings; however, it created an ice-cube-tray-like environment. As collaboration and teamwork became more important, workers began to realize that they could never see or find each other easily.

The computer and its communication connectivity throughout the world has also changed office workers' patterns, and provided more flexibility as to where and when people work. In the 1990s, a number of businesses and individuals began to work from home or other locations, as electronic technology provided communication links to

FIGURE 9.6 The soft seating incorporated into the Involve line by Allsteel accommodates both individual focus work and small, impromptu collaborative meetings.
Courtesy of Allsteel Office

the central office and remote workers. This became known as the virtual office, and it included many amenities, such as answering machines/services, voice mail, e-mail, remote receptionists, videoconferencing, and the virtual office assigned to a building address.

Some people say that there is no future for office planning since offices are becoming obsolete. They believe that the increased use of communication, as well as wider use of computerization at the workplace, will allow a more decentralized work force and society. Workers can work just about where and when they choose, such as at home, in cars, or even on beaches. Their link to others is through a computer/satellite, or other wired or wireless communication networks. We will undoubtedly see communication modes in the future that seem impossible to us today. Yet, people still require face-to-face communication. Offices will not disappear; they will become more adaptable to a particular type of business, merging the user and the environment.

With more emphasis on collaboration and "the team," the evolution of the workplace has gone from emphasizing privacy and the "my space, your space" syndrome to more "activity-based spaces." That is, a variety of spaces is needed that can adapt to whatever is required of the worker—whether it's a quick chat or interaction with a coworker, a private call, or a creative exercise or problem-solving situation involving two or three coworkers (Figure 9.6).

Another factor in more open office space planning in the 2000s was the emergence of the Leadership in Energy and Environmental Design (LEED) rating system, which emphasizes daylighting and views to the outdoors for employees. This standard dictates that cubicle panels, if used at all, cannot be more than 42 inches (1066 mm) high. So, the challenge in designing offices today is how to plan for an open footprint while offering a variety of spaces for collaboration and still accommodating quiet focus work, both acoustically and visually. In order to promote growth and motivation, designing an open environment in which to work allows a natural progression to evolve, which enables creativity among a more productive work force.

Spatial Organization

Let's look at some of the specific steps of the design process in the space planning of a typical office interior. We will assume at this point that the program (discussed in Chapter 7) for our office example has already been generated and published for the designer's use as a guide for goals to be met in the design. The space planning step will be concerned with applying the program and generating schematic drawings to show the interrelationships of the business organization, its needs (physical and functional), and the shaping of the interior space necessary to accommodate the office organization.

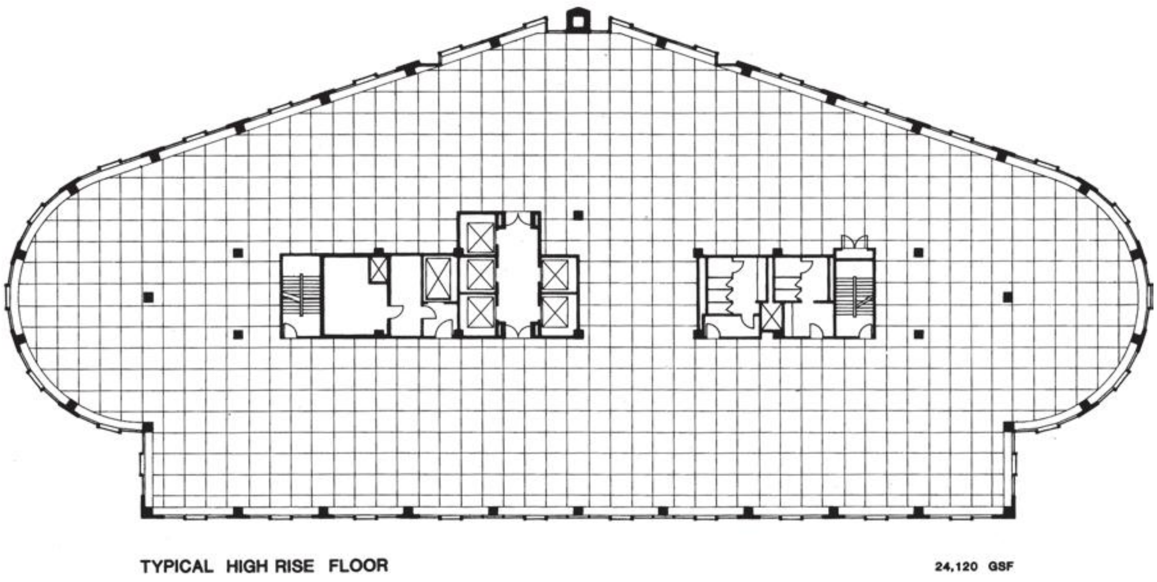

FIGURE 9.7 The uniquely shaped floor plan of this office building provides for some creative interior spaces not available in simple, rectangular building plans.

The interior designer provides services to corporate clients in many different ways when planning office spaces. The client may have already selected or bought a building space. Sometimes, to assist in locating a potential existing interior space that appears to be appropriate, the interior designer provides the initial feasibility studies for a client. The interior designer might also be retained in the initial stages of designing new buildings to team up with other design professionals, such as architects and engineers, to plan a building that will have functional interior spaces, as well as meet LEED rating system standards for a certified building.

The interior designer first analyzes the existing or proposed building's interior and makes note of inherent characteristics and square footages. Locations of building "cores," which include elevators, stairs, restrooms, communication links, and utilities, are noted. Today, we find available office space and shapes or footprints of buildings in almost every size and configuration imaginable (Figure 9.7). Spatial configurations, window placement, and available floor-to-ceiling heights of the building are studied to determine strengths and weaknesses. Another important characteristic the designer looks for is the ability of the building space to accommodate rearrangement of offices and teams, as well as possible expansion. Many buildings are constructed on a structural module that is subdivided into smaller units of one- to five-foot increments. Corresponding interior office sizes, and even the furniture size, are often matched to this module.

Adjacency and Circulation Analysis

After the building's characteristics have been identified and studied, the designer begins to relate the client's program to the floor plan. He or she makes graphic drawings to represent the physical relationships of the office needs. Then adjacencies and functional relationships are diagrammed and eventually transposed into physical space containers. Three graphic tools the designer uses at this stage are the matrix, the bubble diagram, and the zoning diagram. These diagrams address concerns such as the circulation network and the need for spaces to be near one another. Spatial adjacency and circulation patterns involve factors such as the movement of people, material, and information.

MATRIX A matrix diagram (explained in Chapter 7) is often used to determine relative importance or proximity of spaces to one another in the facility (Figure 9.8). If two different spaces cross in the grid, the importance of their adjacency can be noted. It should be noted that sometimes the programmer has already translated much of the data into matrix diagrams and presented them in the written program. In this case, the designer refers to the program to assist in the drawing of the floor plan.

BUBBLE DIAGRAM The bubble diagram translates the decisions recorded in the matrix into a more visual form. As discussed in Chapter 6, this diagram is made up of bubbles that represent each interior area, with lines connecting the bubbles that need direct linkage to each other (Figure 9.9). The bubbles do not attempt to scale the

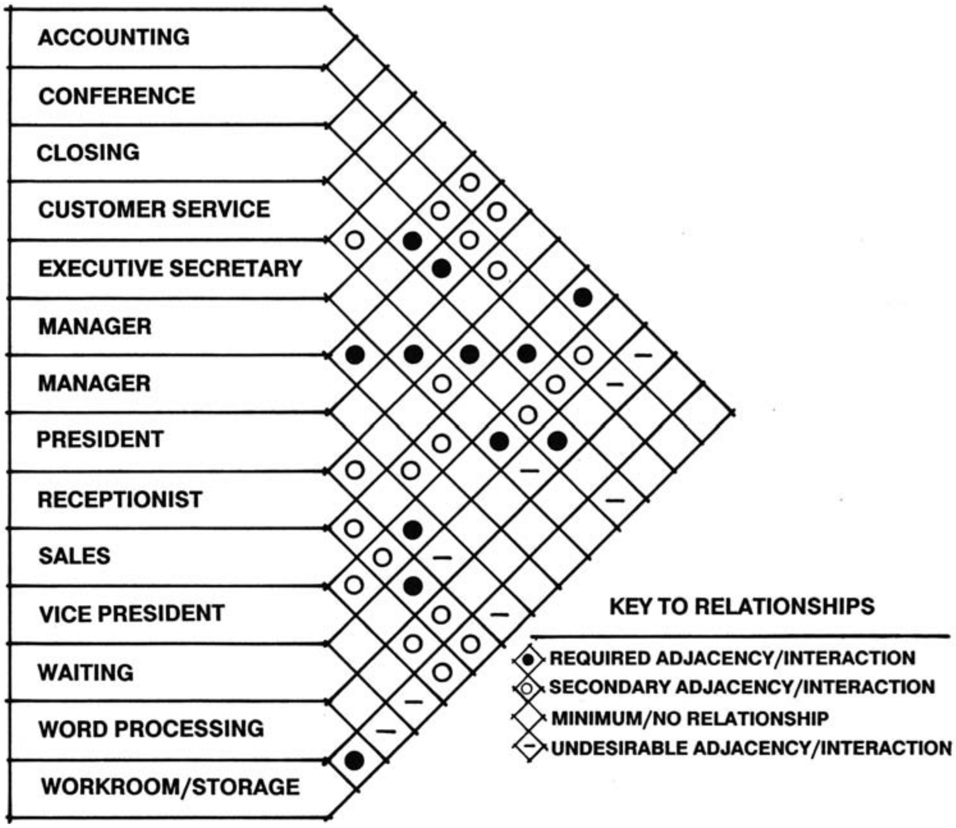

FIGURE 9.8 A matrix can be an effective tool to prioritize required relationships within an office during the initial stages of design. These can be expressed by comparing the symbols where two areas intersect.

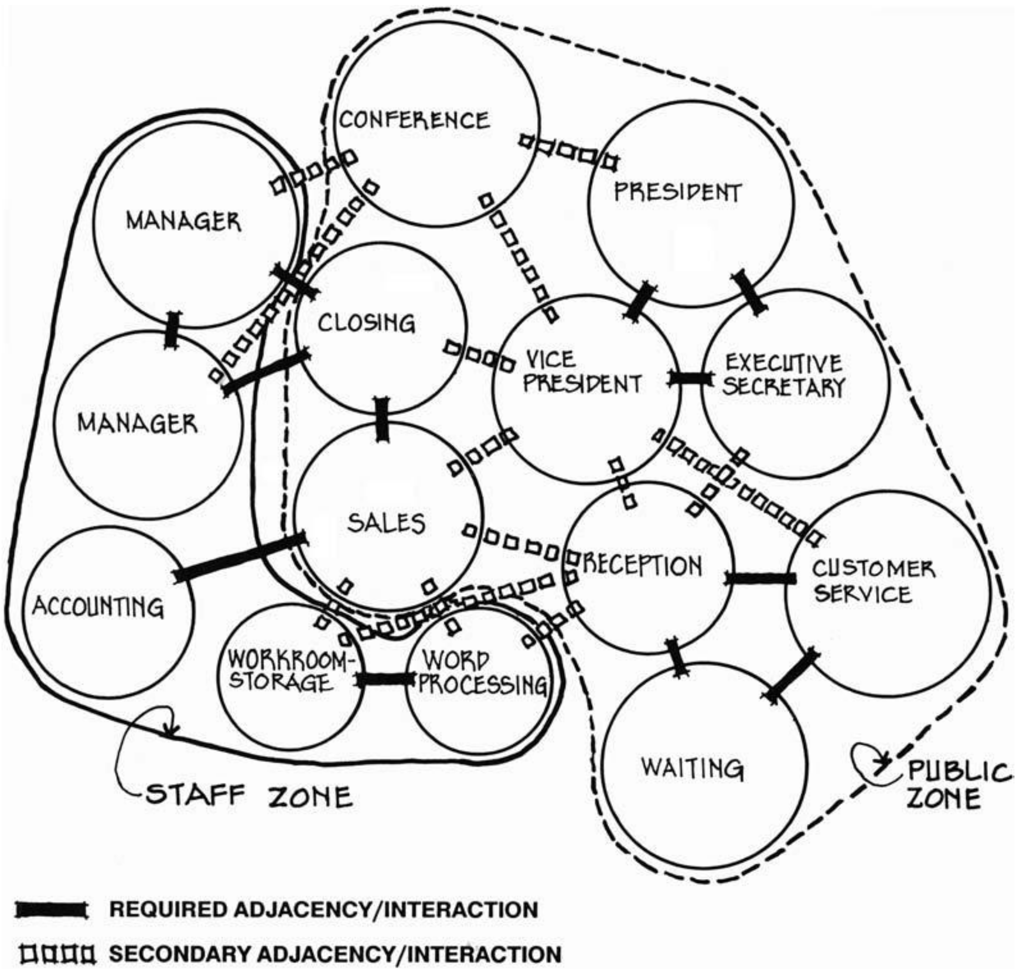

FIGURE 9.9 The relationships established in the matrix (Figure 9.8) are expressed in this bubble diagram.

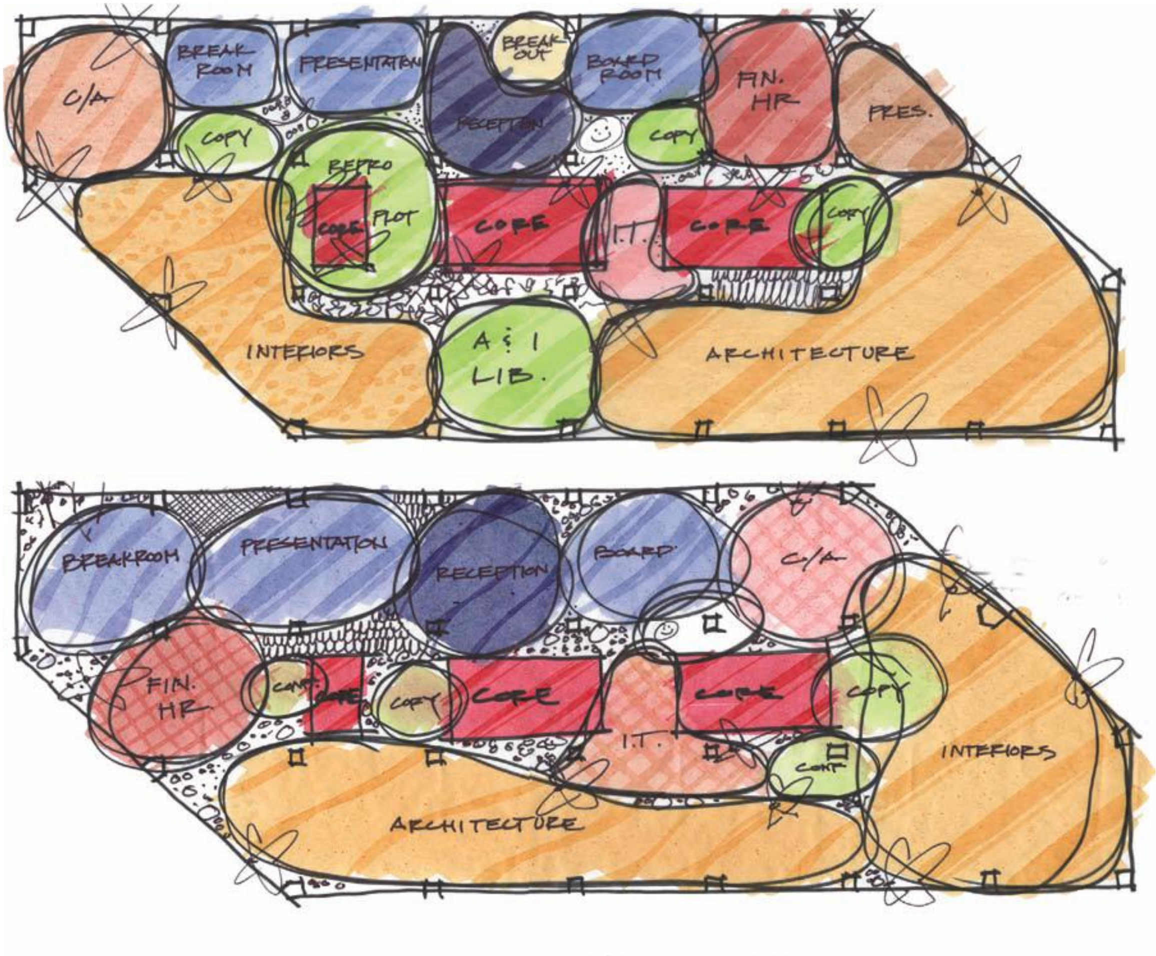

FIGURE 9.10 Bubble diagrams are organized into zoning diagrams to explore comparative departmental layouts on the building's floor plan.
Courtesy of Jeff Johnston

size of the spaces, but represent a distinct unit and its working relationship to others. Although designers sketch bubbles as two-dimensional circular shapes on paper, the real concept implies a three-dimensional space. Students often have difficulty translating their two-dimensional bubble diagrams into three-dimensional space—because they were not visualizing in three dimensions in the first place. They were attempting to map the function of the floor plan, not of the three-dimensional space.

The thickness of the lines connecting the bubbles can indicate the relative type or intensity of the connection between the activities in the spaces.

ZONING DIAGRAM The designer then locates and identifies major areas, or zones, where various departments of a business might be located. In zoning diagrams, additional information is superimposed over the bubble diagram. The designer sketches several alternative layouts of zones to scale on the building plan to study the advantages and disadvantages of each (Figure 9.10). For example, spaces can be grouped into noisy and quiet zones or public and private zones. Each time spaces are connected using a different grouping criterion, a new zone is made. One of the biggest problems to the open office plan is noise and lack of visual privacy. The noise can be addressed by the addition of private places to go for long conversations or conference calls, by adding white noise systems, and by proper zoning of louder activities. In the design process (covered in Chapter 6), this is the ideation stage, looking for many different ways to lay out the overall office onto the building plan. The main and secondary circulation routes for people, equipment, and other communication avenues are defined.

The zones are blocked out for each floor level, and an overall three-dimensional stacking diagram can be prepared for multilevel buildings. Such a stacking diagram is often prepared over a scaled building section to indicate which floors are grouped together for similar zones or adjacency needs.

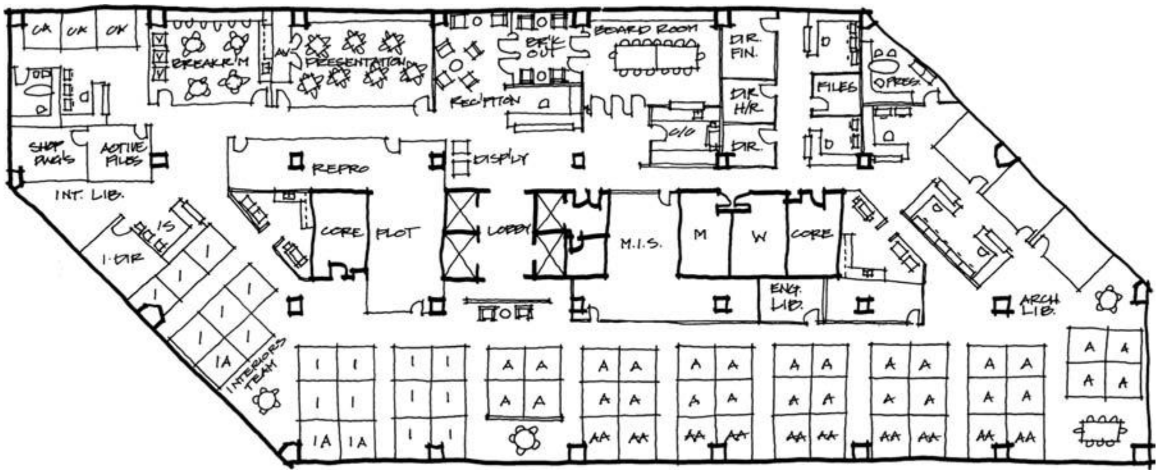

FIGURE 9.11 A preliminary floor plan is roughly blocked out to define the spaces, walls, door openings, and functional relationships. Furniture, workstations, and other design features are added to assist the designer in presenting concepts to the client.

Courtesy of Jeff Johnston

Each zone of the plan is refined and detailed, with its interdepartmental relationships and individual workspaces defined with regard to needs. These schematics are then translated into scaled preliminary plans to indicate how the interior space is to be utilized within the building (Figure 9.11).

COMMUNICATION ANALYSIS In a communication analysis, the interior designer produces diagrams representing the office's activities, paper-flow routes, filing systems, furniture/equipment allocations, and various other aspects from the program (Chapter 7). The purpose of this analysis is to track communication patterns to use as a basis for the layout, ensuring workflow and communication efficiency.

With the development of office technology and computers, communication and storage needs have changed in form. As automated equipment, such as word processors, microcomputers, laser printers, and electronic filing, becomes standard, the interior designer needs to address the ongoing challenge of integrating this hardware into the office environment.

Computer-aided design has permitted many design firms to quickly execute preliminary space planning on video screens and printouts. Computers in design offices are also programmed to move into the next phases of design development drawings, construction drawings, and even cost estimating as the plans are being drawn. Clients often seek the interior designer who can do tenant development planning and can produce design solutions in quick turnaround time to get a business office into a building. The computer has given the designer a tool to keep pace with the demands of office developments.

We have discussed how an interior designer analyzes a client's program, develops graphic concepts, and produces scaled drawings. Designers must also deal with other concepts, such as the image or aesthetic appearance of the new space. A design might function very well but be visually unexciting or lack visual cohesion. With the efficient planning of the space, a designer must also search for the unique overall concept, or thread, that holds the idea together. For example, we might have a concept based on maximizing view and natural light for all employees in the space.

Typical Office Areas

The main purpose of an office environment is to support its workers in performing their jobs, preferably with satisfaction and comfort. With so many different people performing different activities and tasks, it's not always easy to predict the right office spaces. Although each business office is a unique entity, there are some common denominators. The typical spaces are called areas rather than rooms. This is important since in today's open and closed office planning, a meeting area can be a private conference room or a modular group of furniture set within an open area of the building.

ENTRY AND RECEPTION The entry to an office and the reception area are important design features that can project immediate impressions about the company and its interior spaces (Figure 9.12). The image of the firm is

FIGURE 9.12 The entry to an office establishes the image of the business and sets the design character of the spaces beyond, as shown in this office design by SOM.
© Skidmore, Owings & Merrill LLP

often set at this front entrance. Entries are usually designed around several functions that serve both visitors and staff. In addition, the entry must provide security and meet fire and handicapped access codes.

These spaces can be formal or informal depending on the "face" the firm wishes to present to visitors. By greeting, providing directions for, and seating visitors, the receptionist exercises a control aspect that is an important ingredient in providing the office some degree of privacy and a minimum of disruption by outside forces. The reception area can be a convenient place for visitors to leave their coats and, if equipped with a table and chairs, it can serve as a small conference area.

MEETING AREAS Holding meetings is a necessity in business organizations, whether among the staff or with visitors. A firm may have one central space that everyone uses on a rotating basis, or there may be a series of smaller conference or teaming areas (Figure 9.13).

Meeting spaces can be very formal or informal in arrangement and finishes, to reflect the particular type and level of business discussions. For basic functioning, conference areas consist primarily of a table and chairs for two or more people. Other items, such as credenzas, storage, audiovisual equipment, sinks, bars, and lecterns, can be included to serve additional needs. Most conference areas require a high degree of audio privacy; that is, people in adjacent areas should not be able to overhear. However, if meetings are not expected to require total privacy, these spaces might be constructed as open or semi-open conference spaces. As teaming and collaboration are very important, soft seating can also be built into a workstation, which would foster impromptu meetings that don't require a café space or private conference room.

EXECUTIVE AND MANAGEMENT The executive or management area is where policies are set and decisions made. This space is reflective of executive needs, and many times is spatially suited to the status of executives within the company organization (Figure 9.14). Executives may be spaced throughout the floor plan of a building

FIGURE 9.13 This small meeting room provides acoustical and visual privacy from the rest of the office. It is accented by the circular exterior windows.

Courtesy of Knoll, Inc., © Steinkamp Photography

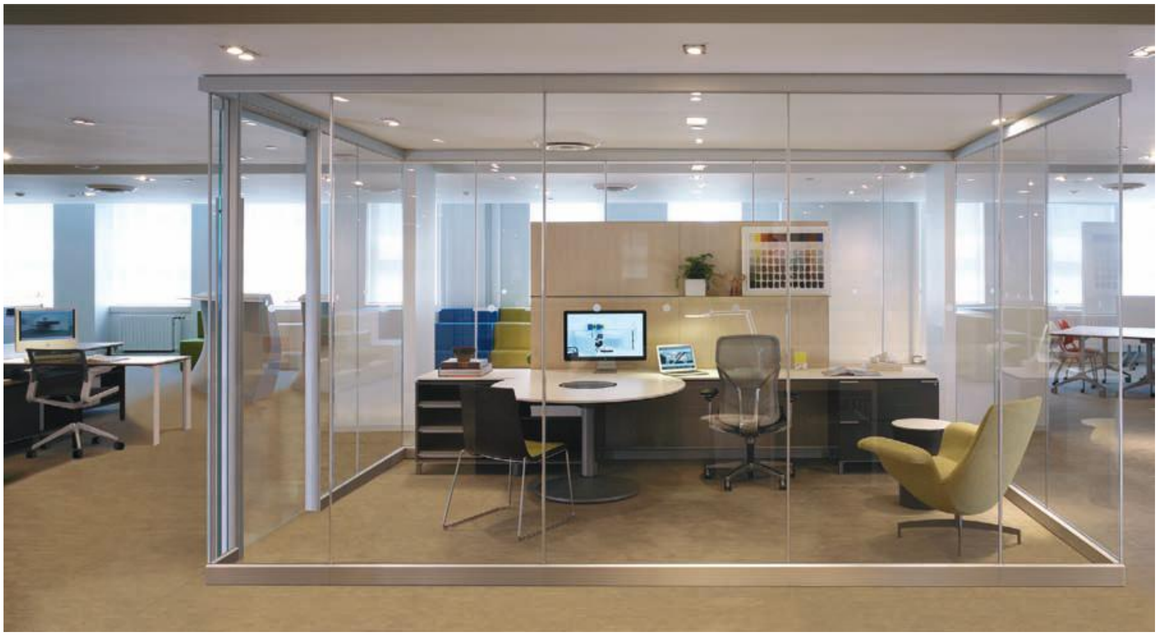

FIGURE 9.14 The executive office in this firm was designed to reflect executive functions and status. Glass walls provide acoustical privacy but allow light to enter the building's interior spaces.

Courtesy of Hedrich Blessing © Scott McDonald

FIGURE 9.15 The workstations in this office are set in a lighted open space. This allows the staff to interact visually with other office activities and to be adjacent to the management personnel.
Courtesy of Knoll, Inc.

or grouped together for efficiency of function and communication. Executive areas are supported by conference rooms or boardrooms, and sometimes with space for executive secretaries. Interior budgets are usually increased for these spaces, to project an executive image to visitors or to staff members. Depending on the individuals and their needs (or desires), private washrooms, bars, and dining and entertainment facilities may also be provided.

WORK AREAS The workers' space areas should be designed to assist employees in performing their functions efficiently in a pleasant working environment (Figure 9.15). Some tasks may be repetitive and monotonous, but the space does not have to be. Office workers should be given some degree of control over their environment and a sense of "personalization." Breaking down large pools into smaller clusters can improve work areas and increase productivity. These areas might include open office workstations, private offices, shared offices, teaming areas for four to ten people, or a touch-down station suitable for one person to perform short-term activities.

SUPPORT SPACES At the heart of many business offices is the all-purpose area designated as the work center or workroom. Typically, these spaces are closed off, since they frequently are cluttered and/or house noisy equipment, such as copy and mailing machines. These spaces can also contain the central files, paper and other office equipment supplies, and a general workspace. In smaller offices where there are no designated employee lounges, the workroom becomes the employee break area or socializing space.

RESOURCES Resource areas might include a library or communications room. The library can house books, films, or other current media. In architects' and interior designers' offices, these resource areas house manufacturers' catalogs and material samples, as well.

BREAK AREA Employees are often given some "special" areas that may not seem directly related to their jobs but are crucial for their well-being. Socializing and an escape from the daily routine are provided in these areas, such as a coffee-break space or an employee cafeteria (Figure 9.16). These areas can also serve as areas for a quick chat or interaction with a coworker, as well as a situation involving two to three coworkers.

FIGURE 9.16 This café, within a law firm, was transformed into a dynamic space using light, color, and unconventional materials. It provides a rich and rewarding experience for the firm's employees.

© Skidmore, Owings & Merrill LLP

Other amenities provided in some office environments are child-care centers and employee recreational or exercise spaces. All of these are important ingredients in the office environment and are designed to increase employee satisfaction and productivity.

FINANCIAL INSTITUTIONS

Financial institutions, including banks, savings and loans, credit unions, and trading centers, provide a multitude of financial transactions and services. Although their business operations differ, some similarities are apparent in their planning. The daily routines of these facilities and their customer relations dictate the functional layout of the spaces.

The image of financial institutions can vary from the formal and traditional look (Figure 9.17) to the modern and visually dynamic. Many financial institutions project customer-friendly attitudes, and their interiors offer patrons a comfortable, relaxed atmosphere.

FIGURE 9.17 This bank is designed in a more traditional look, with rectangular elements, including massive columns for a refined motif.
Courtesy of Kimball Office

Bank design has been greatly affected by the self-directed technologies, such as the increasing use of an automated teller machine (ATM) and the Internet for banking and financial transactions. Most banks still provide some form of customer contact for more complex transactions such as mortgages, loans, and other special services. But the majority of people now do their transactions through the bank's website. Banks are also linked globally, providing access to their services throughout the world. Multiple tellers behind a counter and drive-up facilities for face-to-face meeting with a customer are becoming less needed, as illustrated in Figure 9.18. Even the window between the drive-up and teller is giving way to cameras for videoconferencing from the automobile to the teller.

Let's look at a banking facility to illustrate how financial institutions are planned.

Spatial Organization

Full-service banks are organized into public, semi-public, and ancillary zones (Figure 9.19). The customer enters the public area (which includes the teller line) for most daily transactions and can cross into the semi-public spaces, such as safety deposit areas. Usually included in the public areas are the offices of bank officers and sometimes of executives. These public interiors are designed to be spacious and to direct the customer to the appropriate place. Finish materials are selected to withstand the wear of numerous people using the space. Banks also have convenient drive-up windows that connect directly or by video camera to a teller station or use pneumatic delivery systems. The drive-up facilities also include access to an ATM machine.

Adjacency and Circulation Analysis

The bank's entry leads directly to the main banking floor and related offices. Here we might find the teller stations, information desk, and loan offices. Adjacent to the public space are the secondary spaces, such as the safety

FIGURE 9.18 For face-to-face meetings, teller stations are becoming more informal and semi-public.
Courtesy of Kimball Office

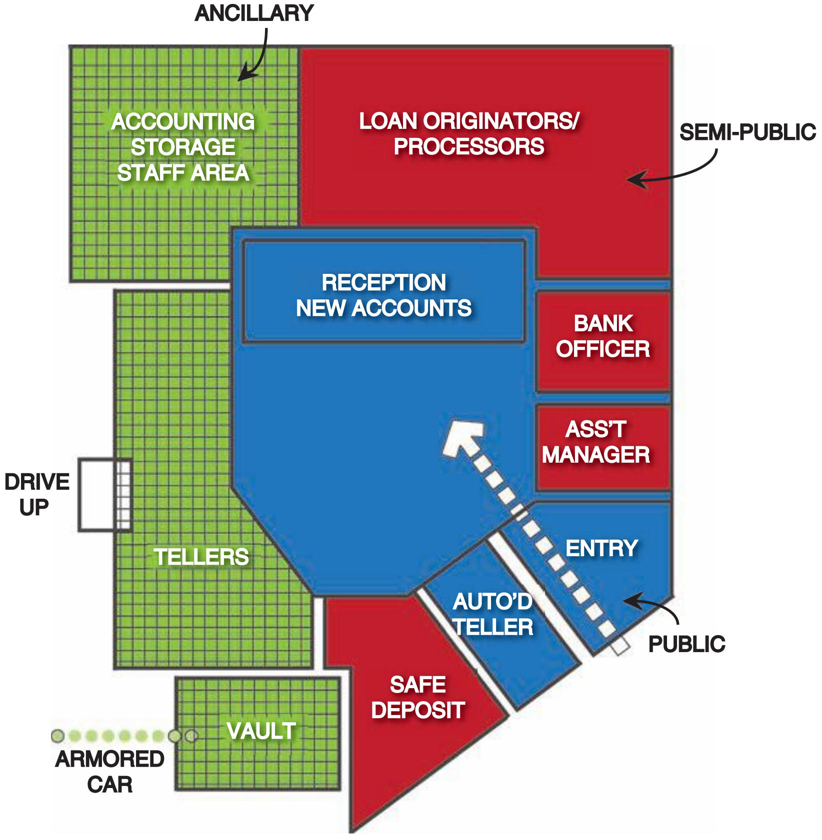

FIGURE 9.19 Banks are organized into public, semi-public, and ancillary zones, as seen in this schematic drawing.

deposit area. Behind both of these spaces, the behind-the-scenes workings of the bank take place. Patrons are not generally allowed in these areas, which are *secured* spaces. These include the main bank vault and armored car delivery area. The ancillary areas of the bank are the employee lounge, central files and storage, and other clerical areas.

Communication Analysis

Bank operations and workflow are highly computerized. Although money and other legal tenders are exchanged and stored, many transactions are electronic. Data are fed into the bank's main computer system, which may be in the same facility, or a remote terminal, or interconnected through the bank's website. Today there are sophisticated automated teller machines and even at-home banking. One of the main design concerns of a bank is the security and monitoring of financial transactions through video cameras and alarm systems.

RETAIL DESIGN

Some of the most exciting interior spaces in our built environment are commercial retail facilities, such as stores, shops, shopping malls, showrooms, and galleries (Figure 9.20). The buying, selling, and customer service aspects of retailing pervade our daily lives through aggressive advertising and specially built environments to lure us into spending our money. The marketing strategies and the design of these spaces are controlled by the location, the type of service or products to be sold, the price, and the targeted customer profile. Retail outlets range from conservative, low-illumination high-end stores to stimulating and playful shops (Figure 9.21). Some stores are geared to deal in quantity of goods and efficient handling of customer movement and buying. Others are geared toward leisure shopping and high levels of customer service. Some specialty shops, such as beauty and other salons, market services, rather than products. Other specialty shops include computer stores, catalog and online showrooms, optical centers, and gourmet food stores.

FIGURE 9.20 This indoor shopping mall has multiple levels connected by elevators that serve as a major design element.

© JD Dallet/arabianEye/Corbis

FIGURE 9.21 This store features strong design elements to draw customers into the shop and provides a unique experience for its patrons.
Courtesy of Knoll, Inc.

In retail designs, through the effective combination of lighting, color, and physical setting, the environment is created to display merchandise and cajole the customer into buying.

Shopping centers are designed for destination buying; that is, the combination of specialty stores attempts to lure customers to the retail complex to do all or most of their shopping. Although most shopping centers and malls contain a large center court, many are constructed as vertical malls, festival malls, and factory outlet centers. These indoor

FIGURE 9.22 This food court within the Mall of America provides an oasis for socializing and purchasing a variety of food offerings for the shoppers.
Ian G. Dagnall/Alamy

and outdoor commercial centers are popular for socializing as well as buying (Figure 9.22). The shopping mall attempts to balance a series of specialized shops with a few large all-purpose retail outlets to round out consumers' choices.

Showrooms are designed as specialty outlets primarily aimed at the intermediary between the manufacturer or distributor and the customer. For instance, many manufacturers of interior products and materials cater to interior designers and architects (Figure 9.23). These showroom spaces are often well designed and stimulating to the senses, in order to show the goods in a most flattering or "applied" manner. A design professional usually must accompany a client to a showroom. Showrooms are found also in other fields, such as the apparel industry. Most showrooms include an online website and links for professionals (and sometimes the public) to do their initial research and selections before going to the showroom to physically examine the objects.

Galleries as defined here are those special retail places used to exhibit and sell works of art. Gallery design serves primarily as a backdrop to the works being displayed (Figure 9.24).

FIGURE 9.23 This Knoll showroom features a Cini Boeri lounge and sofa with a William Platner coffee table and accent lighting to create a distinct design image for the company.
Courtesy of Knoll, Inc./Michael Cullen

FIGURE 9.24 Lighting and custom exhibits set the stage for this gallery to bring out the best features and viewing angles of the art.
frans lemmens/Alamy

Proper lighting, viewing angles, people circulation, and security are important factors. These environments should be conducive to leisure shopping, allowing customers to appreciate the works exhibited.

Museums are similar to galleries in the display of works, but most of these are not for sale. Museums are discussed later in this chapter under the "Public and Government" section.

Spatial Organization

Retail outlets (shops and stores) are designed to attract the customer, display the merchandise, and assist in making purchasing decisions, closing the transaction, and servicing the customer after the sale. The design of the establishment should be targeted toward a specific group of customers. The design should display a clear image to the shopper, reflecting the type and quality of goods offered (Figure 9.25). Some franchised shops use a distinct image that can be repeated in other locations.

FIGURE 9.25 The design of this shop is organized to display the merchandise so the customer can easily make purchasing decisions.
© Fabrice Lerouge/Onoky/Corbis

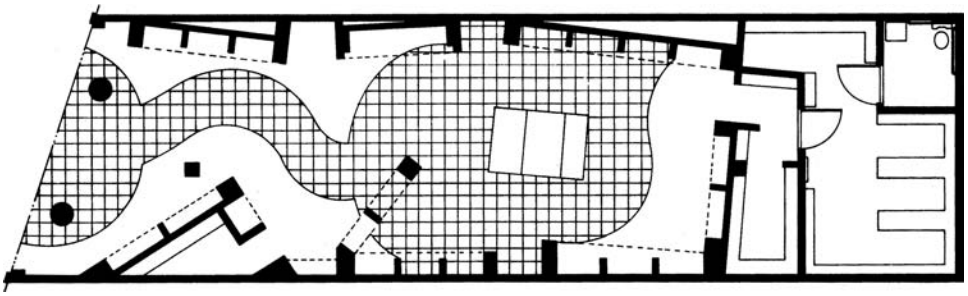

FIGURE 9.26 This floor plan of a shop is divided into customer sales area, product storage, and employees' restroom.

The facility should be designed to meet the needs of the shopper: imminent buying, routine purchases, major purchases, or social shopping.

Most retail establishments are separated into distinct areas, such as entries, merchandise areas, cashier/transaction areas, product storage and receiving, dressing rooms (if applicable), and restrooms (Figure 9.26). Depending on the variety of products, customer service, and other needs, additional spaces can be created. The entry of the shop motivates the customer to come in and begin the inspection and browsing process. Circulation paths are defined according to the targeted buying habits for quick or impulse purchases. Other layouts may entice a buyer to move more slowly and be introduced to highlighted merchandise.

Good visual control of the merchandise and signage is important in store design for security, customer assistance, and proper display.

HOSPITALITY DESIGN

Hospitality interiors are designed to facilitate entertainment and socializing and to otherwise provide for the physical needs of guests. A person seeks these places to fulfill a physical need of nutrients (restaurants and other eateries) and a resting place while traveling (hotels, motels, and inns), or to be entertained and informed (theaters, auditoriums, convention centers). In all of these, however, the guest usually seeks socializing and a sharing of experiences with other people.

Most hospitality facilities must not only present their best image and services to their clients or customers, but must also be concerned about the "usage rate." They seek to maximize the number of users in order to avoid "down-time" or vacancy rates. Competition can be tough, and the management of hospitality facilities is just as important as their design and ambiance.

As with many other facilities, hospitality institutions are increasingly designing, building, and managing with more green and sustainability issues in mind. They seek to reduce their energy needs, water usage, and waste in order to reduce their impact on the environment.

We do not dine out just to eat, or stay in a hotel just to rest. For the price of a meal or admission, hospitality facilities will provide much more than just satisfaction of basic human needs. Space does not permit the authors to touch on every type of hospitality facility, but a few that are most commonly designed by interior designers will be discussed in the following sections.

Restaurants

Dining out is a big business today, and restaurant design is probably one of the most innovative arenas for creating interior environments (Figure 9.27). Some restaurants are actually designed as trendsetters; they either do not expect to be long-lasting environments or will need periodic remodeling. Restaurant design can also be difficult, because eateries are specifically designed for a target market. The interiors should provide an appropriate atmosphere for the serving and eating of food. Even if great interiors are created, however, the eating establishment may be doomed to failure if the marketing, management, and service to the customer falter.

In addition to serving food and providing an ambient atmosphere, restaurants also furnish an arena for the "see and be seen" needs of social life. People who eat out generally fall into one of four target groups. First, there is the "eat and run" type, who usually wants to eat quickly and may find service and time savings more important

FIGURE 9.27 The lounge in the Atlantis Palm Hotel in Dubai was created around a nautical theme and provides a unique experience.

than the price and quality of the food. Second is the "food connoisseur," who wants excellent food. Price, time, and speed of service are not quite as important as being able to experience the high quality of the meal. Third are "comparative" diners, who expect a balance of good food, price, and service. These people tend to dine out dressed informally and often have children with them. The fourth type is the "socialite," who perceives dining out as primarily a social or business event. This can range from a quite intimate couple to a ceremonial, theatrical production. In turn, the design of the eating establishment should correspond to the needs of these four target groups. It should be pointed out, however, that some establishments cannot be neatly categorized into one of these types. Some might cater to more than one group or might change their service delivery, that is, might set up buffet style sometimes but have wait staff serving tables at others.

Successful restaurant operations are based on research and analysis of (1) the market to be served, (2) the type and style of food service, (3) the menu, (4) the location, (5) the competition, (6) the cost of original construction and start-up, and (7) the cost of daily operations.

Theme vs. Contextual Concepts

Many restaurant designs fall under one of two basic design concepts: theme or contextual. Theme restaurants are created around a selected image or idea, or "branding" that appeals to our visual and intellectual senses of places, persons, things, events, experiences, or the restaurant's *brand.* The design is created with the theme as a priority—for example, a nostalgic western saloon—as the underlying guiding principle around which everything else revolves. Unfortunately, many theme interiors can be overdone to the point of triteness or can quickly become outdated as a passing fad. Some theme designs can be very successful and a delight to experience. Themes can be made rather subtle in their design, leaving one's imagination to make strong thematic connections.

Contextual restaurant and café design concepts are based on good design principles and materials. The interior spaces and finishes are supportive of the dining experience and do not create an artificial or theatrical atmosphere. No distinct theme guides the planning, just good design conducive to the act of dining (Figure 9.28).

SPATIAL ORGANIZATION Restaurants are generally organized into a "front" and "back" relationship. The design atmosphere is created in the front for customers, while food preparation, services, and management occupy the back. However, in some situations, such as fast-food establishments, the two areas often overlap or are at least exposed to one another. In some situations, a "display" or "show" kitchen concept is done, where part or most of the kitchen functions are within view of the customer.

FIGURE 9.28 This large café within a children's hospital offers plenty of seating for children and their families as well as hospital staff. The bright colors and mural on the wall create an exciting environment while easing anxiety and stress associated with a hospital stay.
Photo courtesy of Haworth, Inc.

Restaurants and other eateries are generally divided into entry/waiting areas, dining and/or drinking areas, food preparation areas, and service/delivery spaces (Figure 9.29). Other facilities, such as employee locker rooms and management offices, might also be provided. The entry and waiting areas frequently give a glimpse of the dining spaces and experiences within. In some cases, these are designed as comfortable environments themselves; in others, they lead directly to a lounge that can be used for waiting and socializing. Dining spaces are visually oriented outward to a view, inward to a focal point, socially to other views of diners, or compartmentalized to more intimate or small group dining.

Transitional zones exist in several spaces within restaurants. For example, the interface between the waiting areas and the dining areas should provide proper separation, yet heighten the patrons' anticipation as they move from one zone to the other. The transition zone (service) between the kitchen and the eating area must be designed for maximum efficiency of use by the servers and provide audio and visual controls to prevent undesirable factors from entering the dining area from the kitchen.

Circulation and seating of the patrons should be well planned to minimize confusion and interference with the servers. Seating arrangements fall into several categories based on the number of diners. These arrangements are planned for socializing, privacy, and flexibility of groupings, the latter to accommodate varying numbers of people and their desire to interact. Typically, dining rooms are designed with an average of 10 square feet (3 m) allowed per person for fast-food service to 16 square feet (4.8 m) per person for higher-quality table service.

The food preparation areas can vary as much as do the meals served. In most cases these areas are hidden from the patrons by doors or halls (Figure 9.30). In some other restaurants, part of the preparation and cooking areas are visible to the diners, especially in participatory cooking centers that provide theatrics for patron enjoyment. The

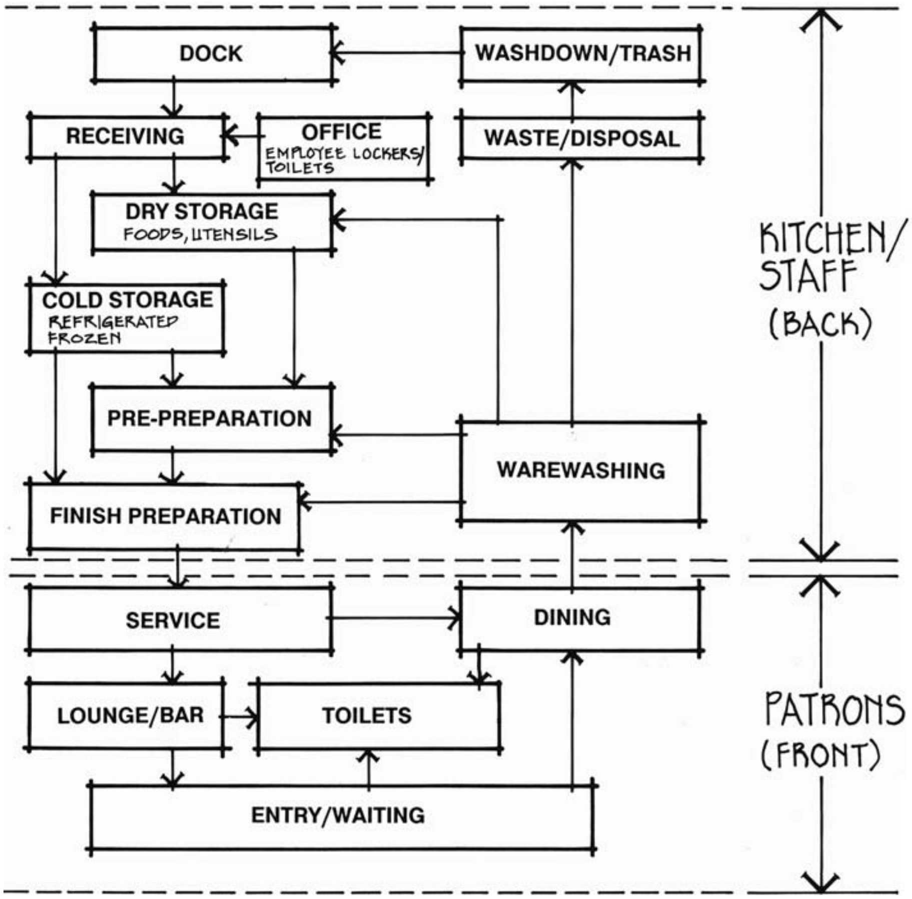

FIGURE 9.29 Diagram of typical restaurant space adjacencies and flow of materials/people

food preparation area, or kitchen, is the heart of a dining establishment and generally is about one-third the size of the dining area in square footage. Most commercial kitchens are divided into areas for receiving and storage, hot food preparation, cold food preparation, beverage preparation, serving, and washing. Variations from this basic planning arrangement are seen in fast food enterprises, cafeterias, and participatory dining establishments.

It is well worth remembering that although design of dining interiors can be very creative, the underlying principle is similar to that of retail design—the price and service must match the customer's expectations. Eating establishments must generate profits if they are to be successful and remain in business.

Hotels, Motels, Inns, Bed & Breakfast, Hostels

Today's overnight accommodations are certainly more than a place to rest or sleep. Hotels have become cities within cities and offer numerous amenities to their guests, such as business centers, exercise facilities, dining, and swimming pools/spas. Guests come from varying backgrounds and might be vacationers, businesspeople, or conventioneers. With an increasing number of international travelers and facilities, the interior designer needs to understand the cultural implications of these guests as well as the locale and culture in which the hotel might be geographically located.

Hotels fall under the basic types of resort, convention oriented, urban, or highway and airport, the latter being travel related. Sometimes there is a mixture of the types, such as the urban downtown hotel that serves a convention function. Whatever the type of hotel, generally the design is related to a locale's outdoor environment, or an interior focal setting is created.

Hotel (and motel) guest rooms are grouped according to the number and type of beds provided. The room configuration, size, and amenities increase proportionately from the single to the double to the suite. Floor plans of hotel rooms vary to accommodate the convenience of the guest and can be a simple layout with one bed to a kitchenette unit with a separate dining area. Of paramount importance to all plans is the protection of the guests, including security and egress routes in case of a fire or other catastrophe.

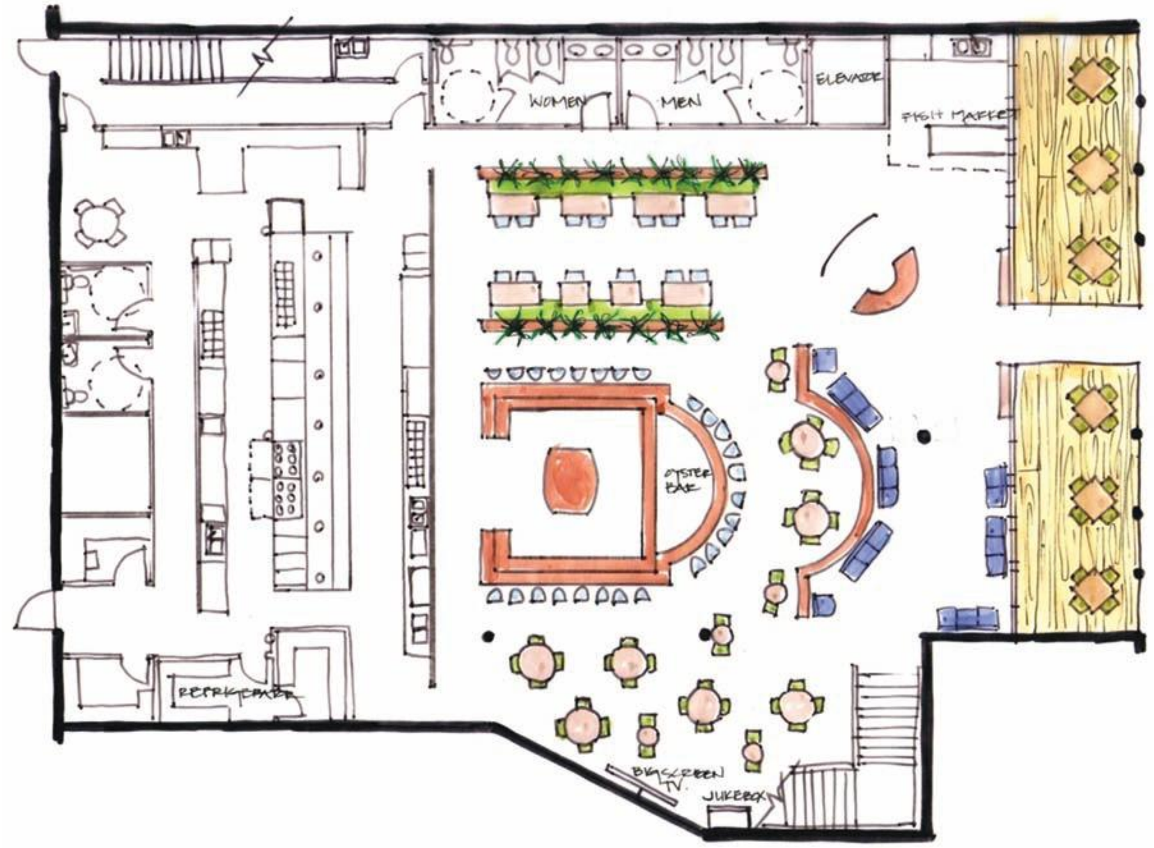

FIGURE 9.30 The floor plan of a restaurant and its kitchen reflects the logical flow of customers, employees, food, beverages, and the many other components necessary for service.

In addition to hotels and similar facilities, there are also bed and breakfast (B&B) establishments that offer lodging and limited food service (often breakfast only). These are small enterprises, often found in private homes or refurbished historical buildings.

For those travelers who look for an informal and budget-oriented place to say, hostels can provide an alternative accommodation. Popular in many international locations (England, Ireland, Australia, etc.), hostels tend to keep costs low by sharing many facilities such as dining and dormitories.

Spatial Organization

Hotels are composed of a series of activities: housing, services, housekeeping, and sometimes eating, exercise, rentals, and entertainment. Although hotels can exhibit individuality by their amenities, several commonalities prevail. There are two distinct worlds in a hotel: that of the guests and that of the staff. Designs should cater to the guests' expectations, and the service should support those needs.

The entry and the lobby (Figure 9.31) provide the first impression of a hotel. This can be an impressive ceremonial expression to beckon the public in, or it can be designed in a manner to keep unwanted people at arm's length. The lobby and reception area is a multifunctioning space that oversees guests arriving and departing and is controlled by a reception desk component. Traffic patterns from corridors, elevators, and baggage handling all traverse this central clearinghouse. Many of these lobbies are grand showplaces to exhibit the hotel's uniqueness and character, and branding.

A hotel is usually multi-floored to lessen the building area and to compact services. The forms can vary from towering skyscrapers to several sprawling floors in a resort setting. Goods, services, guests, and employees create a series of traffic patterns through a hotel. In turn, related activities and spaces are grouped together to form spatial zones (Figure 9.32).

Motels serve the automobile traveler on either a business or a pleasure trip. Motel design provides for quick, easy-to-reach services, such as a convenient parking spot. The traveler who arrives at the motel as an end point of the

FIGURE 9.31 The lobby of this hotel sets the design image of the facility and provides seating for social interaction that occurs in these large-scale places.
David L. Moore—CA/Alamy

journey is more interested in the surroundings or recreation and entertainment facilities than in whether the location is convenient. In this case, the motel design must fulfill the traveler's needs for comfort and convenience, which might include restaurants, lounges, game rooms, or even a kitchenette.

Theaters, Concert Halls, Auditoriums, Arenas

Facilities such as theaters, concert halls, auditoriums, and arenas are often designed to accommodate large numbers of people to view performances. The designers strive to provide the patrons with excellent visual, acoustic, physical and safety parameters where large numbers of people congregate. These facilities are designed not only to be very functional, but to reinforce the special activities and performances. In addition to the seating areas, ancillary spaces (restrooms, lobbies, lounges, eateries, and backstage areas) are incorporated into the overall function and character of the facility.

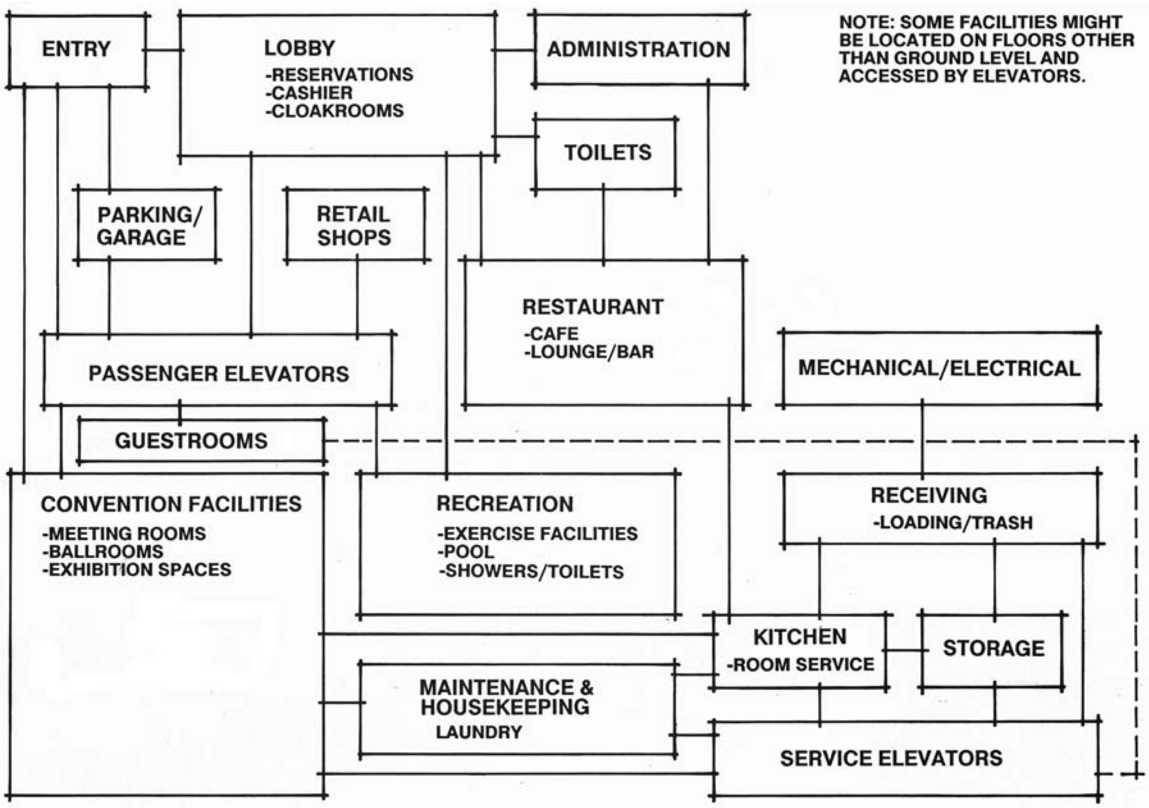

FIGURE 9.32 Diagram of the spaces and circulation routes of a typical hotel

Recreational

The design of recreational facilities encompasses gymnasiums, bowling alleys, swimming pools/parks, and health/sports centers. These might be stand-alone facilities or combined with other areas such as workout centers for hotels or clubhouses for golf courses. Many of these designs not only incorporate the functional needs of the center, but also offer opportunities for socialization, such as the health bars in private health clubs.

HEALTHCARE DESIGN

Healthcare has undergone quite a few changes in the last decade. Improvements have been developed to prevent disease and keep people healthy and mentally in tune with themselves, rather than just treat physical problems or disease.

Healthcare design involves more than merely understanding interior finishes and space allocation. A designer must have some familiarity with medical procedures and specialized medical equipment, and must have an appreciation of current medical philosophies.

Today, we find a lot of focus in healthcare centered on evidence-based design (EBD). This is a process based on research data, project evaluations, and other quantifiable evidence to improve patient well-being and healing. It seeks to use the best current research for designing hospitals and clinics for healthcare needs. EBD's goals are to improve the healthcare providers' organizational effectiveness, reduce costs, and create a better healing environment for the patients, families, communities, and staff.

EBD is related to user-centered design, which integrates user research through interviews, checklists, literature, site visits, surveys, focus groups, and experts in the field to find the best practices to make the healthcare environment truly responsive to the needs of a healing facility.

Design for healthcare facilities includes working on hospitals, physicians' medical offices, dental care facilities, nursing homes, and various specialized clinics. However, we will limit our discussion on space planning to a small office occupied by a general practitioner. This will allow us to look at the basic functions and flow of a typical medical office.

The design of a medical office is directly related to the type of practice and the patients. A plastic surgeon's office would have a different function and look than a pediatrician's office. Although medical offices can vary in their functional layout and services offered, they generally contain three distinct areas: administration, patient care, and support services. Within these, there are specific spaces and functions particular to the type of doctor's practice. The diagram in Figure 9.33 shows how a patient enters the office and checks in with the receptionist,

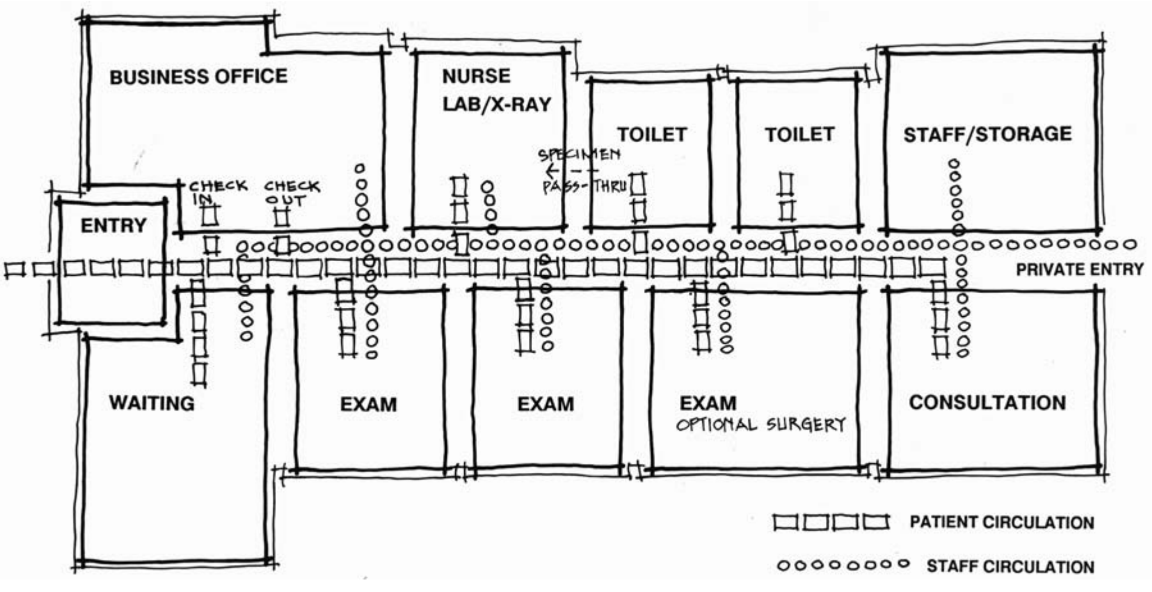

FIGURE 9.33 Schematic diagram of a typical suite for a general practice doctor

FIGURE 9.34 The waiting room for this dental office comfortably accommodates the patients and establishes the image of the dentist's facilities and practice.
Courtesy of EnviroMed Design Group

then takes a seat in the waiting room or is led to an examining area. The check-in is often termed a "hello" window, and the check-out, a "goodbye" area. The check-out window is situated so that all patients exiting the examination rooms must pass it before leaving. This provides control for payments, medications, and future appointments.

The waiting room serves as the design image of the healthcare doctor's office and manner of practice (Figure 9.34). This space should provide a sense of comfort and appeal. Magazine racks, coat storage, and other amenities, such as a children's area, are often included. In pediatrician's offices, there is often an area or room designated for *well babies*, as opposed to *sick babies* who might also be present in the waiting areas. These separations help reduce spread of germs and infections among the patients. Ideally, the receptionist should have visual control over the entire space for monitoring. In some cases, a drinking fountain and toilet are located within the area or close by, depending on the physician's preferences.

The business office contains the patients' medical records and deals with appointment scheduling, billings, bookkeeping, insurance record work, and other clerical duties. It is usually staffed by one to three people, depending upon the size of the practice. In larger practices, a business manager might work within this area, but in a private office.

In small practices, the nurses' station is often located near the business office to facilitate both communication with the business staff and receiving patients from the waiting room. Nurses' stations can be small alcoves or combined with a laboratory for various medical workups. Nurses' stations can also be designed with a small preliminary examination station for taking temperatures before escorting the patient to an exam room. Depending on whether the doctor wants to perform tests within the office or have the work done elsewhere, labs, and x-ray rooms may be included in a medical office.

Examination rooms are placed close together to lessen the extra steps a doctor must take. These rooms are approximately 8 feet by 12 feet (2,438 mm by 3,657 mm). They contain an exam table, dressing area, guest chair, doctor's stool and writing area, built-in cabinets with sink and storage, and miscellaneous small medical equipment. Preferably, these rooms are designed to be functionally the same; that is, they should not be mirror images. The doctor should be able to work in matching rooms and not have to deal with layouts and equipment being "opposite handed" from room to room. Whether to have a window in the exam rooms is up to the doctor, because natural light is not a necessity for examinations, but is a desirable element for patient satisfaction.

One exam room or an additional room is often designated a minor surgery or treatment room. It is basically a large exam room with additional equipment so that casts can be applied and minor surgery can be performed.

The consultation room serves as a private office for the doctor to consult with patients. The use depends on the doctor's practice and philosophy of patient/doctor relationships. Of prime importance to the overall medical suite is a private entry so that the doctor can arrive or leave the suite without going through the waiting room.

For planning purposes, a doctor's office requires about 1,000 square feet (92.9 m²) per doctor. A partnership of two doctors would be approximately 2,000 square feet (185.8 m) and three doctors need about 2,500 to 3,000 square feet (232.2 to 278.7 m). The facilities that can be shared, such as the business office, waiting areas, nurses' stations, or staff break room, have a bearing on the total amount of space needed in a multi-doctor practice.

INSTITUTIONAL, PUBLIC, GOVERNMENT, AND OTHER FACILITIES

Interior designers are involved in the designing of many other kinds of interiors, both small and large scale. This section will provide a brief survey of some of the most typical.

Schools, Colleges, and Universities

Institutional facilities are generally classified as teaching and learning environments, commonly referred to as educational facilities. The design of educational facilities can encompass child-care centers (preschool), kindergarten, primary schools, secondary schools, universities, community colleges, alternative educational schools, and adult education (Figure 9.35). These facilities often include a multitude of ancillary spaces, such as classrooms, lecture

FIGURE 9.35 Educational facilities should be designed to support the learning process and visually to stimulate the eye/mind relationships. *Courtesy of Kimball Office*

halls, kitchen/dining rooms, libraries, laboratories, restrooms, staff support areas (offices, equipment, etc.), and even sleeping spaces (child care, nurseries, and dormitories). Although these facilities are institutional in function, the design should not be the bland look of past years.

Public and Government

Libraries can be part of other facilities, such as schools and offices, or large public buildings supported by municipalities and counties. All of these must provide easy access and proper storage/protection of the records kept there, including access, retrieval, and storage of electronic media. Many libraries also offer their services online. Acoustics and lighting are very critical to provide the users with a supportive environment to do their work.

Museums are most often public buildings that provide public exhibitions on a permanent or temporary basis. Museum design involves the careful planning of function, security, and crowd control—as well as dramatic settings for specific displays.

Government facilities, such as post offices, city halls, and courthouses, have traditionally been designed in historical styles. However, their designs now often reflect an understanding of functionalism and user needs, as well as creating exciting architectural features. Although these public-related buildings are often controlled by tight budget restraints, innovative designs can create some distinctive buildings.

RELIGIOUS

Religious facilities are those places in which a group of people (congregation) gather together for purposes of worship and other related activities. These other uses might include religious teachings, studies, ceremonies, and social functions. These houses of worship might have different names, according to the particular beliefs. These can include temples, churches, mosques, chapels, cathedrals, synagogues, and meeting houses.

Over the centuries, the design and construction of these houses of worship have produced many impressive structures throughout the world, and many of these are still in use today. The sacred architectural styles of these buildings often reflect the beliefs of each religious group, producing some unique structures.

INDUSTRIAL AND TRANSPORTATION

Industrial spaces include those of manufacturing plants, factories, utility suppliers, and other facilities. They can be towering, giant spaces, such as power plants and automobile plants, or small, specialized spaces, such as electronics facilities. Although these are highly specialized in their functional requirements, the designs can provide worker comfort, support productivity, and create a good work environment for the users.

Transportation design involves interior spaces that are both permanent (terminals and stations) and transitory (trains, airplanes, buses, and ships). There is an overlap of interior design and industrial design when doing many of the vehicle interiors. Most of the interior work in the transportation field is done on the terminals and stations. Some are new facilities, but most are the renovation or expansion of existing spaces.

SPECIALIZED INTERIORS

Interior designers execute many other specialized or miscellaneous spaces. A large number of these, such as atriums, greenhouses, studios, kiosks, home theaters, and workshops, frequently are an integral part of another facility. Others, such as recreational vehicles, are highly specialized in function and generally are considered a part of transportation or other categories of spaces.

Some specialized interiors such as set designs for the theater, television, and film are unique to entertainment spaces and are designed in conjunction with designers in the fields of electronics, industrial design, and theatrical productions.

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Environmental Concerns, Codes, and Regulations

10

THE TOTAL ENVIRONMENT: INFLUENCES ON INTERIORS

Why should interior designers be concerned with the total environment or even the environment beyond the immediate spaces they are designing? Other than windows to view the outside and permit sunlight to illuminate the interiors, and doors to gain access, what impact does the "outside" have on the "inside"? Interior design is an integral part of the environmental context, and that connection implies an orderly plan of the way the built environment is constructed in harmony with the natural environment. Designers consider the total picture and its many interrelationships when solving problems. Interior design looks at the contents of a structure and at the building as a container, within the context of the environment and society. This chapter focuses on environmental concerns affecting the built environment, such as (1) the impact of natural and man-made elements, (2) the importance of codes and the regulatory environment, including accessibility for all people, and (3) preserving our historical heritage.

A designer is first a human being and part of the overall physical and societal world. Our daily lives are interwoven with and shaped by relationships and interdependencies. We may develop sophisticated and technological minienvironments that seem independent of the natural environment, but these enclosures are subject to the natural forces that affect our planet and the universe. As people seldom function in isolation from the total environment, interior designers cannot effectively develop interior spaces without considering external influences. For example, it is difficult to develop an interior primarily illuminated by natural lighting techniques if the project is located in a region that is mostly overcast and rainy. And a designer must consider what the effect on an intimate restaurant atmosphere will be if each time the entry door opens the room is flooded with harsh light, noise, and perhaps motorized vehicle fumes. It is the designer's responsibility to be aware of external conditions that will affect an interior space and its occupants.

Today, many clients are looking for designers who can offer a spectrum of design services that includes the exterior and the interior of a project. Firms offering those services generally consist of a team of specialists who can design projects that take full benefit of environmental perception and human behavior. These firms produce projects that exhibit direct linkages between the exterior and the interior, neither space being isolated from the other (Figure 10.1). Successful interiors make good buildings, and successful buildings make good interiors—the two are interrelated.

The interior designer must understand the exterior influences, both physical and nonphysical, that will impact the interiors. Designers must be aware of the overall environmental planning and regulatory processes that involve external forces, whether natural or man-made. Sometimes, it is beneficial to incorporate some of these forces into the interiors, while others will need to be separated from them.

FIGURE 10.1 The interior of this residence is both visually and physically connected to the exterior environment by large windows and doors.
Image Courtesy of Herman Miller, Inc.

Environmental Planning

Environmental planning is a decision-making process that addresses environmental parameters when creating human designed environments. It is an interdisciplinary field that includes urban planning, landscape architecture, architecture, interior design, and related arts and social sciences.

Environmental planners seek to understand and design for both macro (large) and micro (small) worlds simultaneously and to respect their interrelationships. Although specialization is increasing, there is a growing trend for designers to be aware of all environmental forces and their impact on the design process, including responsibility to preserve the quality of our environment.

The natural environment is composed of the ocean, sky, land, plants, animals, weather, and all those other attributes we call Mother Nature. People seek to enrich their lives through direct relationships with their world or to create man-made devices to help them interact with these elements. Many of these creations fall into the categories of harmony, contrast, or adaptability when considered in terms of the natural environment. However, the complexity of the world situation, with increasing populations and rapid growth in technology and consumption, is taxing our resources both in the global and backyard arenas.

A great need exists for careful, thoughtful evaluation and planning of man-made and natural resources, in terms of both current and future usage. Cities, towns, buildings, and other land usage must be carefully planned for people and the total environment. Environmental analysis and planning not only include designers working together but also incorporate input from the users of these developments to achieve solutions.

Flexibility, adaptability, restoration, preservation, and reuse are terms that relate to concepts of designing for today's structures and interiors. These concepts consider the environment as a part of the whole and view civilizations in the context of time—past, present, and future. We perceive and use these environments from the past and pass them on to future generations. Laws, codes, and the enforcement of both help to protect and preserve our environments from shortsighted viewpoints. However, these rules must be humanistic, capable of modifications for the good of all people and the environment.

LAND USE AND DEVELOPMENT

Land use indicates the way people adapt or change the land to suit their everyday functions. Specifically, the term refers to planning for the best use of the landscape to suit the needs of the individual, society, and the environment. Today, land use is increasingly based on sustainable or green design principles, as available land is a finite resource on the planet Earth and must be used more in harmony with the environment. Recycling of land use is encouraged, as seen in new productive use of grayfields (blighted urban areas) and brownfields (former industrial facilities or contaminated sites).

The term *community* refers to groups diverse in size and can mean society in general, a group of people living together, or people living in a particular district within a city. Cities encompass communities of citizens and are centers of population larger than towns or villages. Throughout the centuries, cities evolved around people's activities, needs, and wants and around the usable spaces they developed. A city is a complex, living, dynamic organism made up of many physical and nonphysical intricacies. As occurs in a biological organism, each of these parts contributes to the whole, even though the specific component may be specialized or seemingly self-supporting. Smaller units (such as neighborhoods, commercial districts, and industrial areas) interact to produce a pattern and a character that make that city distinct from others.

Planners speak of a city's having a "fabric," which implies the interweaving of physical and nonphysical attributes, such as a historic district and its cultural makeup, giving it an identity and functioning as a force. Changes in any of these "filaments" of the fabric can have a direct impact on parts of a city, or the city as a whole. Changes can be positive, such as the redevelopment of a city's inner core, which can draw suburbanites back into the heart of the city to revitalize it (Figure 10.2).

More than half of the population of the United States dwells in urban areas that account for perhaps 1 percent of the available land. Suburban living has been a response to crowded cities. People moved to tracts of land developed as small centers or villages within commuting distance of the city centers. Attempts are made in these satellite

FIGURE 10.2 The redeveloped San Antonio Riverwalk provides a pleasant place to stroll, shop, and eat at the many fine restaurants.

Jim Cole, Photographer/Alamy

communities to regulate the orderly growth of these new "cities" through zoning laws and to provide enrichment in their facilities and opportunities for life enhancement.

Transportation has a direct influence on the shaping of our cities and communities, new or old. As people and goods moved from space to space, the vehicles and the avenues they traveled became the connectors of our centers. Historically, transportation has been one of the most influential plan generators of our cities because most growth took place around railroads, streetcars, and more recently, the automobile.

The automobile has its conveniences, yet can cause heavy polluting and traffic gridlocks in large cities. Furthermore, as we continue to use more land to build roadways, we decrease the available land for people and buildings.

Urban Planning

Throughout history, many designers and planners have conceived of urban centers that would solve the problems of the populace, such as overcrowding, sprawl, poor working conditions, crime, and pollution. These utopian schemes tried to satisfy the social and physical needs of individuals and to consider the overall good of the community.

In the 1920s and 1930s, Le Corbusier and Frank Lloyd Wright each proposed a scheme for city planning, although neither was constructed. Le Corbusier proposed that approximately 600 acres be cleared in the center of Paris and that sixteen 60-story towers be erected to house people, office facilities, and shopping. Streets and parks between these structures would create beautiful garden settings for all to use.

Around 1932, Wright proposed his "Broadacre City," which followed a decentralized scheme in which people were to live in single houses on an acre of leased land, where they would grow their food. In his concept of a "garden city," apartments and high-rises would be carefully placed, and elevated arteries would be used for public and private transportation. Community facilities and other services would be placed beneath these routes. Actually, some of Wright's ideas have been realized in larger cities where services have been constructed beneath elevated freeways and rail systems.

In the 1960s, the term *megastructure* was given to a large, single-entity structure that sought to house large communities within it. These communities in turn were to be small cities within cities and would offer a variety of services, habitats, and workspaces. During the same decade, Peter Blake published a series of conceptual megastructures that received a great deal of interest at the time, although they were never built.

In the Arizona desert, Paolo Soleri (1919–2013) envisioned what he termed "arcology"—a unified mixture of ecology and architecture. He proposed large, three-dimensional complexes of great population densities and mixed community experiences (Figure 10.3). He expanded the concept of a megastructure to a city scale, designed for varying geographical locations and population sizes. Modular living units are stacked in layers around large commercial, civic, and industrial facilities. These gigantic structures are envisioned as preserving the land from two-dimensional sprawl by concentrating buildings and people into three-dimensional layers.

Now we can see some of these earlier concepts of huge three-dimensional complexities with the size and offerings of a small city (Figure 10.4). The Palm Islands at Dubai are an artificial cluster of islands in the shape of a palm tree, topped with a crescent. These combine entertainment, leisure, and residential centers.

Cluster Planning

Traditionally, suburban developments were laid out in straight rows in a grid to facilitate access in an organized fashion. These developments sprawled across the land, each residence having its own lot. The cluster plan was developed to prevent this sprawl and gridlock form, while minimizing the area of the lots. This clustering concept has been of particular help in multifamily developments, where open space, pools, parking, and views can be shared by all. The land areas between buildings are made smaller but dedicated, and have green spaces and amenities, often leading to common greenbelts (Figure 10.5).

Planned Unit Development

Originally a housing development concept, the planned unit development (PUD) is being increasingly used for other zoning types, such as commercial zones and even the intermixing of several zones. For example, a PUD might contain several office buildings, restaurants, a small shopping center, and some apartment buildings, all in close proximity or within the same buildings. PUDs vary in scale and are based on the principle that if a development is carefully planned, it can produce a beneficial and efficient use of land and amenities not otherwise available in traditional zoning.

FIGURE 10.3 Associates of Paolo Soleri are constructing one of his visionary cities, "Arcosanti," in Arizona.
CC-BY-NC-2.0/Alan English

FIGURE 10.4 The Palm Islands in Dubai combine entertainment, leisure, and residential centers.
CC-BY-SA-2.0/Richard Schneider

FIGURE 10.5 Las Palmas Ranch is an attractive subdivision tucked into the foothills of the Salinas Valley, California, and provides the residents with shared outdoor activities spaces.

Craig Lovell/Eagle Visions Photography/ Alamy

Specialized Planning

Some developments or communities, such as retirement or vacation communities, are designed for specific groups or a particular clientele (Figure 10.6). These developments include such amenities as recreational areas, clubhouses, increased security, and other shared benefits. Vacation communities are designed for short-term use on a year-round basis. Ski resorts are a good example of seasonal communities that reach their peak in winter; however, sunny, southerly developments also reach a pinnacle of popularity in the winter, as people seek the warmer climates and lower energy costs (Figure 10.7).

New Towns

A new town is planned before construction and is often planned for undeveloped land. It can be planned as a residential community, but more often it is designed with a variety of single-family and multifamily housing dispersed among amenities such as shopping facilities, public services, recreation, offices, cultural centers, and other desired community needs. Although we tend to call them "new towns," the concept can be traced back to the 1930s, in such planned communities as that of Greenbelt, Maryland.

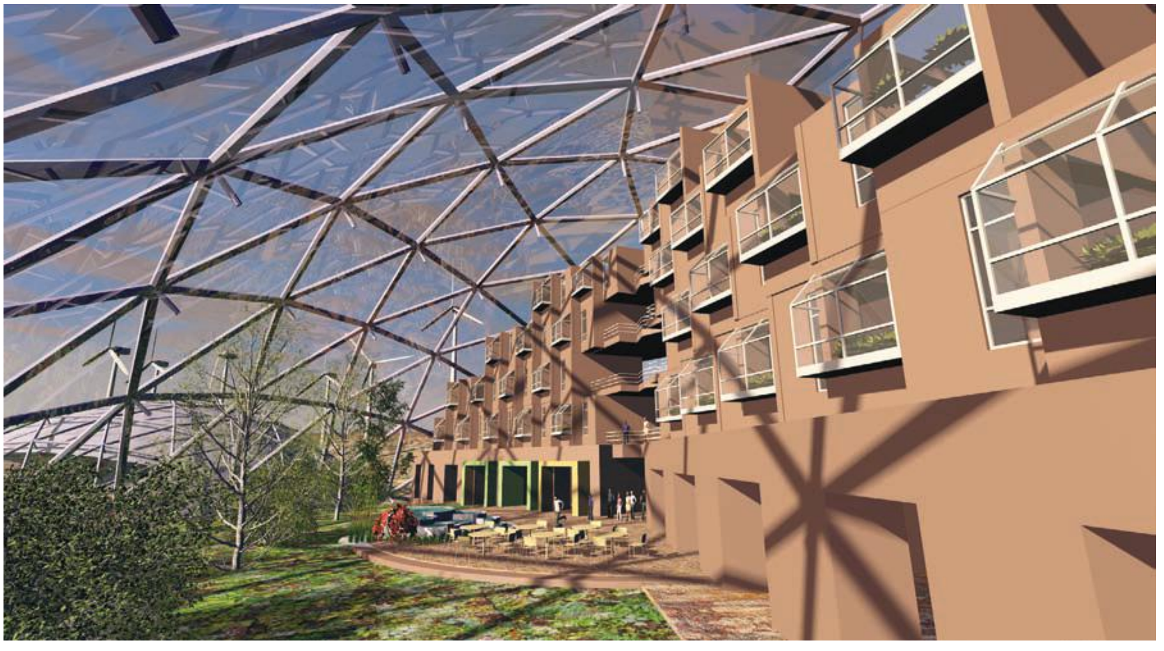

FIGURE 10.6 This planned development for a self-sufficient adult community, by architect Dennis Holloway, provides residences, a gymnasium, and a solarium.

Courtesy of Dennis Holloway, architect

FIGURE 10.7 The Savoie Meribel ski resort in France was designed primarily for winter skiing, but also offers many activities throughout the year.
Hemis/Alamy

Zoning

All states, counties, and cities, and many subdivisions have passed zoning laws to regulate controlled growth and provide desirable amenities and infrastructure for the populace. Zoning laws govern land use, specifying what kind of facility can be constructed and for what specific uses. Zoning ordinances seek to set and preserve the character of a community by separating land uses that might be incompatible. The ordinances also seek to establish buffer zones between conflicting land uses—such as residential areas and commercial or industrial districts.

This zoning of land not only regulates the category of development but also dictates lot and building size, setback distances to the street, height of the structure, required parking, and sometimes even the character of the building. Zoning districts within urban developments vary according to their location but can be broken down into the basic categories of commercial, residential, industrial, or agricultural development. Within these categories, more definitive areas are outlined with regard to specific sizes and uses of those districts.

The commercial district is composed primarily of businesses and stores from small neighborhood corner groceries to shopping center developments to large groupings of major stores and offices in a downtown city core. These might be further defined as local business (LB), downtown or central business (CB), or highway business (HB), rather than just commercial.

Residential zoning encompasses dwellings where people live. It is divided into low-density, single-family residences; medium-density, two-family residences; multiple-family residences, and so on, depending on the specific housing type and square footages (or square meters) permitted.

Industrial zoning (I) is divided into light and heavy. Facilities that produce a minimum of noise, fumes, traffic, or other intrusions upon the environment, such as small electronic assembly plants, are considered nuisance and fall under the light manufacturing category. Heavy manufacturing includes businesses such as steel and aluminum plants that store and distribute large amounts of nuisance materials. Sometimes industrial zoning is concentrated in industrial parks and intermixed with related offices.

If a zoning ordinance creates a hardship for an individual or an organization wishing to do something in a zone contrary to the regulations, a variance can be filed. The community's zoning commission or similar body hears the plea for a change in the regulation, solicits public input on the situation (pros and cons), and acts to allow the exception or deny it.

FORM DETERMINANTS FOR BUILDINGS

It is important for the interior designer to be knowledgeable about the process of designing a building for a particular site. Understanding this process enables the designer to see why and how an architect and other consultants generate a particular form for a building, the way it relates to its surroundings, and how zoning or other regulations influence the final solution. Often a direct link connects the visual and physical interdependencies of the interiors with the external spaces. An interior designer should be cognizant of these and be able to capitalize on them.

It is generally accepted that the geology, location, hydrology, topography, climate, vegetation, and cultural use of the site will indeed have a major influence on the design of a building, open spaces, and the interiors. Some major elements, such as mountain slopes, rivers, lakes, and existing buildings, cannot be readily changed on a site and generate strong design determinants and constraints. Other natural forces—winds, temperature, erosion, and sunlight—also become prime influences on the planning process.

Site Planning

Site planning is the process of harmoniously relating buildings and other structures to the environment and to one another (Figure 10.8). The professions of architecture, landscape architecture, engineering, and urban planning are all involved in the site planning process. This planning is not limited to buildings and the immediate site, but encompasses parks, highways, and other elements in the macroenvironment. Site design also must take into account zoning, utilities, traffic circulation, historic uses, culture, and existing structures on and adjacent to the immediate site. Included in this planning is the review for incorporating sustainability into the project. Usually a direct relationship exists between the interiors of a building, its exterior design, and the site surrounding it. Most successful architects and interior designers use these relationships to create a concept encompassing all of them.

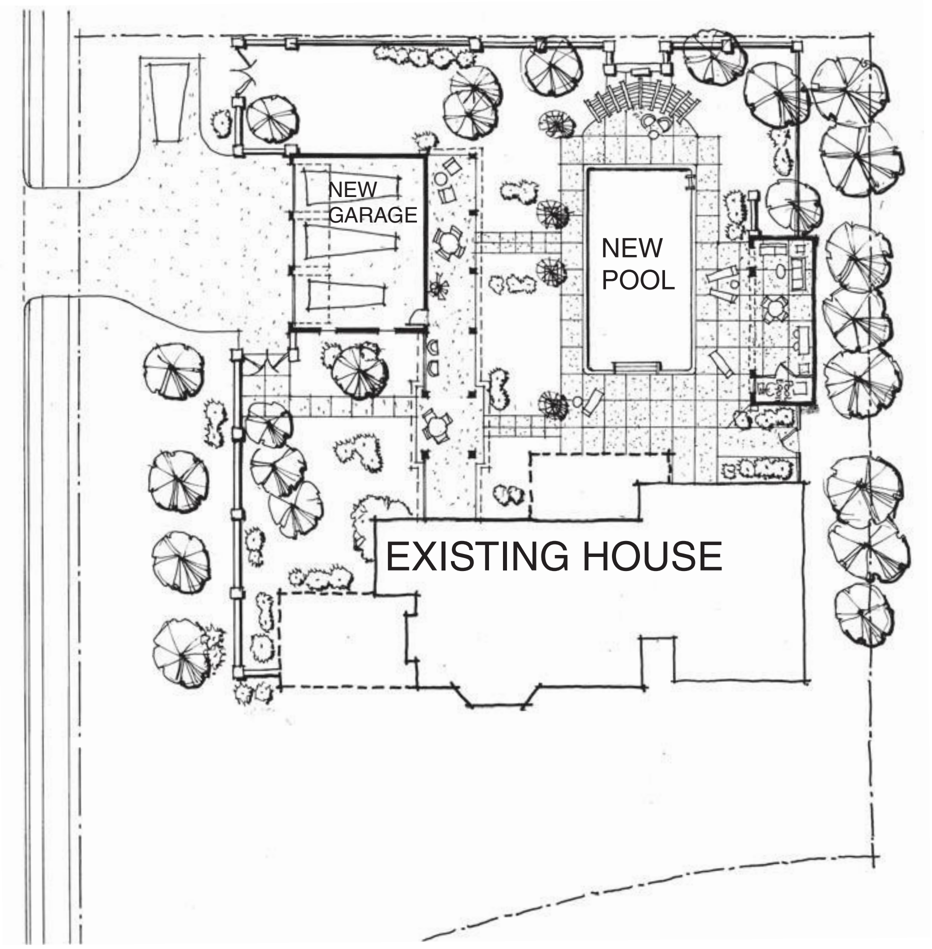

FIGURE 10.8 A new swimming pool, courtyard, and garage are added in this site plan of an addition to a neighborhood residence.

FIGURE 10.9 A Site Analysis Checklist is made to analyze all the aspects that can have positive or negative influence on the site design.

ITEM	POSITIVE OR NEGATIVE DETERMINANTS
CLIMATE	Wind, precipitation, temperatures, solar availability, and orientation. Possibilities for energy efficiency and outdoor use.
HISTORIC IMPLICATIONS	Historic or archaeological features to be preserved.
SOCIAL CONTEXT	Relationships and impact of people and their activities to the site or adjacent to it.
ZONING AND LAND USE	Existing, proposed, and possible variances needed for any development. Restrictions on building height, setbacks, lot coverage.
TOPOGRAPHY	Ground surface changes, slopes, geology, and hydrology resources.
VEGETATION AND ANIMAL LIFE	Species, number, location, size, and age of existing and implications of site development to these.
UTILITIES	Existing and new electricity, gas, water, sewer, communication, and other utility needs.
SENSORY IMPACTS	Sounds, smells, and views generated on and adjacent to the site.
ACCESS	Transportation onto the site for pedestrians, vehicles, and goods. Circulation patterns within the site.
MAN-MADE STRUCTURES	Existing buildings and other structures to be removed, left, or remodeled.
LEGAL	Existing and proposed ownership, leases, rights-of-way, uses, taxes.

Site Analysis

The process of site planning begins with an analysis and understanding of the particular site and its relationship to the proposed or remodeled building. A program and subsequent design recommendations are then made to guide the eventual construction of a building or any reconstruction of existing features. A thorough investigation of both the site and the impact of a structure to be constructed on it is necessary to achieve harmony between the two. The best site design is usually one that requires the least amount of reconstruction to the site.

Site analysis involves a careful investigation of the physical and nonphysical characteristics on and surrounding the site. These site data are compiled with a site analysis checklist, as seen in Figure 10.9. The information is then graphically sketched on the site plan to provide a visual study that depicts the most important information (Figure 10.10).

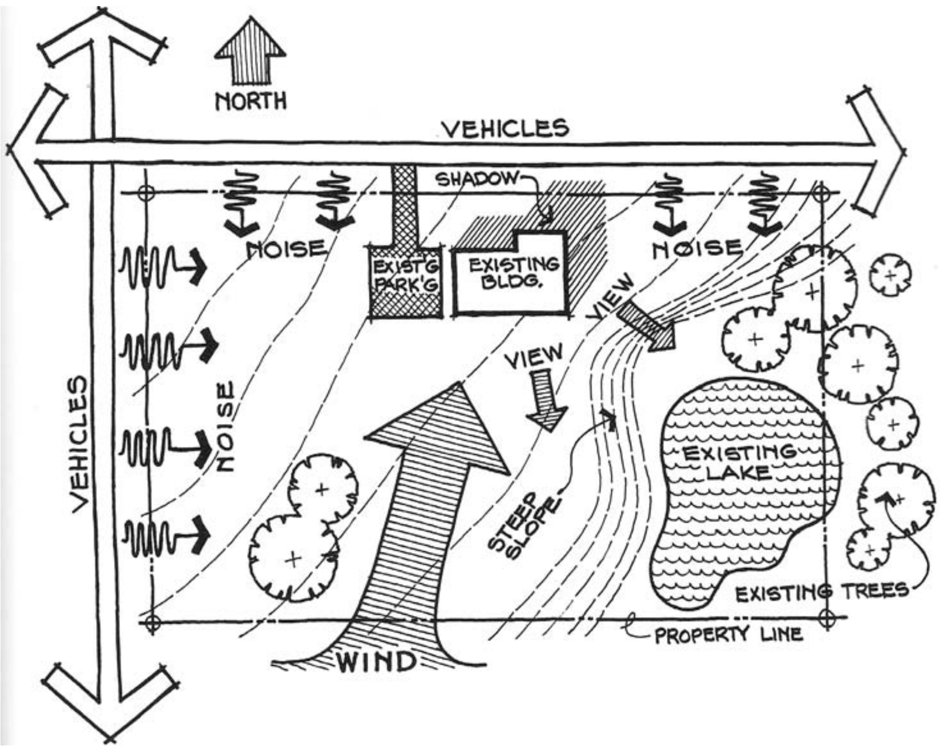

FIGURE 10.10 The site is studied for its unique features that have possible advantages and disadvantages for development.

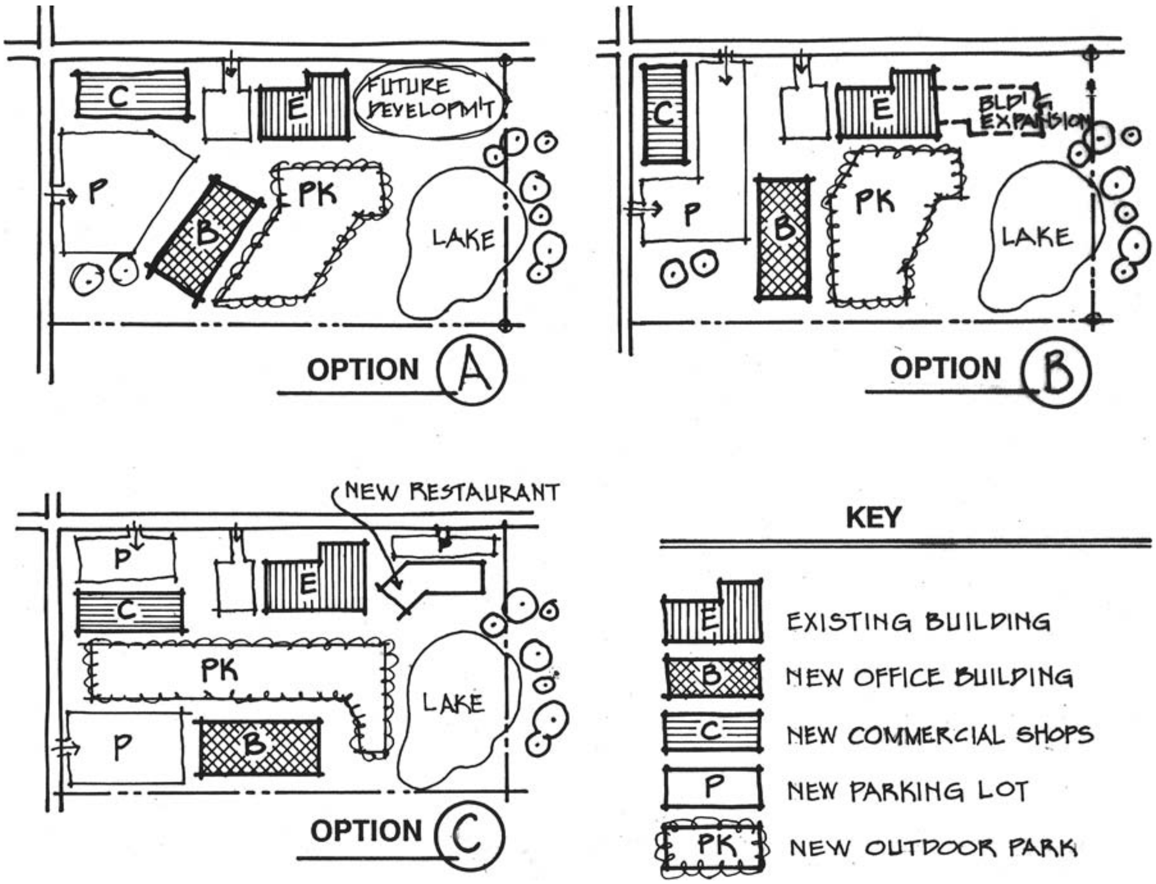

FIGURE 10.11 The site use is studied by exploring several alternative layouts. The advantages and disadvantages are listed for each option and compared to one another.

Building Siting and Design

With the site analysis complete and the building program finished, the optimum placement of the building is determined; this is accomplished through a series of preliminary studies examining alternative arrangements and locations on the site. Advantages and disadvantages are weighed until the best solution is derived (Figure 10.11). This integration seeks to determine whether the building and site are compatible.

The building design is also controlled by a number of other variables: function of the building, style of the structure, materials and structural systems, budget constraints, the occupants' uses, and building codes. The site coverage, or the "footprint" the building makes on the site, is governed by the zoning restrictions, floor area, number of floors, and configuration of the structure.

BUILDING CODES

Building codes are regulations established to set minimum performance and/or prescriptive standards for design, materials, and methods of construction for new or remodeled structures. Earlier codes were written for the protection and preservation of human life and property from losses, such as those caused by the great Chicago fire in the 1800s. After some of these tragedies, various codes were established to attempt to prevent these widespread occurrences. In 1905, a national building code was established. Building codes now are set at the federal, state, and local levels to protect and promote the health, safety, and welfare of people in all kinds of structures. Codes set guidelines and minimum standards for electrical, mechanical, and structural systems and for plumbing, lighting, stairs, exits, windows, and materials, as well as for complying with requirements to aid the physically impaired.

Building codes and their enforcement vary among countries. Some governments adopt a model building code and enforce it through various government agencies. In turn, these agencies might modify it as needed to fit local conditions. A governing agency, such as a building department, is set up to administer and enforce the codes through checking drawings and inspecting construction. Cities and counties also establish districts of varying fire zones according to density, construction, and heights of buildings, and the fire stations required to cover the areas in which the buildings are located. A large percent of the codes are directly or indirectly related to fire issues.

In the past, architects, engineers, and contractors were the people usually involved with the code compliances of projects. Today, however, interior designers also must be involved with codes, and their designs must specify flame-spread characteristics of materials, exit requirements, features to aid physically impaired people, and many other items in the building's interior.

Building Codes and Interiors

Although the numerous codes governing the construction of buildings and their interiors can vary across the states and even from county to county, most states have adopted the International Building Code (IBC) and other international codes, specifically for residential (one- and two-family dwellings), electrical, mechanical, fire, energy conservation, and others. The first edition of the IBC was published in 2000. Canada has adopted the National Building Code of Canada. Even if all the codes applying to interiors could be listed here, each local building department interprets the codes slightly differently for its region and allows for variances. However, most building codes follow some general guidelines that are comparable in scope and intention, and those guidelines will be mentioned here.

The organization of the IBC is similar to the building codes that preceded it. Its categories (Figure 10.12) address the use of the building (or structure), its occupants, the height and area limitations, and the types of construction permitted (as related to fire resistance). Sections are also devoted to interior finishes, fire protection systems, means of egress, and accessibility. The IBC also includes sections on items such as conveying systems, roof systems, floor and wall systems, and many specific materials and their permitted usage.

Building Use and Occupancy Classifications

Existing, remodeled, and new buildings are classified according to their usage or general character, as seen in Figure 10.13. This classification is the "occupancy group" and is directly related to potential fire hazards and required egress, or escape, routes. Based on the number of people in a building or the type of potentially flammable materials stored there, each group is subdivided into less hazardous occupancies. For example, an assembly area (such as an auditorium) is distinguished from a residence or an automobile repair garage. In turn, the occupancy load that is set determines the number of people and concentration of floor loads permitted for the specific groups. In some cases, one building might incorporate more than one use. For example, a building might contain a basement garage, retail shops on the first floor, offices on the next floors, apartment floors above the offices, and a restaurant at the top. In these instances, each use and floor of the building must be studied individually for code compliance and proper fire separations (such as fireproofing) provided between groups.

Building Heights and Areas

The IBC establishes height and area limitations for buildings based on their intended use for the building and different types of construction. For example, a building constructed of steel and fire-resistive material is allowed to be built as multiple stories, whereas a nonrated (not fire protected) wood construction is limited to one and two stories in height. A building's height is allowed to be increased in some cases if sprinklers are installed. The code becomes very specific about fire-resistive construction, required exits, and fire protection systems in buildings of more than three floors.

The IBC sets maximum allowable floor area for buildings, depending on the fire zone, type of construction, and occupancy use. Wood-framed buildings are generally limited to less than 18,000 square feet for assembly occupancy. Concrete and steel structures can be much larger, and often unlimited, if all other code requirements are met. Increases in floor areas are sometimes permitted if more fire-resistive construction or sprinklers are added.

Allowable floor areas of buildings can also be increased depending on the location of a building set back from the property lines and proximity to public ways (streets, alleys, or dedicated open spaces such as parks). The way property lines, streets, alleys, and other buildings relate to the spread of fire from one structure to another determines the specifications for the setbacks of the structure. These distances are set so that they are proportional to the fire-resistant construction of the exterior building materials. The number and size of door and window openings, as well as the fire protection requirements concerning them, are governed by the setback code. As a

FIGURE 10.12 The major sections of the International Building Code

Chapter 1 – Administration
Chapter 2 – Definitions
Chapter 3 – Use and Occupancy Classification
Chapter 4 – Special Detailed Requirements Based on Use and Occupancy
Chapter 5 – General Building Heights and Areas
Chapter 6 – Types of Construction
Chapter 7 – Fire-Resistance-Rated Construction
Chapter 8 – Interior Finishes
Chapter 9 – Fire Protection Systems
Chapter 10 – Means of Egress
Chapter 11 – Accessibility
Chapter 12 – Interior Environment
Chapter 13 – Energy Efficiency
Chapter 14 – Exterior Walls
Chapter 15 – Roof Assemblies and Rooftop Structures
Chapter 16 – Structural Design
Chapter 17 – Structural Tests and Special Inspections
Chapter 18 – Soils and Foundations
Chapter 19 – Concrete
Chapter 20 – Aluminum
Chapter 21 – Masonry
Chapter 22 – Steel
Chapter 23 – Wood
Chapter 24 – Glass and Glazing
Chapter 25 – Gypsum Board and Plaster
Chapter 26 – Plastic
Chapter 27 – Electrical
Chapter 28 – Mechanical Systems
Chapter 29 – Plumbing Systems
Chapter 30 – Elevators and Conveying Systems
Chapter 31 – Special Construction
Chapter 32 – Encroachments into the Public Right-of-Way
Chapter 33 – Safeguards During Construction
Chapter 34 – Existing Structures
Chapter 35 – Referenced Standards

preventive measure to keep fire from spreading, no door or window openings are permitted (in most codes) between buildings that are closer than five feet (1,524 mm) (Figure 10.14).

Type of Construction

Structures are classified by type of construction, which refers to the materials, construction methods used, and known fire-resistive qualities.

The IBC establishes fire types or categories for building construction elements as rated in hours of fire-resistive materials and assemblies. These types include the structural frame of the building, bearing walls, nonbearing walls (partitions), floor construction, and roof construction. Type I, II, and III buildings are generally constructed of steel

FIGURE 10.13 The IBC establishes occupancy groups as related to the potential for fire hazards and the egress needed.

(A)	ASSEMBLY
(B)	BUSINESS
(E)	EDUCATIONAL
(F)	FACTORY AND INDUSTRIAL
(H)	HIGH HAZARD
(I)	INSTITUTIONAL
(M)	MERCANTILE
(R)	RESIDENTIAL
(S)	STORAGE
(U)	UTILITY AND MISCELLANEOUS

and/or concrete with varying fire-resistive ratings throughout the building. Larger and taller buildings can be constructed with these types of construction unlike buildings of combustible materials. Type IV buildings are constructed of heavy timber and offer some fire protection due to the large cross-sectional wood members that tend to char in a fire and offer some natural fire resistance. Type V buildings are of wood construction and offer little fire resistance, unless protected by a fire-resistive material. For example, encasing a wood-framed wall between layers of fire-rated gypsum board panels can provide one-, two-, and three-hour resistance to a fire and its spread throughout the building.

The IBC describes in detail various materials and assemblies that can be used to provide varying fire-resistive barriers. These are listed as one-, two-, and three-hour ratings in the many charts within the code book.

Fire Resistance, Safety, and Fire Protection

Interiors can become harmful environments if there is an accident or an outbreak of smoke and fire. Building codes and other national standards, such as those of the National Fire Protection Association (NFPA), have established and monitor various requirements in the design of buildings to protect life, the building's contents, and its structure. These regulations also govern the placement and performance of fire-fighting equipment. These rules come into effect when new structures are built or old buildings are remodeled.

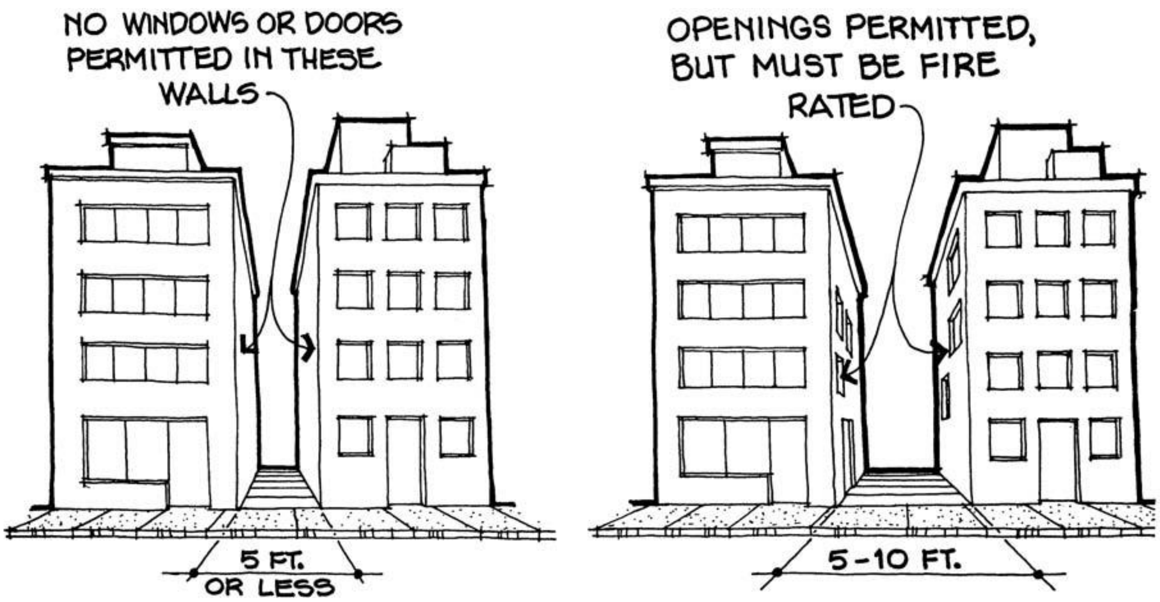

FIGURE 10.14 Building codes set minimum distances between buildings where any openings must be fire rated or not permitted.

Fire-Resistive Construction

Buildings are designed and constructed with fire-resistive materials to protect people and contents and to keep the structure from collapsing. Generally, the more people in a building (higher occupancy load), the larger the building. The particular usage of the building (for instance, manufacturing versus offices), dictates how stringent the fire-resistive requirements are.

Fire-resistive barriers, that is, specially constructed walls, doors, ceilings, or floors, are placed throughout a building to slow the spread of a fire. These barriers are given fire ratings of one or more hours, depending on the materials and construction used. This rating implies the length of time an assembly can be expected to contain a fire or smoke; this period of time allows occupants to escape and firefighters to do their job. Sometimes spaces between floors that include stairways and other openings must also be protected by closing off each floor separately to slow the vertical spread of fire.

Codes also govern flame spread, toxicity levels, and smoke ratings. Interior finishes, furniture, and furnishings are regulated according to their abilities to withstand fire or to prevent the spread of smoke, toxic fumes, and flames.

Fire Detection

Smoke and fire detectors are required in all new and remodeled buildings to give the occupants an early warning of the possibility of a fire hazard. Most of these signal with an audible alarm, and some transmit a signal to the fire department or a manned security system. Some of these devices automatically close fire doors or dampers in a building to prevent the spread of fire and smoke.

Fire Suppression

High-rise and other large buildings have elaborate systems of fire extinguishers, piping, and hose cabinets to fight fire. As will be discussed in Chapter 11, wet and dry standpipe water sprinkler systems designed to fight a fire at its source in various ways can be used throughout a structure. All sprinkler heads can be activated to spray water; however, most installations are fused to activate only the one detecting the fire's heat. Although most are water-filled, some systems use carbon dioxide or other gases to fight the fire more efficiently and even prevent water damage. These special gas systems are used in computer installations where large amounts of water could be devastating to the equipment.

Exits and Stairs

Exits are designed primarily according to their use in an emergency. Exits and their locations are determined by a number of variables in the building, such as occupancy load and fire resistance of the structure. Codes for corridors and doors along exitways govern their minimum width, maximum length to prevent dead-end corridors, direction of door swing, and other features (Figure 10.15). Codes also provide details for the tread and riser sizes, handrails, landings, construction, and other items used in conjunction with stairways serving as exitways.

Fire codes in commercial buildings generally specify at least two separate exits per floor for use in an emergency. If one becomes blocked, the other can be used as an alternate escape route. Doors and hardware may be required to be "panic" type, opening outward with a minimum of handling. Exits must be clearly marked and, in most cases in commercial buildings, are lighted with emergency power.

Residential structures are governed by fewer detailed exit specifications, but there are requirements for size, location, and minimum width and height of escape windows; in addition, the maximum distance from the window sill to the floor is spelled out for sleeping areas. Every building, whether commercial or residential, should have an evacuation plan. In government and most commercial buildings, it must be posted along the emergency route.

Code Compliance

When designing a project, the designer/architect must analyze the building and interiors, address each of the aforementioned areas, and demonstrate that the project is in compliance with the building codes. The result may be a written document, but oftentimes it is a detailed analysis of a project and summarized with a graphical presentation, as seen in Figure 10.16.

Accessibility

The IBC contains a chapter on accessibility specifically for the design and construction of buildings to be accessible to physically disabled persons. These areas and specific guidelines range from the site (and parking) to the building and the accessible routes, spaces, and objects within the building—down to detailed requirements such as door

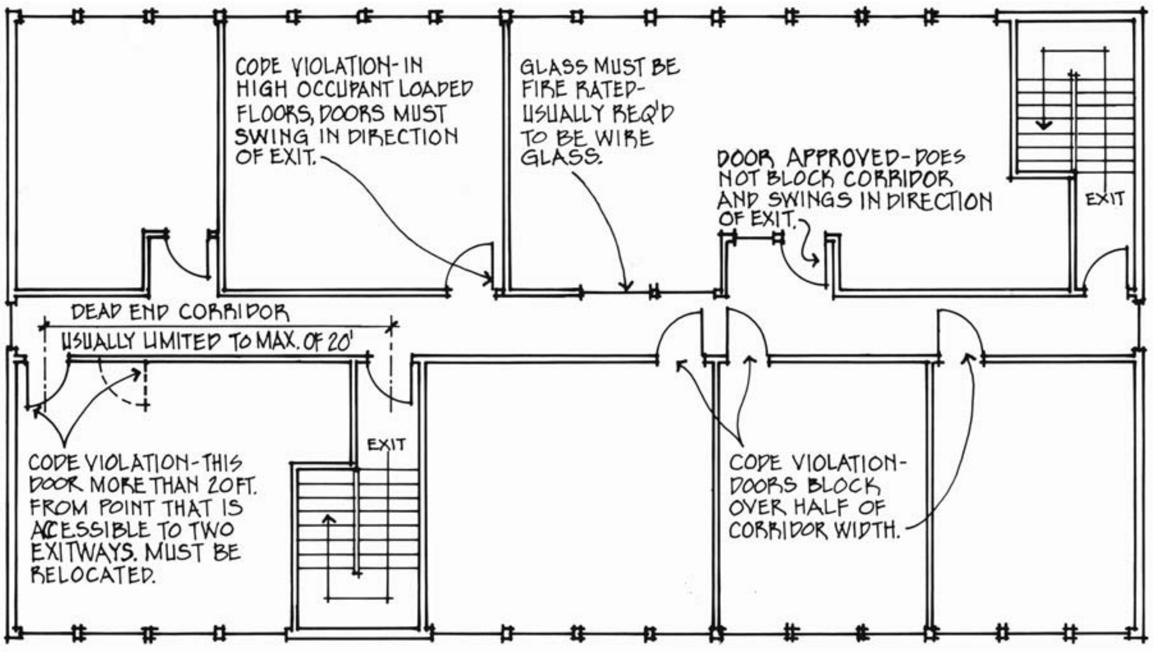

FIGURE 10.15 "Dead-end" corridors, minimum hall width, direction of door swings, and number of exits are specified by building codes, and can vary from code to code.

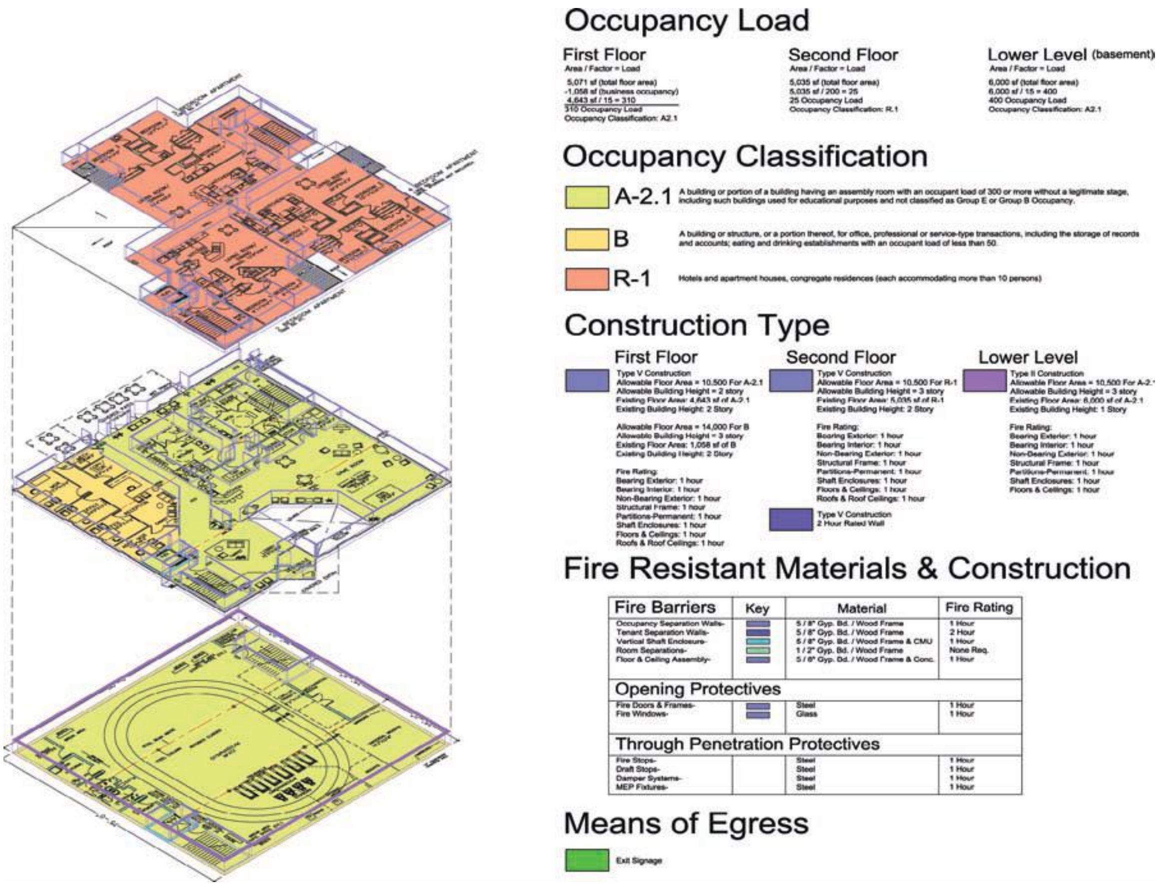

FIGURE 10.16 Compliance with all the applicable building code requirements for a project might be shown in a graphical presentation.

Courtesy of Jeff Johnston

levers and the like. The IBC relies on the ANSI A117.1 standard for the technical requirements. The Americans with Disabilities Act (ADA) also utilizes this national standard for the basis of those technical regulations. Hence, one will find similarities in the building codes, standards, and guidelines.

BARRIER-FREE ACCESS

Barrier-free access is very important for the interior designer to understand and use as a design parameter. Freedom of access is perceived to be an individual right for Americans, particularly since the passage of the first Americans with Disabilities Act in 1990. However, a significant number of people in our society have not been accorded freedom of access because of architectural barriers, such as narrow doorways, corridors, and stairs that prevent wheelchair access. Physically impaired people have had extreme hardships in working, living, and enjoying our environment for a long time. Social concerns and legislative actions have changed the way handicapped people are perceived. Now they are being given access to what most of us take for granted.

In addition to permanently disabled people, there are also those who experience physical impairment through accidents and illnesses. These disabilities might include mobility limitations, sensory (sight and hearing) limitations, cognitive function limitations, or extremes of physical size. The built environment has many obstacles for these people, making it difficult for them to carry out their daily activities. These physical barriers are also a problem to the elderly, who might have difficulty in walking or seeing hazards in their paths.

Laws have been passed at the national, state, and local levels to promote better access for physically impaired people. Voluntary cooperation of many concerned citizens is also helping to create new structures or adapt old ones for access by disabled individuals. Many books and articles have been published on general guidelines for designing for barrier-free access. *Accessible and Usable Buildings and Facilities* (American National Standards Institute document ANSI A117.1) has become a standard guide, widely adopted, for creating barrier-free environments.

Sometimes designers execute ideas around the "average person" as the user of a facility, basing anthropometric measurements around these "typical" people. There is, however, much variety in physical size and ability throughout the population. Children, the elderly, and the physically impaired can outnumber the "typical" population; their needs also should be addressed in a design scheme. Special interiors can be created for these population groups, but all interiors should be designed to be sensitive to and to accommodate their many physical variations.

Designers are responsible for planning the built environment, the materials selected, and the ability of these spaces to be accessible to and for the physically impaired. Building codes are established for disabled compliance, and although the particulars can vary, certain standards apply to all and are briefly discussed here.

General Guidelines

Regulations and requirements for barrier-free design can vary from state to state, as well as between public/commercial facilities and private/residential facilities. Although private/residential structures are less controlled than public-sector buildings, most housing projects that include three or more units are required to have at least one "accessible" or "adaptable" unit for the physically impaired.

The following guidelines detail some of the requirements for designing for the physically impaired in commercial and public facilities. These are presented in the order of the route of travel a person would take upon arriving at the building site.

Parking, Walkways, and Ramps

Convenience, an adequate number of spaces, and proximity to the building are of prime importance for parking. The designation for accessible parking must be clearly identified, and the area must be policed.

The pathway from the parking lot or street must be a hard surface, free of obstructions, wide enough to accommodate a wheelchair, and otherwise made safe for the user. Ramps must have handrails and minimum grade changes: slopes of a 1-foot (304 mm) rise to a 12-foot (3657 mm) run. Low-sloped ramps are also a benefit to the elderly and those using crutches or other assisting devices.

Building Entry

The entry must be accessible to a physically impaired individual with regard to the floor area adjacent to the door, the threshold of the door, and the clearance through the doorway. Narrow or revolving doors do not permit access for the physically impaired. Also, adequate maneuvering clearances must be maintained on both sides of the doorway.

Corridors and Doors

Once inside the building, a physically impaired person must be able to gain access to various rooms, including restrooms. Some buildings are classified as "accessible buildings," with the facilities designed for wheelchair travel in many areas, that is, in most spaces, in corridors, and through doors. Although each year more structures are being constructed with full accessibility, some buildings have only "accessible routes" to the entry, exits, and restrooms. Proper clearances must be allowed on both sides of a door, depending on direction of approach (Figure 10.17).

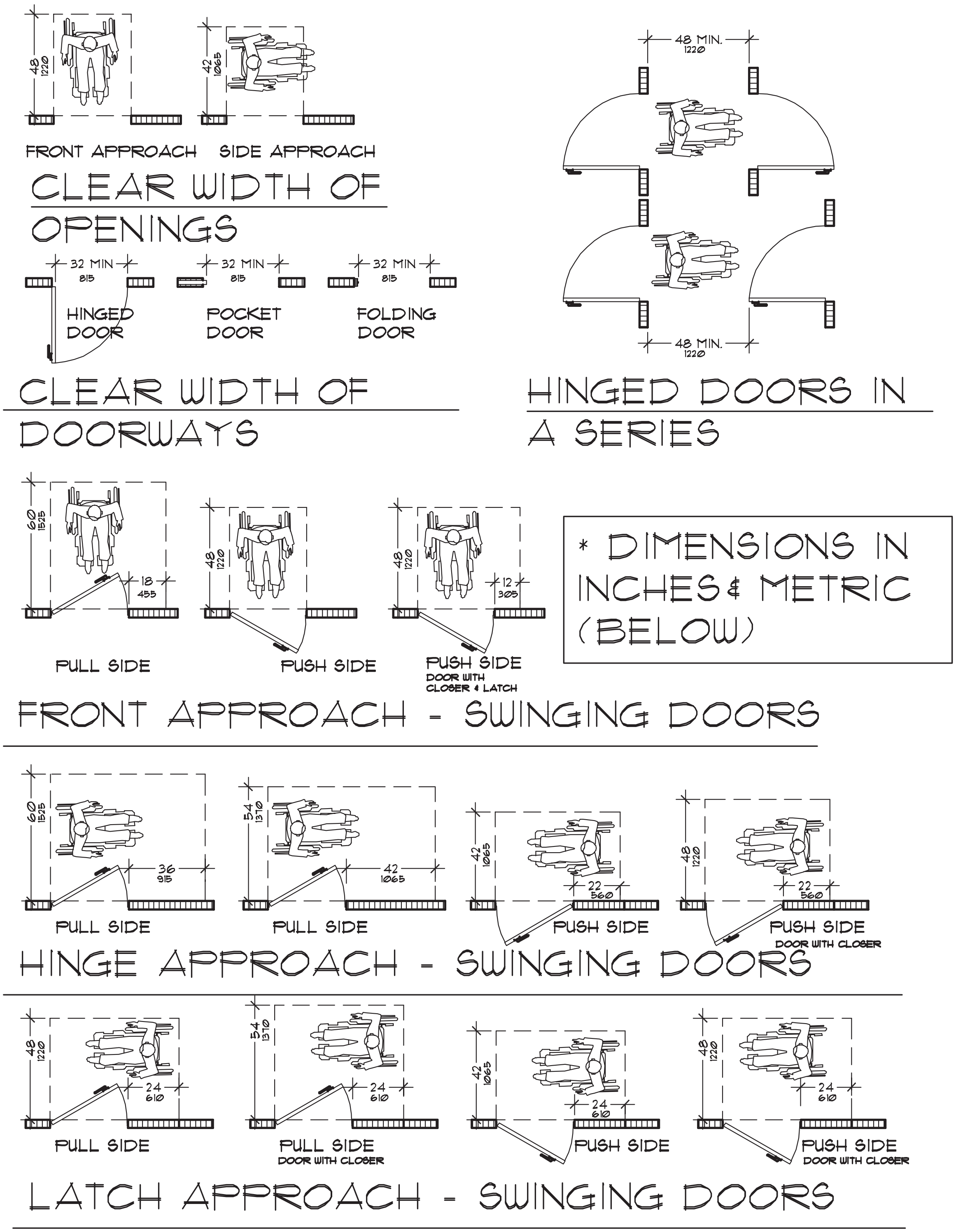

FIGURE 10.17 Minimum clearances are required at doors encountered along accessible routes. These are dependent on which way a person approaches the door.

Restrooms

Almost every commercial building today must provide the physically impaired with access to a restroom facility. Depending on the number of visitors and employees, additional restrooms for both genders must be provided, particularly if a physically impaired employee is hired. Restrooms and bathrooms for the disabled can be arranged in many different patterns, but all must meet minimum spatial requirements and provide convenience features such as grab bars (Figure 10.18). A clear space 60 inches (1525 mm) in diameter is required for a wheelchair to make a 180-degree turn.

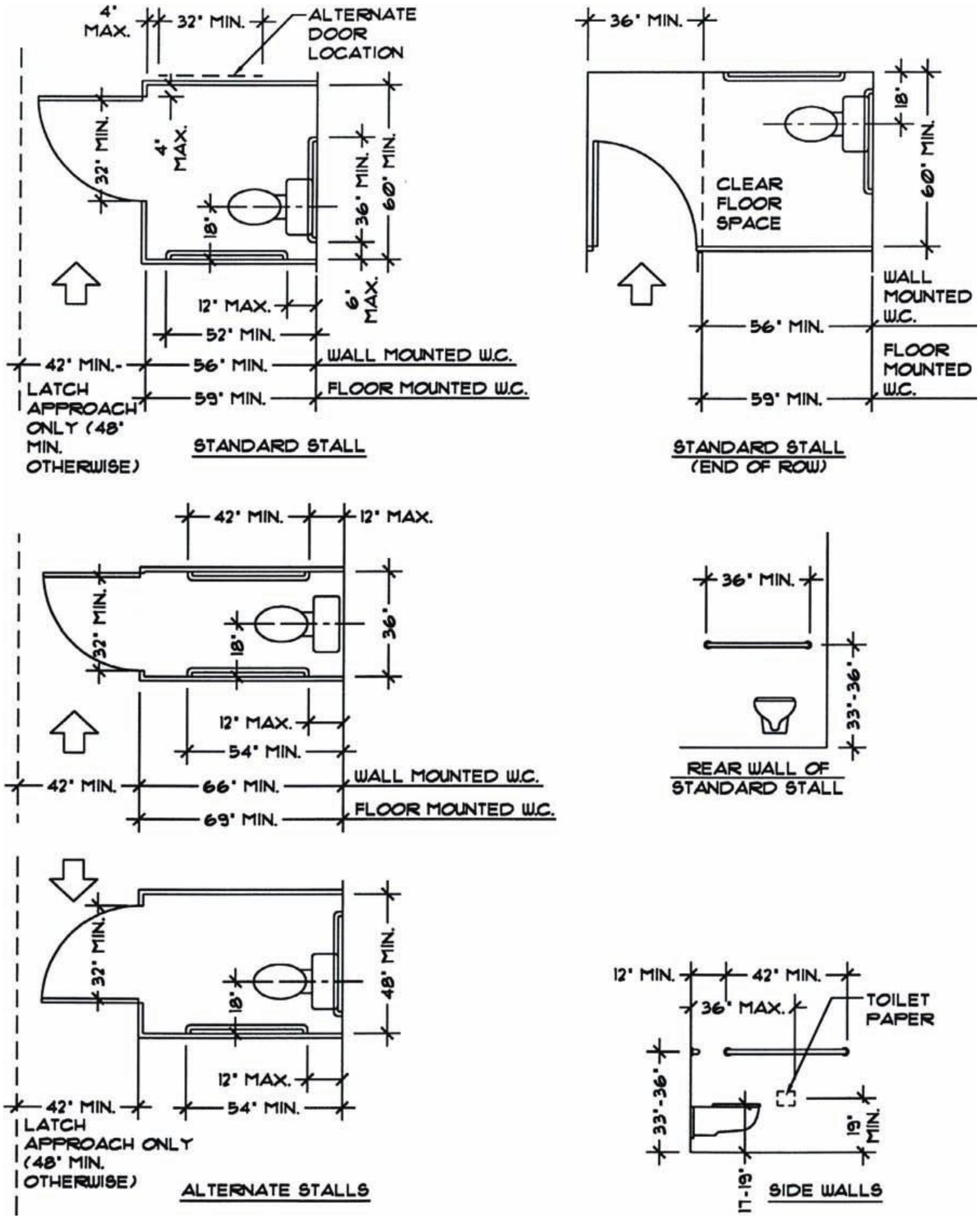

FIGURE 10.18 Toilet facilities for the physically disabled require minimum spatial features and equipment.

Stairs

Building codes usually specify minimum and maximum riser and tread dimensions, handrail requirements, and stairway widths. These should meet fire exit requirements and the needs of the physically impaired. (See Chapter 15 for more information.)

Special Features

Water fountains, signs, telephones, counters, and emergency devices must be designed for the physically disabled. These items must meet clearance, height, and materials requirements, among others, for easy use by the physically impaired.

HISTORIC PRESERVATION, RESTORATION, AND ADAPTIVE REUSE

Of increasing interest in our environment is the preservation, restoration, or adaptive reuse of historic areas and buildings (Figure 10.19). Historic buildings are an important part of our nation's background and culture; they not only remind us of the past but serve the present and the future. Old buildings and interiors serve as focal points and add variety to our streets and interior spaces.

Preservation is an often-used generic term, but it has specific meaning: using methods to preserve, conserve, and sustain an existing structure's materials, form, and integrity to ensure that it does not deteriorate or cease to exist in the future. The process of preservation can be undertaken at any time in the structure's history, but is ideally begun when it is built. Historic preservation is a specialized field, a comprehensive undertaking quite different from the design and construction of new buildings or the remodeling of existing ones. Many historians, scientists, architects, museologists, engineers, archaeologists, and experienced craftsmen are jointly involved in the preservation process. The saving and protection of our nation's landmarks and buildings maintains tangible evidence of our history and culture.

Restoration means to carefully return a historic structure to its original appearance and integrity as it appeared in a particular period in history. This can be accomplished by reversing decay or by removing later additions and modifications that were not authentic to the original intention or materials. Any missing earlier work is restored, and repair work to the structure is hidden.

Renovation or *rehabilitation* is involved with improving, upgrading, or altering existing buildings to extend their useful life and function. Although repairs might be major, any historical, cultural, or architectural features of the building are generally preserved.

Adaptive reuse is concerned with adaptation and modification of an existing structure to enable it to serve a useful purpose today. Although the character of the original structure often remains, the new use can be entirely different from the original use. For example, a former train depot might be modified to become a new shopping center, an old house adapted to become a restaurant, or a former warehouse may become a new office building (Figure 10.20). In the future, these old landmark buildings may again be reworked for new uses, yet retain the integrity of the original building.

FIGURE 10.19 Nighttime diners enjoy the warm evening of summertime eating at tables outside next to a redeveloped retail businesses.

Wolfram's Baltimore Stock/Alamy

FIGURE 10.20 The original window façade of this old building remains and becomes part of the interior décor, reflecting the historical character of the original building.

Courtesy of Knoll, Inc./Adrian Wilson

Background

Preservation was first undertaken in Europe in the 1800s; the impetus spread to the United States, where the movement has become very important. A considerable amount of literature exists showing both how earlier periods saw the need to preserve buildings and the methods they used.

In the United States, a private group was organized in 1853 to save the home of George Washington; eventually, in 1966, the National Historic Preservation Act was established, setting historic preservation as a national policy and providing incentives for preservation activities. Now, the National Register of Historic Places includes national, state, and local historic sites and buildings. Guidelines are published for rehabilitating historic buildings and must be followed to achieve National Register designation.

The "National Standards for Rehabilitation," published in a section of *The Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*, "are used to determine whether a rehabilitation project qualifies for Federal consideration and funding."

Landmarks: Districts and Buildings

Historic preservation involves historic landmarks, whether they are districts, buildings, or both. For example, a building located in a historic district might not qualify for inclusion on the National Register if it is not itself of historical significance in its construction or place in history. On the other hand, a building could have historical significance but not be located in a historic district.

Historic Buildings and Interiors

The preservation of a historic building involves two main areas: the historical character or context of a building in time and the building's historical materials. If these two can be saved, the structure will continue to serve as a historical testament. The historical character of a building is its individuality or integrity exhibited in its physical form and its reference to historical times. The building's original materials are either those that were used when it was constructed or their remains that have withstood weathering by elements, use, and repair.

Interior historic preservation has been an important part of preserving the overall building, but many interior designers were not involved until the last decade. Now, however, we see historic restoration being undertaken by teams of interior designers and architects who specialize in this type of work and are sought nationally because of their expertise.

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Interior Environmental Control and Support Systems

11

Interior environmental control and support systems are important parts of a building, providing thermal, sanitary, power, electrical, and other, sensory aids essential for the comfort, utility, and convenience of the users (Figure 11.1). Consequently, these systems are designed as an integral part of the building's structural and enclosure systems.

Although architects and engineers are primarily responsible for the design and remodeling of most control systems, interior designers should be aware of the systems and their functioning, since these systems have a direct influence on the quality of the interior environment and affect the aesthetic considerations of the spaces. Interior designers need a basic understanding of these systems in order to consult with the various professionals and workers to provide for the coordination and proper selection of these interior support systems and their components. Many of the requirements of the systems covered in this chapter are specified in detail in the International Building Code (IBC), or one of the other model codes. These include the International Mechanical Code (HVAC), International Plumbing Code (water and sanitary sewer), and the National Electrical Code (electricity).

All the systems illustrated in Figure 11.1 are discussed in this chapter except lighting, which appears separately in Chapter 12 because of its uniqueness and complexity within the interior environment.

ENERGY CONSERVATION AND CLIMATE CONTROL

The interiors of our buildings should provide an ideal environment in which occupants can function well and appreciate the quality of life. Depending on the location of the structure and its harmony or disharmony with the local environment, this ideal environment can be accomplished by using external factors in a direct relationship to the interiors, by relying on artificial methods of control and support, or by a combination of the two approaches.

Architectural design and energy concerns attempt to minimize energy consumption in a structure by integrating the building with its surroundings and taking into account local climatic conditions. In most cases, a beneficial blending of the interior and exterior spaces can be accomplished. However, excessive odors, noises, or temperature extremes may have to be regulated or blocked from reaching the occupants. The designer creates interior and exterior control and support systems to assist in making the environment better serve the users and their equipment.

Energy conservation and the efficient use of our natural resources have received widespread attention, particularly since the 1970s, when rising costs of fossil fuels and the oil embargo drastically affected our living, working, and transportation patterns. Today, concern for the natural environment and high replacement costs of energy sources have shifted our attention to conservation and recycling on a global basis. How we obtain, use, and conserve energy today will have a direct impact on current and future generations.

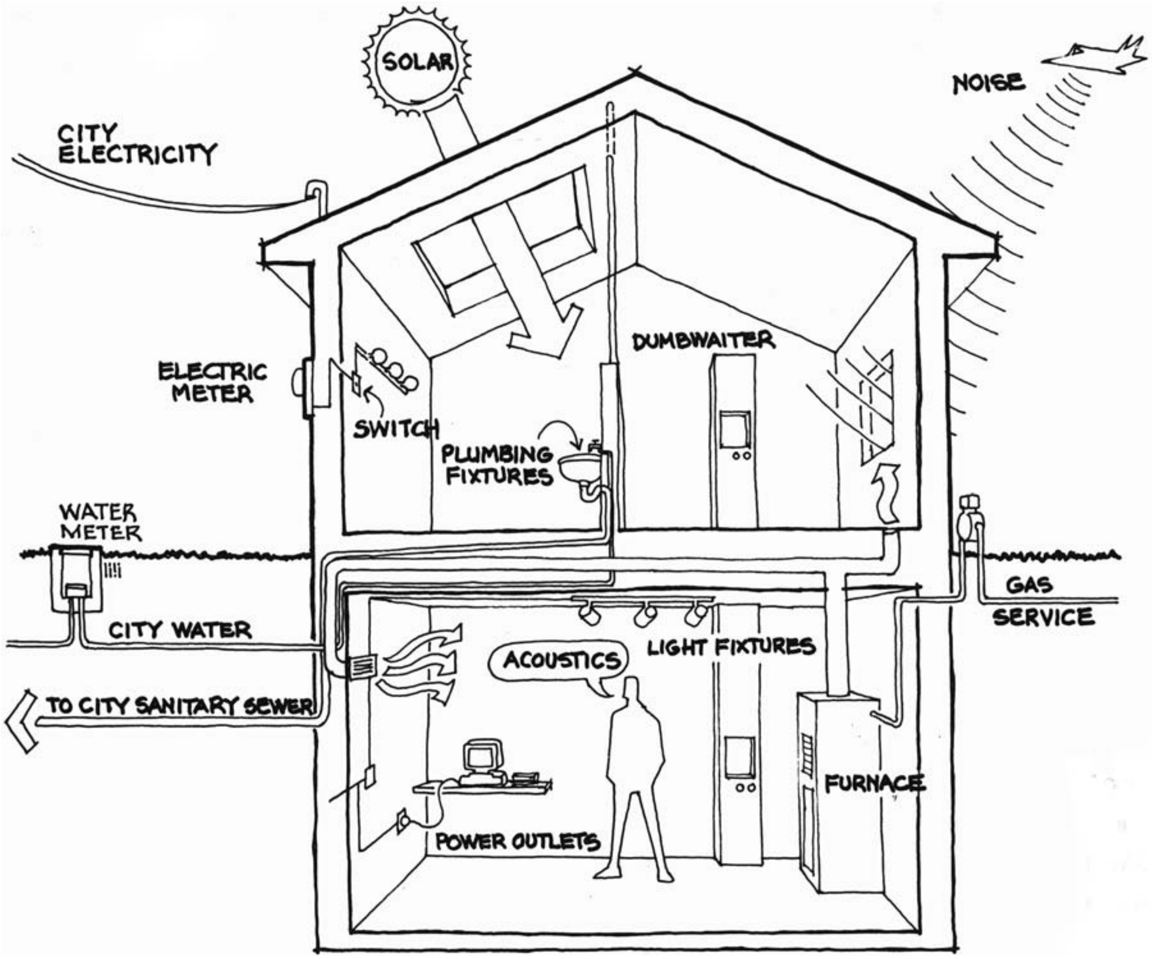

FIGURE 11.1 Interior environments are augmented by electrical, mechanical (HVAC), and plumbing systems. Vertical transportation equipment and acoustical control methods can also be employed.

Design for energy conservation in buildings aims to minimize energy dependency and provide optimum comfort in the interiors. These goals are achieved through good site planning, orientation, massing of structure, the building's envelope (such as windows, other exterior materials, and insulation), and interior systems responsive to exterior influences. In turn, many of these design approaches, such as passive solar design, have created stimulating environments quite different from former building types that rely mostly on mechanically heated and cooled interiors. Buildings and interiors designed for energy conservation may become more regionalistic in appearance and function as they are influenced by local climatic conditions and cultural preferences.

Standard insulating systems have been developed that ensure consistency among various insulating materials. These are generally related in R-values and U-factors. R-values represent resistance to heat flow, and the higher the R-value, the greater its resistance and insulating potential. U-factors measure the conductivity of a material or building component; this is given as the inverse of the R-value. The lower the U-factor, the slower the heat flow, which also means a greater insulating potential. Many insulating materials such as rigid foam, fiberglass batts, and blown-in insulation are generally listed in R-values, whereas many windows and doors are listed in U-factors. Again, higher R-values and lower U-factors are the desirable units to look for in energy conservation.

The Human Comfort Zone

Acceptable climatic conditions for human comfort vary from culture to culture and individual to individual, depending upon each person's activity, metabolic composition, and psychological adaptation to his or her environment. This comfort range can also vary seasonally as individuals go through their daily functions. This human comfort zone has definite boundaries in temperature, ventilation, and humidity beyond which some physical and psychological stress might occur.

The comfort zone of the majority of the people in the United States lies approximately between 68° and 78° Fahrenheit (20° and 25.5° centigrade) with about 20 to 80 percent relative humidity. Our interior environments are designed to fall within these ranges through natural or artificial conditioning for local climatic conditions and season of the year.

Heating, Ventilating, and Air-Conditioning of Interiors

Heating, ventilating, and air-conditioning (commonly called HVAC) of a building's interior spaces are necessary in most climates to provide environmental comfort for the occupants. Machinery and electronics have been developed that provide an automatically balanced comfort zone. Some of these systems are fairly simple and controlled by the user, but others are elaborate and operate automatically. The building's HVAC system controls the following aspects of the interior environment:

1. Surrounding air temperature
2. Mean radiant temperature of the surrounding surfaces
3. Relative humidity of the air
4. Air movement
5. Air quality or purity (odors, dust, or pollen)

The first four of these factors make up the "thermal environment," which is modified as necessary by the HVAC system to condition the interiors according to the degree of human activity and comfort in the space. The system's controls seek equilibrium to adjust for users' bodily heat loss as they perform their various functions.

Architects and engineers are primarily responsible for the design and inspection of HVAC systems, and contractors install and operate them. However, the interior designer of today is increasingly required to understand the basics of the HVAC systems and the way they affect interiors. For example, a designer should know that if many incandescent lights and people are added to a small space, the resulting heat load will increase and could become uncomfortable if not addressed by the mechanical system. A designer should also be able to read the basic blueprints of HVAC systems (particularly the ceiling plan) because the placement of light fixtures and other elements he or she adds must be coordinated with the HVAC elements, such as grilles, air registers, and required clearances (Figure 11.2). The interior designer should also take care that furniture, furnishings, and equipment do not obstruct parts of the HVAC system. Many books and articles on the design and performance of HVAC systems have been written, and several are listed at the end of this chapter.

Sources of Energy for HVAC Systems

Buildings can utilize a number of different primary energy sources to control their thermal microclimates. Some of these sources, such as wood (in a fireplace), can be used directly to heat an interior; others, such as oil, must first be refined and then burned in a furnace for radiant energy. Currently there is also an interest in using more renewable energy sources, such as solar, wind, hydroelectric, biomass, and wood, as opposed to nonrenewable ones, such as oil and coal, which have fixed and limited reserves. The advantages, disadvantages, and costs vary according to region and availability. Some of the common energy sources are discussed here.

FOSSIL FUELS Fossil fuels are those natural resources, such as coal, oil, and gas reserves, that lie beneath the Earth's surface. These are extracted directly and burned (coal), refined (heating oil and gas), or used indirectly (burned in large generating plants) to produce electricity.

NATURAL MATERIALS Today, wood is often a secondary heat source in airtight stoves or fireplaces. However, many people are less concerned with heat output from these materials than with the visual or aesthetic aspect of a fire. Wood-burning equipment has become more efficient; however, in some cities "no burn days" and other restrictions are being placed on wood-burning devices to help reduce air pollution.

ELECTRICITY Electricity is an excellent and universal source of energy generated by hydroelectric (water), fossil fuel, biomass (biological materials), wind, photovoltaic, or nuclear plants and distributed to our buildings.

GEOTHERMAL The Earth's crust covers large amounts of trapped heat that can be tapped for steam and hot water in some areas for generating geothermal heat sources. Similarly, deep-well drilling near a building can be coupled with a water-driven mechanical heater to use groundwater as a source of heat. This will be discussed later.

SOLAR ENERGY Since the oil crisis in the mid-1970s, solar energy has been looked upon as possibly one of our most renewable energy sources for the future. Depending on the location of a building, it is possible to replace

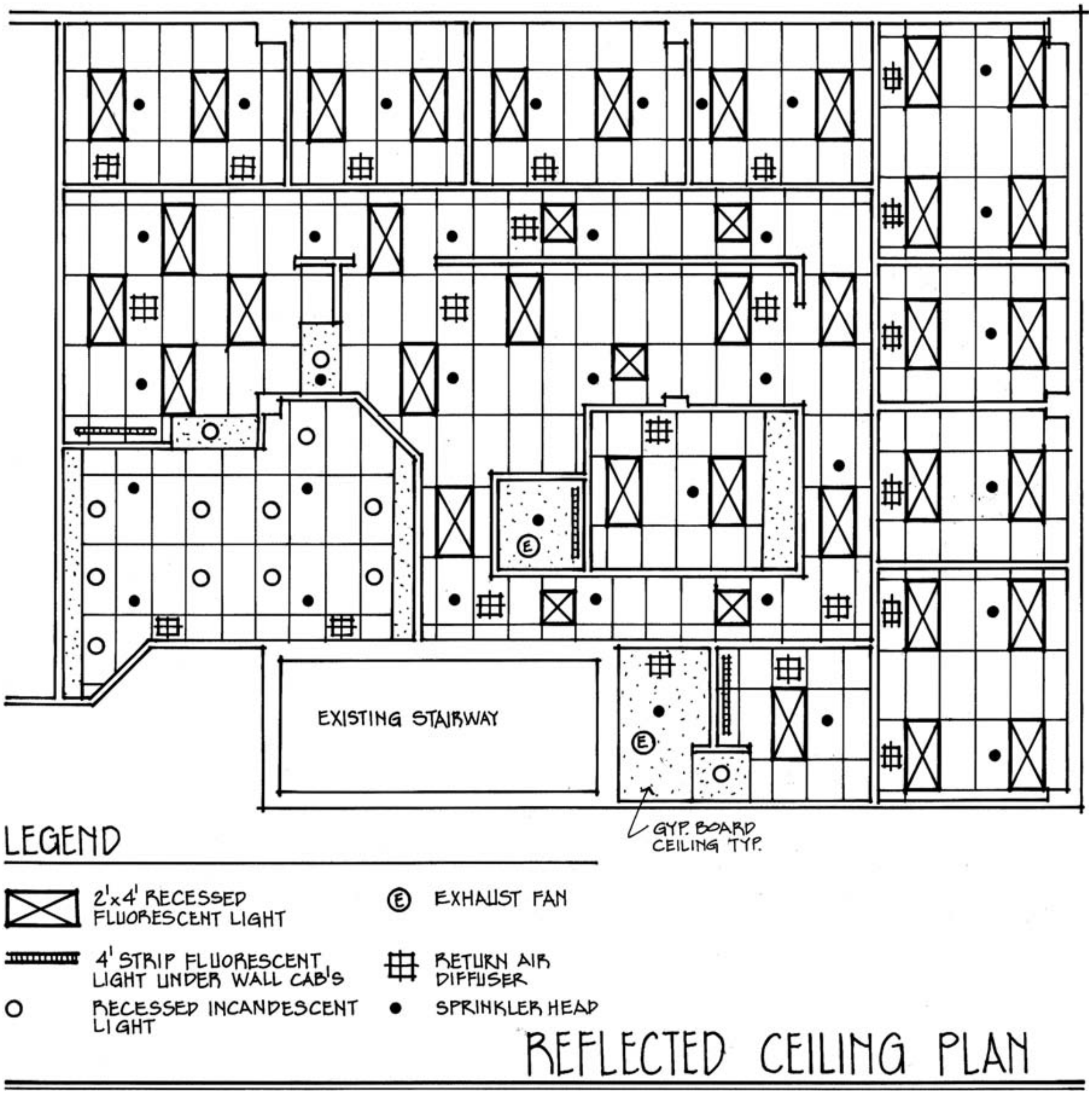

FIGURE 11.2 The interior designer assists in coordinating the placement of lights, mechanical system devices, and other elements, as seen in this reflected ceiling plan.

30 percent to 80 percent of the energy required for heating needs by utilizing principles of solar energy design. As mentioned, radiant heat and light from the sun can be used directly, or converted into electricity by photovoltaic cells.

Heating Interiors

Heating interior environments can be achieved in two different ways: directly, by burning fuels within a space such as a fireplace, or indirectly, by transferring a heated medium (such as hot air or hot water) to the space from a central plant. The particular method used is dependent upon several variables, such as the exterior climate, desired comfort level of the users, renewable resources, energy efficiency, and availability of fuels. The costs of the system's installation, operation, and maintenance are also of prime importance.

A building's potential heat losses are due to its materials, fenestrations of doors and windows, its shape, and the local climatic conditions, all of which must be taken into consideration when a heating system is designed. The heating plant is sized to replace heat losses to a level that will maintain a comfortable interior climate for the occupants. Engineers and architects also take into account heat generated by the occupants, lighting, and equipment in the space. There are four basic methods by which this heat loss in buildings, called heat transfer, occurs (Figure 11.3).

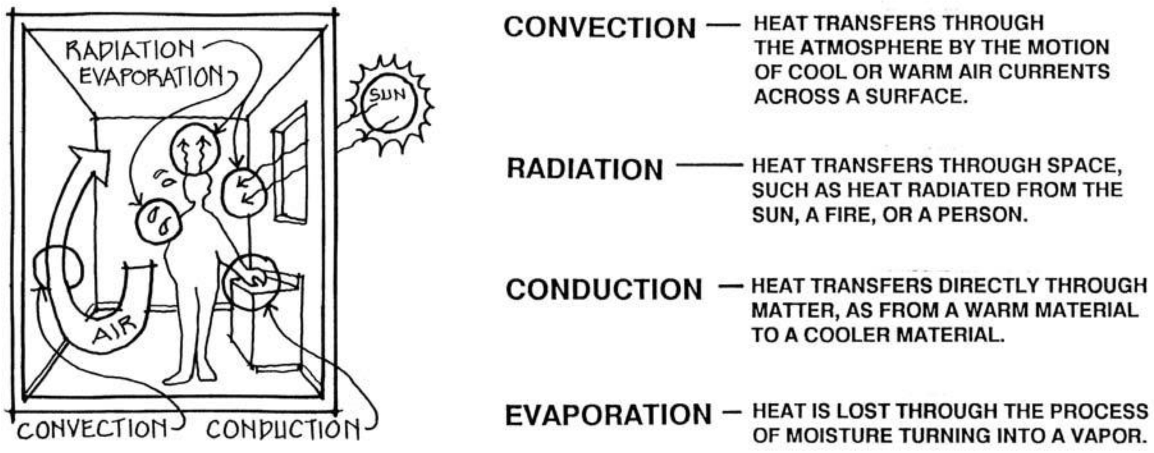

FIGURE 11.3 Heat is lost or transferred from one medium to another in four basic ways.

ENERGY AND HEAT CONSERVATION Buildings are designed today to use less energy than in the past, and more emphasis is now placed on heat conservation and efficient heat utilization. Structures are designed to slow heat loss to the exterior during cold periods, resulting in the heating system having to generate less new heat, thereby increasing efficiency. For example, more heat is needed from a furnace to heat a poorly insulated building than a well-insulated one. Standards are now set and enforced by most building codes to help conserve the amounts of energy we use to heat our buildings. Most people are aware of the need to caulk, insulate, and turn down thermostats in homes and workspaces to help conserve the world's energy sources.

As mentioned earlier, insulation is used in buildings to slow the loss of heat to the exterior in cold seasons and help buffer the interiors from high heat in hotter seasons. The choice of insulation depends on a material's resistance to heat flow, physical characteristics, and purchase and installation costs. Generally, the greater the resistance (R) value, the better the material serves as an insulator.

Heating Systems

Heating systems function primarily by warming a particular medium, such as water, air, or steam, and delivering it to the various building spaces. Other methods, such as electric radiant heating elements or electric coils, transfer their energy directly to the surrounding air to warm a space. Air can be force-blown over these elements or allowed to circulate in natural patterns.

A thermostat automatically monitors the temperature of a space and switches the furnace accordingly, controlling both the air-conditioning system and the heating system. A mechanical engineer generally determines the location of a thermostat. The thermostat is placed away from exterior walls, in a location free of drafts and direct sunlight, since these can influence the accuracy of its readings. Typically the thermostat is located about 18 inches (457 mm) above a floor level, but might be placed lower for accessibility requirements. A programmable thermostat is often specified today for provision of settings for unoccupied times or for daytime and nighttime usage.

WARM-AIR HEATING Most heating systems include furnaces that use air as the medium to transfer heat to interiors by delivering it with fans or gravity feeds. The latter type uses the natural principle of the tendency of heated air to rise, then fall as it cools, and was used before forced-air systems were developed. In mechanical systems, the air is moved through proportionately sized ducts and enters registers, which are outlets through floors, walls, or ceilings (Figure 11.4). These devices are designed to direct the warm air to different parts of a space. Their size, number, and location depend on the expected heat loss of the space, its size, heat-producing equipment, and activities within the space. The air then finds its way back to the furnace through individual return air grilles and ducting, or is drawn through a large, centrally located return air grille to be heated again. These furnaces can be gas or oil fired, use electrical heating coils, or use a combination of compressors and heat pumps (discussed later in this chapter).

Heating ducts are designed in relation to the velocity of the warm air delivered to create a "balanced" system of the various interior spaces. These ducts are constructed of metal, fiberboard, or plastic and are rectangular or round, depending on the design and material used. Their cross-sectional area is in relation to the cubic feet per minute (CFM) of air needed for the spaces and to the permissible velocity the engineer specifies in the duct. The ductwork branches out to deliver a specific volume of air to the respective spaces, corresponding to their size,

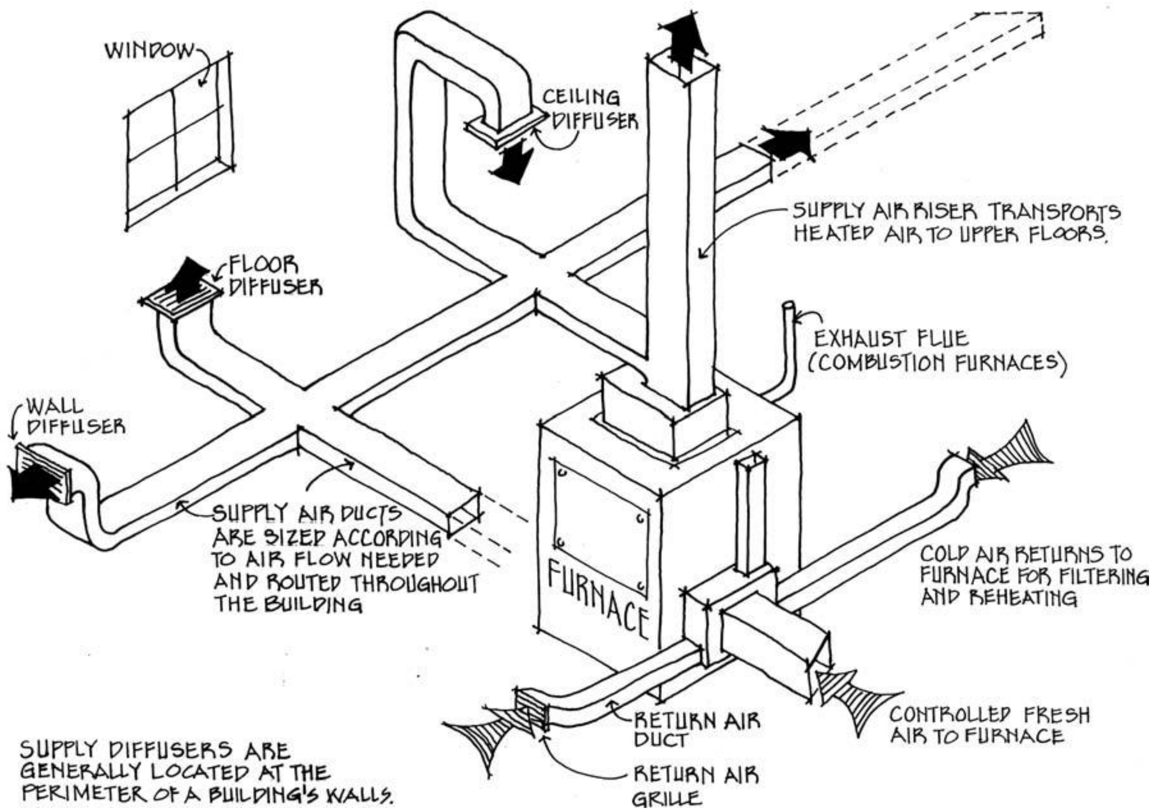

FIGURE 11.4 Warm-air heating systems use a furnace to heat the air and deliver it through a system of supply and return air ducting.

shape, desired temperature, and use. These layouts can be designed as an underfloor perimeter or branch system, an above-ceiling system, or an exposed arrangement. Today's building codes often require some insulation of ductwork in unconditioned spaces (such as attics or basements) and even higher insulation values if the duct is located outside of the building. They also specify requirements of sealing duct joints to prevent air leakage.

Warm-air heating has some advantages over other systems, since humidifiers and filters can be added to the system for conditioning the air. The same system of ductwork can also be used during warm seasons to ventilate or to provide air-conditioning.

HOT WATER HEATING In contrast to warm-air heating, hot water (hydronic) heating uses water to transfer heat from the furnace (called a boiler) to interior spaces via piping. Although hot water heating can be more expensive to install, it has some advantages over warm-air systems: Piping requires less space than air ducts, does not cause air drafts, and tends to maintain a more even temperature.

A boiler heats water to a predetermined temperature, circulating it by electric pumps through piping to individual radiators or "fin tubes." Air flows over these radiators naturally or is blown by a fan, picking up heat and warming the space. This type of heating uses several different layouts: the series perimeter loop, the one-pipe system, or the two-pipe system (Figure 11.5).

In some cases, the hot water is circulated through radiant heating pipes imbedded in a concrete floor, or placed under a wood floor with tubing runs. This system has two advantages: It eliminates cold floors, and it uses no space in the interior for radiators. However, this system can be difficult to repair if it breaks.

STEAM HEATING In a steam heating system, water is heated to a high temperature until it changes into steam, which is then sent through insulated piping to the individual radiators. As the steam cools and condenses to water, a separate gravity-return pipe delivers it back to the boiler for reheating into steam. Steam heating and hot water systems have some advantages over air in that they can be piped into zones, which allow individualized control of different rooms and areas of the building.

ELECTRIC HEATING Electric heating is generally the least expensive of all systems to install but often costs more to operate because of its higher electrical demand. However, it can easily be zoned, with separate wiring or a

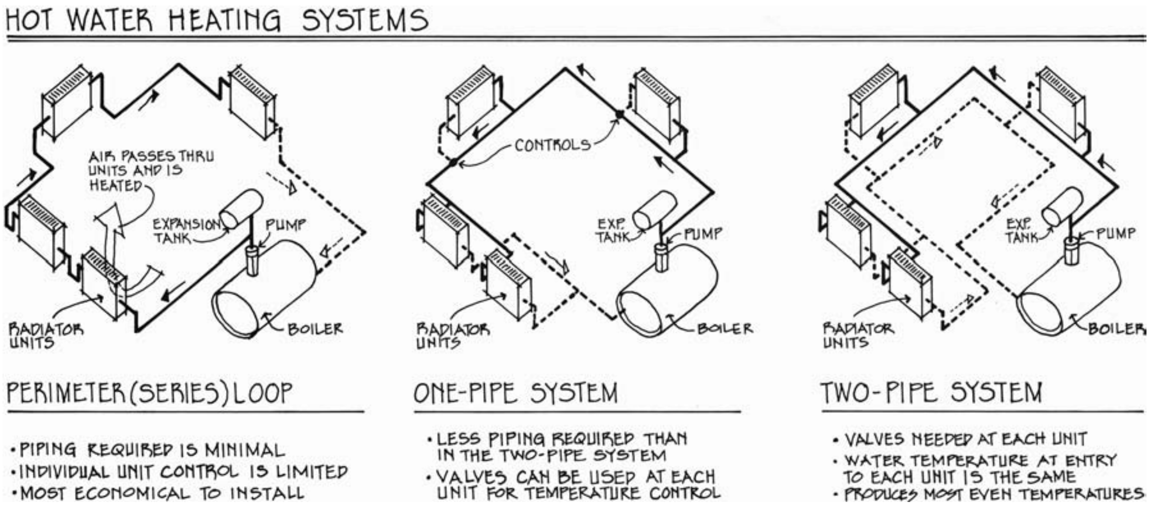

FIGURE 11.5 Hot water systems boil water to a high temperature and deliver it to radiators to heat spaces. Although there are many piping methods, there are three basic methods.

thermostat at each unit, to allow great flexibility. There are several ways to use electricity to supply heating. The most common method is installing electric baseboard strips or wall units in a space, although this method of heating in cold climates requires a lot of energy usage. The wiring creates a resistance to the flow of electricity, causing it to heat up and transfer to the surrounding air. Fans can also be added to help circulate air throughout the space.

Radiant electric heat can also be used to heat interiors, by placing cables under flooring materials, and even in wall and ceiling panels.

HEAT PUMPS Heat pumps are a hybrid system that combines some of the features of all the formerly mentioned systems, yet are unique in their operation. A major feature of these devices is that with the flick of a switch, they can heat in the winter or, by reversing the fluid that goes through them, can cool in the summer. By using a reverse-cycle refrigeration system, the electrically driven system can be utilized in a variety of building types—and, unlike other systems, it does not require a flue to exhaust spent gases. The heating and cooling can be accomplished by reversing the flow of the refrigerant in the system (Figure 11.6). These units derive their heat from outside air or a water source, such as a geothermal well in the earth. These geothermal heat pumps are more costly to install initially, but they produce lower energy bills than the air-source heat pump. The air systems are very efficient in their operation for heating when outside air temperatures are above approximately 34°F (1.11°C). Below these temperatures, the outdoor part of the system has difficulty drawing heat from the surrounding air. In these cases, the electric resistance heating inside the furnace takes over, decreasing the unit's efficiency because it is operating like straight electrical resistance heating.

UNIT HEATERS Most of the previously described systems utilize one or more central heat plants, depending on the size of the building. Sometimes unit heaters might be used instead. These heaters can be thought of as a decentralized system in which furnaces are placed within or adjacent to the space being served. Unit heaters eliminate the need for a lot of ductwork or piping and can be located in specific areas for more independent control. Most of them combine air-conditioning and a fan to help distribute air. Because of their versatility in comfort control for heating and cooling, these units are popular in hotels, motels, and other spaces requiring individualized climate control.

Ventilation

Ventilation refers to the process of replacing all or part of a space's air to control temperature and other factors discussed in this section. It includes the circulation of air within a building's spaces as well as exchange of air to the exterior. Interiors can be maintained at the desired temperature by tempering the air in the space with some of the heating and cooling methods already described. However, at some times of the year, it may be possible either to exhaust air out of the building or to introduce air into the building from the outdoors. If the outdoor air is cooler or warmer than the interior, this outdoor air can be used directly for the desired effect. This process, called ventilation, involves moving the air either through the heating or cooling system or just transferring it separately by individual ducts or vents. Moving air through the interiors can help maintain uniform temperatures and be coupled

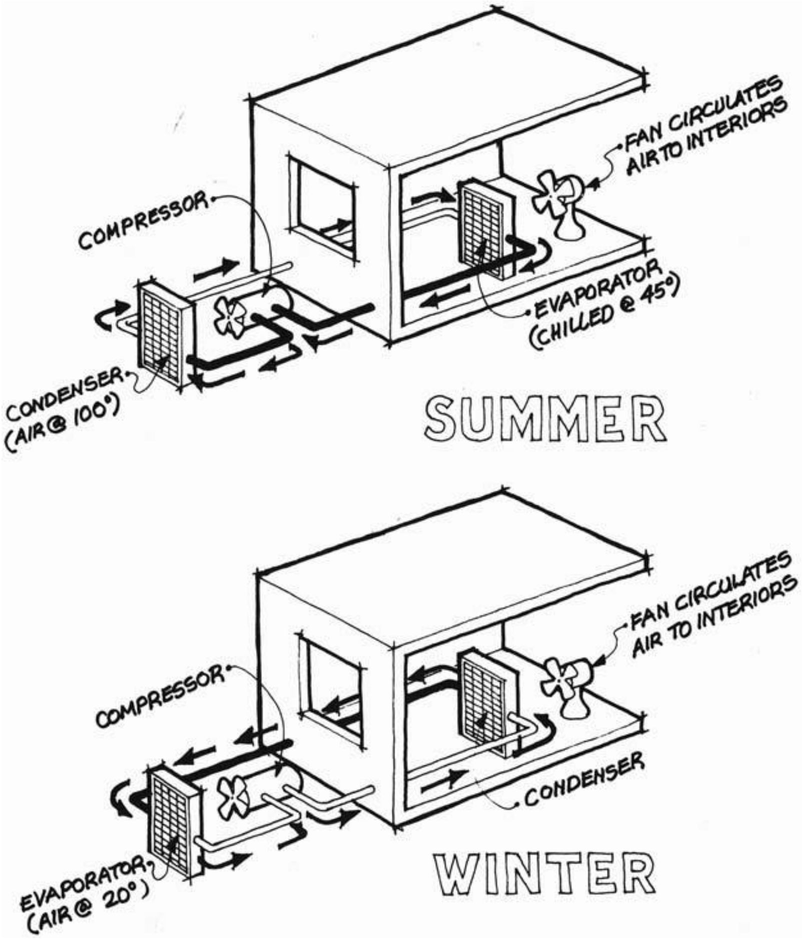

FIGURE 11.6 A heat pump reverses the flow of a refrigerant to produce a cooling or heating mode as needed for the interior spaces.

with other air improvement modes, such as humidity and filtering controls. The latter of these can control or remove pollen, dust, and unwanted odors.

Ventilation also is essential in introducing fresh air to replace air that can become stale when it is recirculated within a closed building or space (such as a classroom with many occupants). Inadequate ventilation can also produce what has been termed "sick building syndrome," as a result of concentrated indoor air pollutants such as volatile organic compounds (VOCs). These sometimes occur from the off-gassing of building materials such as carpets, paints, and other pollutants. In medical facilities, fresh air makeup is added as well as filtration of biological contaminants such as fungi, mold, or bacteria.

Ventilation systems might also employ what is called "energy recovery ventilation" (ERV) or "heat recovery ventilation" (HRV). These systems recover the *sensible* or *latent* heat from exhausted air, such as air expelled by bathroom exhaust fans. The units transfer the heat energy from the exhausted air to the incoming outside fresh air—thus reducing the amount of energy needed to raise the temperature of outside cold air in the winter (temperate climate locations).

NATURAL AND FORCED VENTILATION Air is either moved through buildings by natural convection or air currents, or it is pushed and pulled by mechanical means. A natural method is the simple opening, closing, or regulating of windows and doors. Breezes from the exterior can be captured by these openings and funneled through interiors. While most of this movement is horizontal, air can also be moved vertically by adjusting the openings at different heights within a space or multileveled building. For example, a combination of first-floor and second-floor windows can be opened to prevailing winds to create a vertical air movement that can cool the interiors. This principle can also be used in rooms with cathedral ceilings and other vertical spaces to help circulate air through natural air currents as hot air rises.

Forced or mechanical ventilation uses air handlers such as electrical fans to move air through ducts to adjacent building spaces. Generally the fan is located in a central plant, although other remote locations can also be employed. Ceiling fans, exhaust fans, and "whole house" fans are used in many interiors to push or pull air for the desired effects.

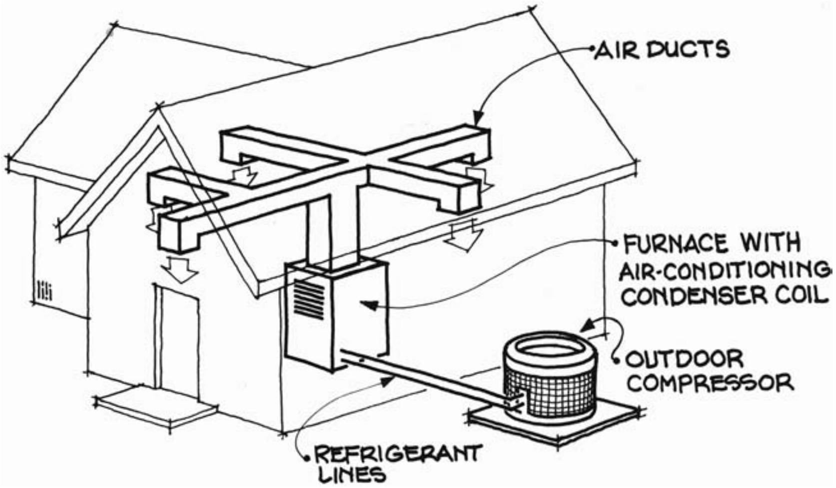

FIGURE 11.7 Cooling of building interiors can be done with a refrigeration system that transfers interior warm air to the exterior, thus cooling the building space.

Air-Conditioning

Air-conditioning is a process that removes heat from a space by delivering air cooler than the air existing in the space. Although air-conditioning is sometimes called cooling, air-conditioning really refers to year-round climate control, whether it is cooling, heating, or ventilating air. When air is dried by removing water vapor from it, the lessened relative humidity promotes an evaporative effect on our bodies that results in a feeling of coolness. Humidity control is an important comfort factor, and some forms of cooling simply remove humidity without introducing chilled air.

Cooling of air can be accomplished in two ways: the evaporative method for arid climates and the refrigeration method for high-humidity areas. Evaporative coolers will not cool as well in areas where the air has greater humidity levels. The evaporative system, which involves cooling by water, introduces more humidity, which can be tolerated in the Southwest but not in areas such as the Midwest, since the higher humidity adds to the heat gain. Refrigeration systems operate like household refrigerators and heat pumps. They draw heat out of the refrigerator (house) and dump it into another space (outdoors), using a refrigerant under pressure, rather than water, to create the cooling effect. Various refrigerants are used in these systems, and efforts are being made to discover new ones to ensure that any leakage of these gases will not be harmful to the environment and atmosphere, particularly by depleting the earth's ozone layer.

COOLING BY WATER, AIR, AND HEAT PUMPS Cooling and conditioning of air can be accomplished by sending chilled water through piping and radiators to a space, similar to the way hot-water systems work. The lower temperature of the water will absorb the heat from the air, transfer it to the water, and carry it back to the central plant.

Cooling by air-to-air transfer utilizes the refrigeration principle of compression, condensing, and evaporation, as is used in the household refrigerator. The heat in the room air is literally transferred to the outdoors by being absorbed in the refrigerant. Air is conditioned by its exposure to chilled or heated refrigerants in the system, rather than to water. Cooling units are placed in the furnace room and have an outside compressor (Figure 11.7).

Solar Energy and Interiors

The sun floods the earth with abundant energy that can be a viable resource for heating, cooling, and generating electricity for our needs. Solar energy is not newly discovered; for many centuries, it was used by our ancestors, who discovered that cave and building wall openings oriented in the direction of the sun would be heated and illuminated on cold winter days.

Historically, the Greeks designed their homes around central courtyards and oriented buildings to take advantage of the sun's rays. Even today in the Mediterranean, houses are whitewashed to reflect the hot summer sun. The autumn rains then wear away the whitewash to expose the structure's darker colors, which tend to absorb winter solar energy as heat. In the United States, Southwestern Pueblo structures and New England saltbox house designs are evidence of the effective use of the sun. By understanding the sun's path, cliff dwellers in the Southwest also used solar principles to capture heat and create cooling (Figure 11.8).

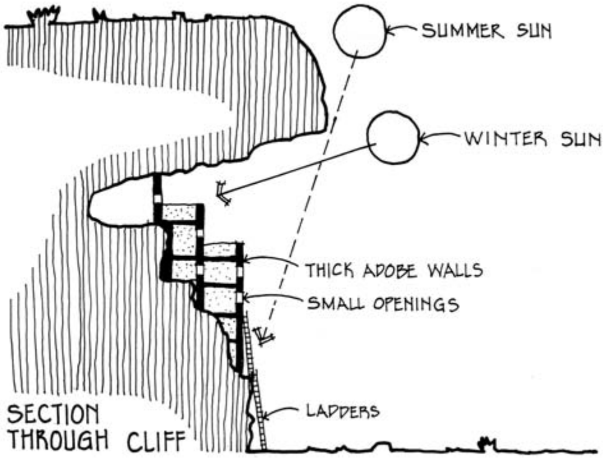

FIGURE 11.8 The hot summer sun is blocked by the cliff overhang in this ancient cliff dwelling. Low winter sun strikes the adobe or massive stone walls, storing heat for the occupants.

At the 1933 World's Fair in Chicago, a glass structure was exhibited that had a large expanse of south-facing glass to admit winter sun, which would heat interior masonry surfaces. In the evening, the stored heat warmed the interiors. In the same decade, several projects attempted to capitalize on the principles of solar energy, creating a new interest in solar heating. Since that time, many individuals and organizations have designed, built, and tested structures to use solar energy for heating and cooling.

When energy prices are fairly stable, the interest in solar design is not as apparent as during energy crises, such as the oil embargo of the 1970s. However, there is indeed a need for this technology as we deplete our world's natural resources in the quest for energy.

The interior designer today needs knowledge of the principles of solar energy and their effects on interiors. The use of additional open spatial plans within buildings to encourage solar heating and distribution can directly affect the design of the spaces and materials used. In recent years clients have been asking for more sunspaces, greenhouses, and glassed dining spaces. The designer must understand the effects and functions of these solar rooms; overheating and the fading of colors by sunlight can be of great concern.

Various regions in the world are better than others for utilizing solar energy for heating, depending on the amounts of sunlight hours and radiation available. For example, because of the number of cloudless days with more direct sun, the Southwest of the United States is better suited than the Northeast for harnessing a high percent of solar energy (Figure 11.9).

FIGURE 11.9 Architect Dennis Holloway designed this building complex to take advantage of the Southwest region's climate and sun.

Courtesy of Dennis Holloway, architect

Many books and charts give detailed information on the sun's path across the sky for different seasons, times of day, and geographical locations. These data are used by architects to determine when, where, and how much of the sun's rays will strike a building and penetrate the interiors. The interior designer can use these findings to design for "daylighting" techniques (Chapter 12) to supplement artificial lighting and ascertain the likelihood of interior materials fading.

Generally, windows in cold and temperate climates can be oriented southward to receive the sun's rays during winter and be shielded from hot summer sun with various screening devices. North windows can be small to reduce winter heat loss, with west windows designed to be shielded from low, hot summer sun. East windows are designed to fall between these extremes.

Methods of Solar Heating and Cooling

The use of solar design affects a high level of energy conservation. Most heating and cooling systems in solar structures are not capable of providing the instant high and low temperature control of conventional methods. Effective insulation can help the building conserve the heat generated, and to help block the sun's energy effectively when cooling is needed, various shading devices that help store or deflect heat are needed. Some of these are in the form of movable elements that can be adjusted for proper times of the day and seasons.

Cooling with solar energy uses shading of a building and its windows, air ventilation, and other methods for natural cooling. Cooling can also be done using the refrigeration principles discussed earlier. In these, solar collectors are used to heat a liquid to a high temperature, and the liquid then becomes the refrigerant to draw heat from surrounding spaces.

There are two approaches to designing for solar heating and cooling: passive or active systems. These can be found in both residential and commercial structures, although residential use is more common because the spaces generally are smaller, requiring less output from the solar source.

Active solar systems also include the use of photovoltaic panels to convert solar energy to electricity, as well as utilizing the thermal properties of sunlight. The photovoltaic systems can be sized in a manner that allows extra electricity to be stored (by batteries) for future needs, or sent back through the electrical power grid, producing energy credits.

Passive Solar Systems

Passive solar systems use natural or passive means to transfer energy from the sun, and use little or no mechanical equipment. These systems take advantage of the physical laws of heat transfer within the building's design and materials. Passive solar concepts make energy conservation and natural energy modes an integral part of the building's design, also providing natural light to the interiors (Figure 11.10). However, passive solar can demand active participation by a user, such as periodically opening and closing window shades, windows, and other devices. Temperature variations can become uncomfortable in some cases because greater fluctuations in temperature levels can occur. Some spaces might overheat while others become too cool. The three ways to achieve passive design are through direct, indirect, and isolated gain (Figure 11.11).

DIRECT GAIN The simplest method of passive design is the direct solar gain method, in which the occupied interior space serves as the collector. This method requires large expanses of south-facing glass and some means to restrict sunlight or exhaust heat, either by shading with roof overhangs or by using vents. Insulation properties of windows or movable insulation must also be considered, to prevent major heat loss.

The most successful direct gain systems use a thermal mass, such as concrete, brick, or other dense material, to trap the sun's heat and release it later into the space. These masses are located within the space to receive direct sunlight in order to gain maximum heat input from the sun's rays. Direct gain techniques can result in the fading of materials and other damage to furnishings and furniture from the excessive amounts of direct sunlight.

INDIRECT GAIN Indirect solar gain involves receiving the sun's energy and heat in a place separate from the occupied spaces. The sun strikes the thermal mass of concrete, stone, brick, or water in these remote spaces. The heat is then transferred to the occupied space, allowing the collector and storage to be operated separately. In this method, excessive heat buildup or heat loss can be better regulated for the occupant's comfort. Indirect gain can use several different ways of collecting, storing, and heating interior spaces.

The Trombe wall system of indirect gain, named after the French scientist who developed the technique, utilizes large expanses of south-facing glass with a dark-colored thermal mass set a few inches behind. The mass receives the sun's heat, stores it, and slowly releases it into the adjacent occupied space for a lengthened heating effect

FIGURE 11.10 Passive solar design concepts include south glazing, and other techniques of collecting sunlight in the winter and shading in the summer.

Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

throughout the day and even at night. Vents are placed low and high in the Trombe wall mass to take advantage of the natural convection loop of hot air rising in the interiors, drawing the cooler, heavier air back into the lower part of the wall as the air is returned from the occupied space.

A roof pond system of indirect gain locates the thermal mass on the roof of the building to obtain heat from the sun's rays and distribute it to the occupied spaces. These systems are more commonly found in moderate climates, such as California's, where the liquid medium is not subject to extreme heating and freezing temperatures.

ISOLATED GAIN Sunspaces (used for solar gain) or greenhouses (used for growing plants) are examples of isolated solar gain systems of solar heating. These are very popular and are used both in residences and a variety of commercial buildings, particularly restaurants. They not only can add heat to interiors but also are a bright, cheerful extension to an interior space. Sunspaces work most efficiently when coupled with thermal mass storage and movable insulation/shading devices to prevent major heat loss or overheating.

Thermosiphoning is an isolated gain principle that uses a convective loop system based on natural forces. The system and collector are independent of the occupied space. The heat flows through the medium of either water or air; as it is heated in the collector, the transfer medium rises to the occupied space and at the same time pulls cool air or water to the collector for reheating.

Another form of isolated gain is the double-envelope house, or what is termed a house within a house. Passive heat from the sun is circulated via natural air flow between the two building envelopes.

ACTIVE SOLAR SYSTEMS Active solar systems use technological hardware and mechanical equipment to collect solar radiation and convert it to thermal energy, which then heats water, air, or other fluids to warm or cool interiors. These systems are often more expensive to install than passive systems and can usually be recognized by the solar collection panels on the building's exterior. In many cases, the solar panels on a building's roof are actually

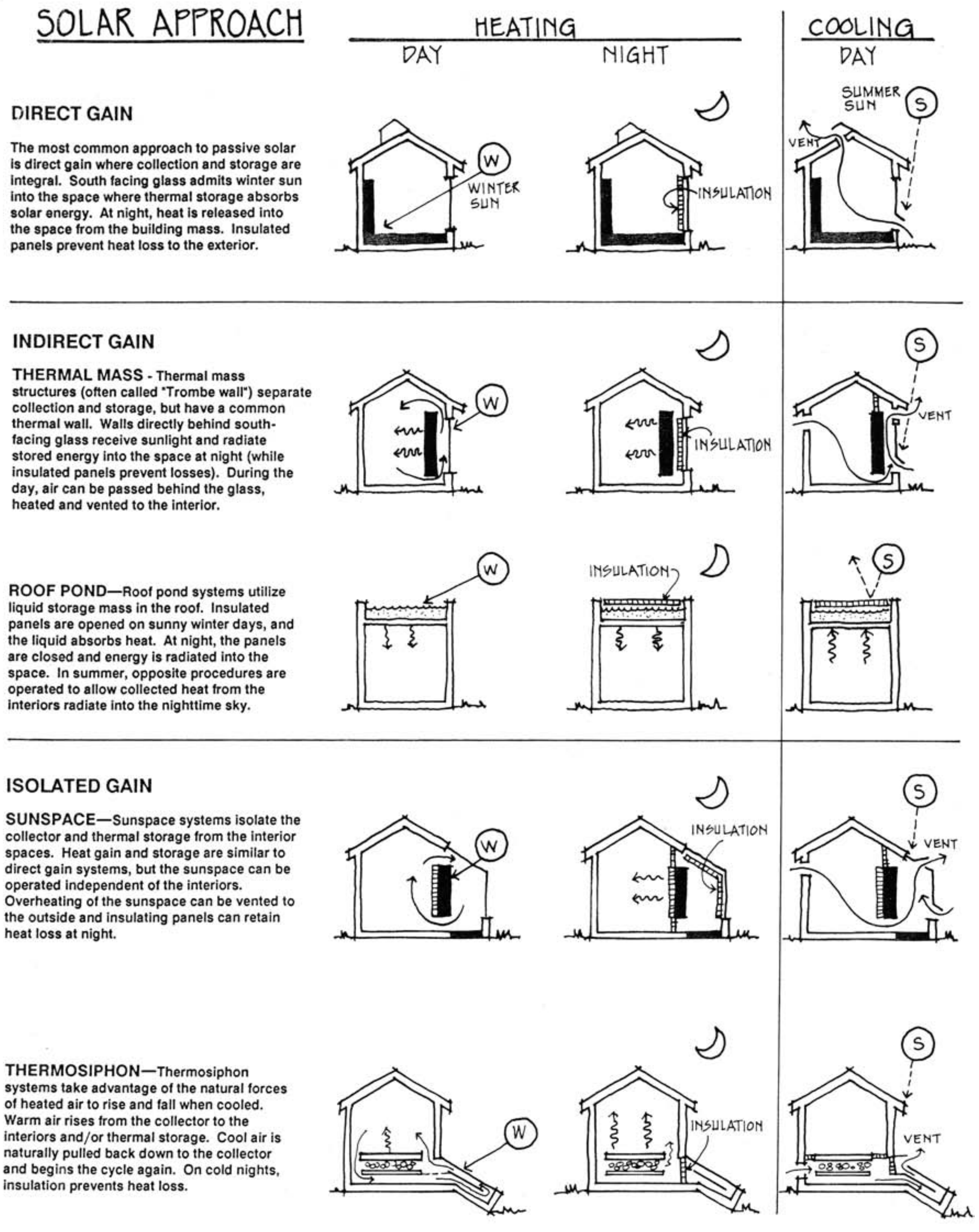

FIGURE 11.11 Passive solar design involves three basic approaches. Each is studied for its winter, day and night, heating needs and its summer cooling features.

photovoltaic collectors that convert sunlight into electricity that powers the building's electrical needs for power, heating, cooling, and ventilation (Figure 11.12). If more electricity is generated than needed, the extra is sold back to the grid of the utility company, resulting in credits to be applied at a later date.

One of the most common active solar heating systems found today is that used for heating domestic hot water. In some cases, the initial installation costs can be offset by the payback of lower operating costs over a period of time. An active solar system has six basic components: collectors, transport medium, distribution, storage, backup source, and controls (Figure 11.13).

FIGURE 11.12 These photovoltaic panels supply more electricity to this small house than it needs, resulting in a "net zero energy usage."
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

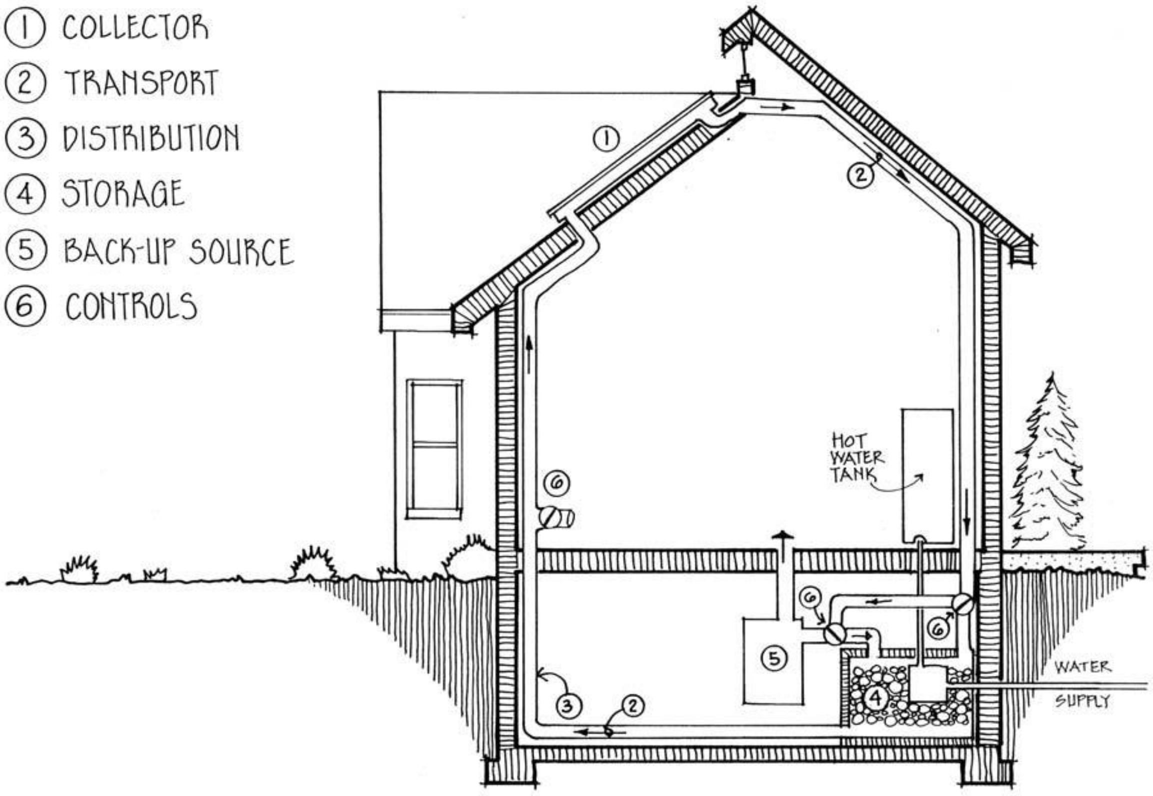

FIGURE 11.13 Active solar systems have a variety of unique features. However, there are six basic components to all: (1) collector, (2) transport, (3) distribution, (4) storage, (5) backup source, and (6) controls.

COLLECTORS Collectors capture the sun's rays by means of panels facing toward the south and the sun. These collectors can be the nonfocusing type (flat collectors), absorbing an equal amount of energy across their surface, or they can be focusing, such as a parabolic louver that concentrates the sun's energy into a small area, increasing the intensity of the sun and of the heat generated. Inside the collector, a material heats up and transfers energy to a liquid or air medium. Most collector systems are fixed in their panel arrays, but can be more efficient if incorporated into tracking systems that follows the sun through its path in the sky. However, this adds to the costs of the system installation and operation.

TRANSPORT MEDIUM The transport medium that passes through the collector can be a liquid or air, depending on the type of system designed. Most of the liquid systems use water, except in climates where the nighttime temperatures can cause freezing at the exposed collector. In these cases, an antifreeze solution is used. The transport delivers the heat to the next stage by gravity, fans, or pumps.

DISTRIBUTION Through ducts or piping, depending on whether air or liquid is used for transport, the distribution system carries the heated transport medium from the collectors either directly to the space that requires it or to the storage center for later use. The distribution system also delivers heat from the storage area to the spaces and recycles the transport medium back to the collectors. It can be natural in its operation or use pumps and fans for forced circulation.

STORAGE The transport moves the collected heat to a storage reservoir if the interiors do not need the heat directly. It can be transferred in the storage facility to rocks, water, or other materials to hold for use at a later time. This storage might provide heat for a few hours or for several days, depending on its size, insulation, and degree of initial heat.

BACKUP SOURCE A backup energy source is needed to take over heating requirements if the solar system cannot produce enough heat, such as on cloudy days, at night, or when stored heat is depleted. These sources can be wood stoves, fireplaces, or the other conventional furnace systems.

CONTROLS Active solar systems require more controls than just a simple thermostat. Several types of thermostats, sensors, and other monitoring devices work in stages to control the operations of an active system. Some are automatic, and others require some direct involvement by the user.

Electrical Systems for Buildings

Electrical systems (hard wired and wireless) for buildings usually are designed and installed by electrical engineers or licensed contractors who handle the technical aspects, since they are aware of the many codes and restrictions that govern electrical devices and power supplies. However, the interior designer does get involved in planning for electrical systems, particularly switch locations, dimmers, outlets, and an increasing variety of lighting circuitry and types. Computers and other specialized devices have placed a greater demand on the interior designer to understand the functioning of electrical systems in the interior environment. The designer must be able to read, and frequently to draw, an electrical or lighting plan using the symbols that indicate the placement of lights, switches, electrical outlets, telephones, and basic circuits. The interior designer is also involved at the beginning of a project in analyzing and specifying electrical and communication needs.

Information-age electrical systems include seamlessly integrating many forms of computer software and hardware into a building's power structure. Today, many of our appliances, televisions, telephones, computers, personal electronic devices, audio players, and satellite, energy, and security systems are interconnected and "talk" to one another and us. For example, numerous lighting devices can be automatically controlled and monitored. Many of these systems are also connected through a wireless network, bypassing a direct or dedicated wiring network. This allows greater adaptability and expansion of many of the systems mentioned here.

Electrical Theory and Terminology

Electricity can be thought of as the flow of a current, like water through pipes. Electricity uses various sizes of wiring and circuitry to produce usable energy when it is tapped. Electricity can be in the form of alternating current (AC) or direct current (DC). AC is primarily used for higher voltages, to run electrical equipment and general lighting; DC mostly powers smaller energy devices, such as telephones, signal equipment, automobiles, flashlights, and specialty low-voltage lighting. More efficient light sources are used today that require less power to operate, such as fluorescent and light-emitting diodes (LED) fixtures.

AMPS AND VOLTS A certain amount of electrical current flows past a particular point in the wire or conductor at any given moment. The measure of the rate of flow is the *ampere*, or *amp* (A). Just as we can measure flowing water in gallons per minute, we can measure electrons as amps per second.

Volts (V) represent the unit of electrical potential of the flowing electrons created by causing a higher electrical charge to exist in one end of a conductor than in the other. The potential difference, or voltage, is the effect—similar to the pressure difference caused in a hydraulic system.

OHMS, WATTS, AND POWER Just as the flow of a fluid in a pipe is slowed by friction, the flow of electrical current in a conductor meets resistance. Whether AC or DC current is used, the resistance measurement is the ohm, abbreviated R. Materials that have a lesser resistance to the flow of electric current are termed *conductors.* Wires and circuit boards, made of metals such as copper and aluminum, are conductors of electricity. Glass, rubber, and other synthetics are more resistive to current and are termed *insulators.* These materials are used to insulate electric conductors.

The watt (W) is the unit of power in electrical theory that is the measure of one volt causing one ampere of current to flow. In a formula ($W = A \times V$), the power (watts) is derived by multiplying the current (in amps) by the pressure (in volts). For example, if a light bulb uses approximately .5 amps when burning and is connected to a 120-volt electrical line, the power consumed is 60 watts ($.5 \times 120 = 60$). Light bulbs and other devices are rated according to the amount of power (watts) they draw and are labeled by wattage to assist in selecting the proper device and determining how much energy is being used.

Electrical companies sell electricity based on the amount used and the length of time it is used. Electrical consumption is usually expressed in kilowatt hours (kWh), each of which represents 1,000 hours. Buildings today are metered to establish how much electricity is being used and how many hours should be billed to the consumer. In electrical systems that incorporate photovoltaic panels, it is possible to "sell" excess power, or gain energy credits for sending excess electrical power back through the electrical meter and the utility's power grid. Most of the public is aware of the need to conserve energy by turning off lights and equipment when not in use. The designer should also be more aware of conservation in specifying energy-efficient appliances, lighting, and other devices.

Distribution of Electricity

Electric companies route electricity as high-voltage alternating current to our buildings from overhead or underground. Transformers are periodically installed in the high-voltage system on utility poles, in boxes placed on the ground, or within buildings to serve branch circuits from main feeder lines. These transformers lower or raise voltages according to the building's needs.

Electrical service wiring enters a building through an electrical meter and a main disconnect switch that can interrupt power in an emergency or to service the system. From here, wiring is distributed throughout the building (Figure 11.14).

SERVICE PANELS, CIRCUITS, FUSES, AND BREAKERS Exterior electrical lines are connected to a distribution or service panel within the building. From this panel, wiring is fed to the various parts of the structure through separate circuits. These circuits serve equipment, the HVAC system, light fixtures, and other electrical convenience outlets. Each circuit is wired separately to the service panel to differentiate it from other circuits. Each circuit is designed and calculated with the proper size of conductors based on the anticipated loads that will be placed upon that circuit. Each is protected from overloading or short-circuiting by a fuse or a circuit breaker within that branch. These protection devices are rated in maximum amps to handle the attached electrical loads and to trip off or burn through when overloaded. The maximum circuit load in amps is determined by dividing the total wattages of devices on that circuit by the available current. For example, twenty-four 100-watt light bulbs placed on a 120-volt supply would require a minimum 20-amp circuit. The equation for this is amps equals watts divided by volts ($A = W \div V$), or 2,400 divided by 120 = 20 amps.

Electrical circuits that contain switches and convenience outlets in wet locations, such as bathrooms and outdoors, are termed ground fault interrupter circuits (GFIC). These contain very sensitive circuit breakers that trigger immediately to prevent electrical shock to people.

Panels, breakers, wiring, and all other electrical devices are strictly standardized and manufactured to specific codes. The National Electrical Code sets most local, state, and national requirements for electrical systems. When specifying electrical devices or lighting, the designer must be aware of the requirements of those codes that directly affect the equipment, such as clearances, finish coverings surrounding electrical devices, and the like.

Interior Wiring

Electricity is distributed through a building generally as a two- or three-wire system, although specialized currents, such as telephone and computer systems, can be carried with multi-wiring, or even fiber optics, or wireless. Wiring is sized in diameter according to (1) how much electricity it can safely carry at a maximum operating temperature and (2) the ability of the insulation to protect it.

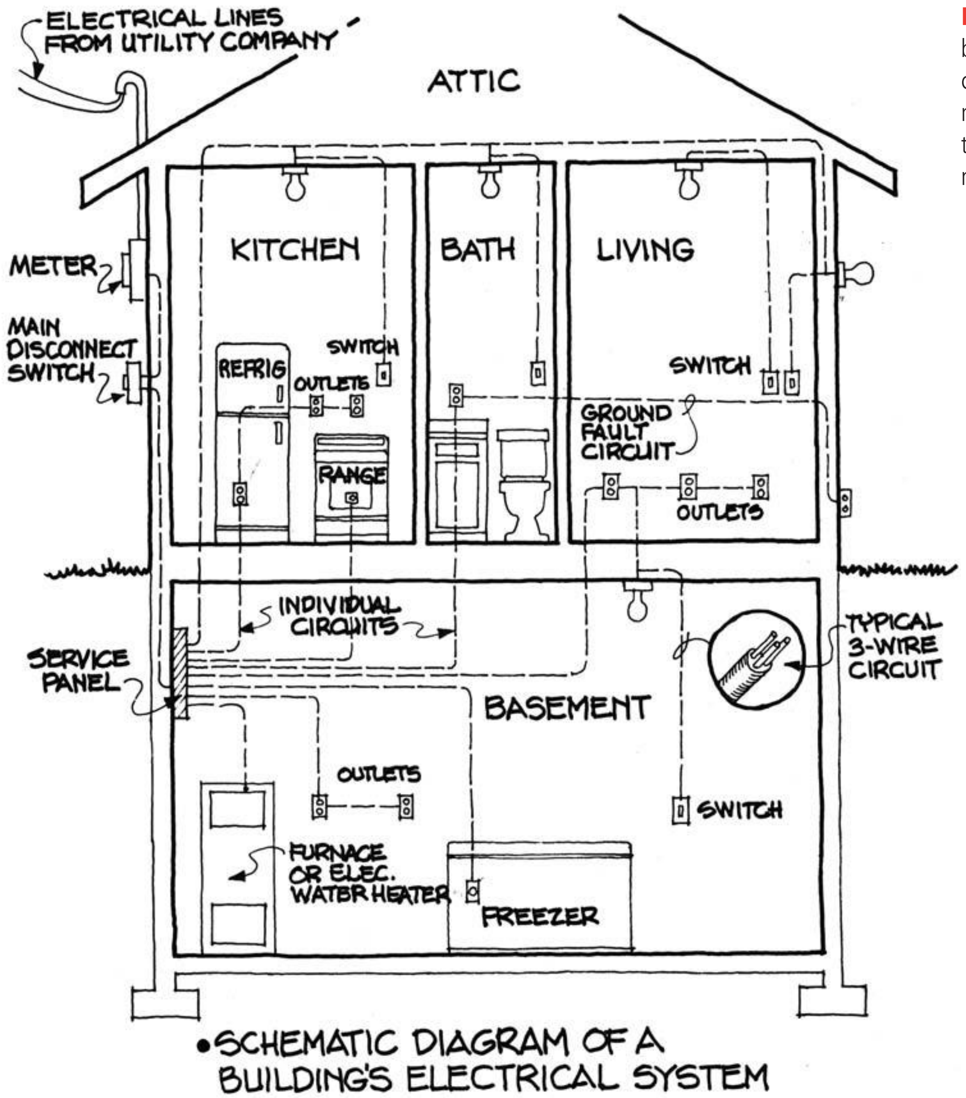

FIGURE 11.14 Electricity is delivered by wiring into a building and connected to a service panel. It is then routed in designated circuits throughout the structure for various needs.

Service wiring is distributed throughout a building in three forms: insulated wire (used mostly in walls of residential installations), insulated wire in closed feeders (metal conduits and underfloor raceways), and insulated wire in closed special feeders (such as premade metal conductors or other special types). The first example is commonly called Romex® cable, which is a nonmetallic sheathed cable consisting of two or more insulated (often with plastic coverings) wires, a conductor and a ground wire. All wires are then surrounded by a plastic jacket. In large commercial buildings and other areas specified in the building codes, nonflammable metal conduits are used to hold wiring runs to the various areas. These might be in the form of a flexible metal-clad hollow cable, called BX cable, or commonly called "flex" cable. These are conducive to use in remodel projects as the cable can be pulled through existing walls and spaces. The other metallic conduit is rigid cable or EMT. Wiring within commercial office furniture systems is another example of specialized wiring routed or concealed in raceways (Figure 11.15).

Wiring can be routed in a building through the walls, floor, or ceiling, according to the specifics of the system and the type of installation needed. Although wiring runs have been standardized over the years, computer and communication needs, energy conservation, and flexibility of use have created new wiring systems, such as low-voltage wiring and flat under-carpet systems (Figure 11.16). This system consists of factory-assembled flat cable that can be installed under carpet squares and connected to various outlets and other devices. Other forms of electrical wiring are being developed to interface with today's increasing technologies. These systems and "intelligent" networks coordinate the electrical systems in one computerized control package that can even be accessed by "smart" phones (Figure 11.17). In turn, these systems can be tied directly to fire alert, security, HVAC, appliances, and other monitoring devices to produce an interrelated "brain" that controls all these devices.

FIGURE 11.15 Some office furniture systems contain conduits or raceways for distributing electrical power, telephone, and computer wiring.

Image Courtesy of Herman Miller, Inc.

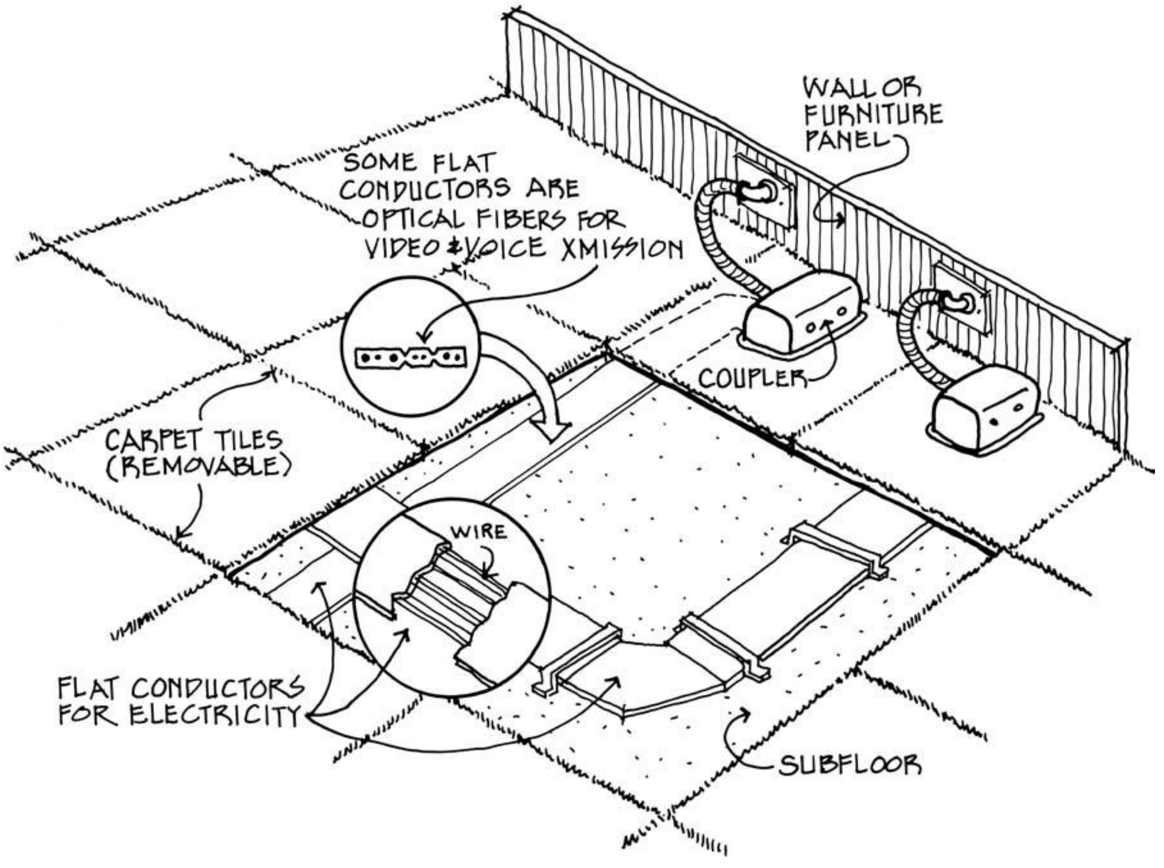

FIGURE 11.16 Example of electrical flat wire cable system as installed under carpeting

FIGURE 11.17 This personal device controls the lights and a number of other electrical devices in this small solar home, by Team California in the 2011 Solar Decathlon Competition.

Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

Electrical outlets and light switches are carefully located for the convenience and safety of the user. Light switches are generally located accessible to a room's door locations, giving the occupant the opportunity to switch the light on when entering or off when leaving. Or, the switch can be installed with an automatic sensor that detects when the space is occupied or not, and automatically turns the light on or off as needed.

Most residential electrical codes require that outlets be no more than 12 feet (3,657 mm) apart, measured along the floor line. Outlets are a standard 12 inches (305 mm) above the floor or 48 inches (1,219 mm) above cabinetry, although variances are used for special needs. Wall outlets above kitchen countertops are required to be installed so that no point along the wall is more than 2 feet (305 mm) from a receptacle. Commercial building locations of outlets range from floor level to ceiling level, depending on specific uses. However, in most cases, requirements are similar to those for residences.

Specialized Electrical and Communication Systems

A number of specialized electrical and communication systems other than the main power sources are used in a building. Although these systems require electricity to operate, they are often of a specialized electrical nature, independent of the primary electrical distribution. Some are permanently installed, such as emergency lighting, doorbells, and intercoms, but others can be unplugged and moved, such as telephones and computer connections.

Methods and equipment for communication are constantly changing. The expanding fields of electronics, fiber optics, light-wave technology, low-voltage circuits, and satellite links are creating whole new modes of communication. These are increasingly being handled in our buildings as a communication system that is networked with many of the other building support systems. Communication systems now utilize a variety of electronic devices connected by wire and satellite interfaces for teleconferencing and entertainment over great distances.

Traditional forms of paper flow and large storage files are being replaced with electronic media, decreasing the amounts of physical space necessary for storage and equipment. The interior designer is being called upon to assist in specifying and designing around these communication systems as they shape interiors and the human interface.

TELEPHONES AND INTERCOMS The telephone system normally enters a building as the electrical system does, but consists of an independent, low-voltage source. Specialized telephone wiring or fiber optics are placed throughout the structure, terminating in outlets (telephone jacks) where telephones can be plugged in, or in a special station device that allows cordless phones to be free of wiring by employing radio waves. In other instances, the phone can be combined with an intercom system, or an independent communication network can be installed in the building. More and more people are relying on cell phone systems instead of hardwired land-based lines.

COMPUTERS AND VIDEO Many computers and electronic video devices, such as televisions and video cameras, use their own independent network of electrical distribution by wire or wireless connection. These can be tied together within the building or tied into a global network by employing satellites or other transmission modes outside the building. These and the telephone system can combine with fax machines, computer modems, the Internet, and other teleconferencing equipment.

OTHER SYSTEMS A number of other specialized electrical systems can be found in a building. Security systems detect unauthorized entry, monitor a space, and/or sound an alarm when required. These systems can be in the form of hard-wired sensing devices or can use infrared and ultrasonic waves or light waves for their detection and operation.

Fire-alert electrical systems are composed of detection devices and an alarm device that emits a loud warning sound or calls the fire department. In turn, these can be linked with heat-sensing devices that emit an extinguishing agent, such as water, to contain a fire outbreak and are generally backed up with an emergency power supply in case of the disruption of the building's main power.

Water Use in Buildings

Water has been used abundantly and sometimes wastefully over the past decades because people took for granted its low cost and seemingly endless supply. Fortunately, growing concern for water conservation and water quality is helping to regulate this precious resource. Water usage can be reduced by specifying low-flow showerheads, sensor-activated faucets, low gallon per flush toilets and urinals, and more efficient clothes washers/dryers.

However, as the population increases and the need for more water arises, stress can be placed on the resources and systems that deliver potable, or drinkable, water. International and local programs are actively seeking alternatives. Just as in space technology, these studies are looking into ways of turning grey and waste water into pure water for drinking and domestic purposes. In some communities and rural areas, gray water from sinks, lavatories, showers, and dishwashers is being used to water lawns and for other practical purposes. The increased utilization of these alternative water systems will have a direct bearing on the current design of plumbing systems within buildings, as well as on the environment.

Water sources are classified as hard or soft, depending on the environment and the conditions of the soil from which the water is drawn. Dissolved impurities and minerals affect the quality and taste of the water, as well as the type of piping it is delivered through. Since hard water can cause low suds for washing and leave spots on drinking glasses, some buildings (particularly residences) incorporate water softener equipment to temper the water into a softer, or demineralized, state.

Water is used within a building for three basic functions: human or domestic use, sanitary drainage systems, and mechanical systems. Each has its own distribution system and governing codes.

Although the interior designer does not become directly involved in the design or repair of these systems, he or she must have a working knowledge of them for selecting fixtures or specifying locations for water use equipment in relation to plumbing walls. The designer is often called on for preliminary advice for remodeling or providing new kitchens, bathrooms, wet bars, and other water facilities. Consideration must also be given to the location of access doors, or access panels, and piping runs that need periodic adjustment, inspection, or repair. The interior designer seeks to make access to these devices an integral part of the design of the interior environment.

Cold and Hot Water Distribution

Water enters a building in large piping systems below ground and is piped throughout a building (Figure 11.18). Because of the depth of the pipe, to prevent freezing in cold climates, the water is usually cold or cool to the touch (53° to 70°F or 11.7° to 21°C). It is delivered at a pressure of about 40 to 50 pounds per square inch in most locations of the building. Since this pressure can diminish in tall buildings, the piping is augmented with additional

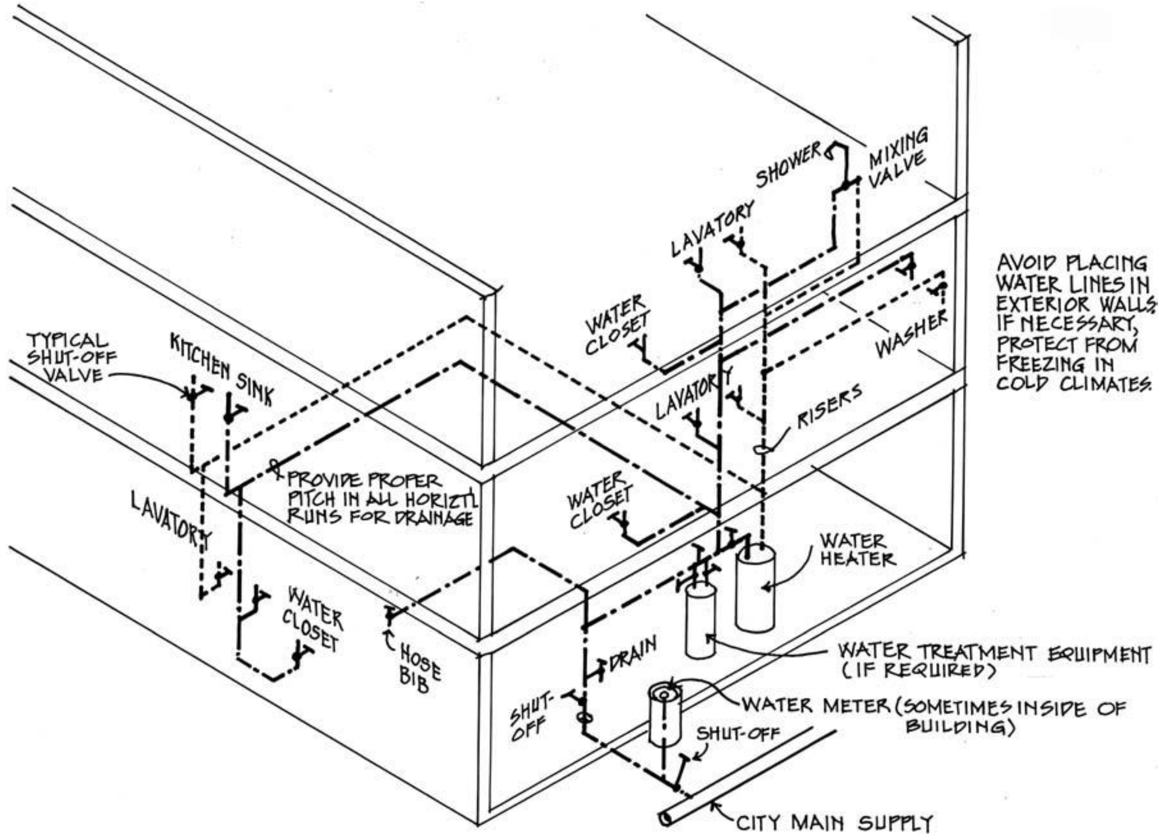

FIGURE 11.18 Schematic of a typical domestic water supply system in a building. The size of the piping is determined by the water pressure and flow required at each fixture.

pumps or piped to a large, separate tank high above the ground (for gravity-fed systems). Both a water meter and a shutoff valve are installed for each building.

Pipes are sized to ensure adequate pressure and quantity of water for the appropriate fixtures and equipment. Pipes are usually made of copper or plastic, depending upon the building codes. Piping is concealed within walls, above ceilings, or below the floor where possible, except when access or economics dictates exposed piping. An interior designer must have knowledge of which walls and columns contain plumbing when calling for a modification or locating a fixture that is not adjacent to these runs of piping. These locations are often called "wet walls" or "wet columns."

In humid climates, the cold water piping is sometimes wrapped with an insulation and vapor barrier to keep the pipe from sweating, which is caused by the condensation of the surrounding warm air when it comes in contact with the cold pipe. Insulation is used to keep the water at a cool temperature as it is delivered throughout the building.

Water heating is thought to be the second-largest demand for energy use in residences and up to the fourth in some commercial buildings. So, the installation of energy-efficient water-heating systems can save a substantial amount of energy and utility costs. Water is piped to a water heater before being delivered as hot water to the appropriate fixture in a separate piping system. To conserve heat, these pipes might also be wrapped with insulation. In some systems, small tankless water heaters (called *on-demand* or *point-of-use* preheaters) are added adjacent to the fixture location rather than using hot water piped from a central heater. This can be an economical method, depending on the amount and frequency of hot water needed, since long runs of piping and constant heating can be expensive. Water can also be heated through solar panels, or a water coil can be placed within a furnace system that can heat water as well as provide space heating.

DOMESTIC USE OF WATER Water systems that serve human functions, such as drinking, cooking, washing, and bathing, are termed *domestic* water systems. These usually include both the cold and hot water supplies, which are sanitized for human ingestion. Because each fixture that dispenses water has its own pressure requirements, the piping must be carefully sized to ensure a balance in the system and proper delivery at the outlet.

An average domestic system in a residence uses approximately 80 gallons per day per person, and a large hotel might use twice that per person because of a multitude of water requirements for cleaning, food preparation, and occupant use.

SANITARY DRAINAGE SYSTEMS A building's sanitary drainage system uses gravity piping to drain fluid wastes and water. Wastewater is discharged into a city collector system for treatment or into septic tanks in rural areas. Wastewater is classified as black water if carrying materials from body wastes, or as graywater if containing material from sinks, lavatories, showers, and washing machines. In most cases, one sanitary system collects both varieties of wastewater; however, in some rural areas the different types are handled separately, since the gray water might be used for outdoor watering needs.

Many buildings have storm drainage systems that rid the roof or other areas of heavy rainfall. These are fed into storm sewer drainage systems separate from the sanitary systems.

DRAINS AND VENTS The sanitary drainage system is composed of various types of drain piping, traps, and vents (Figure 11.19). The traps, vents, and vacuum breakers prevent gases and odors from decomposing materials from escaping into the occupied spaces as fluids and wastes are drained away. A trap is an integral part of a drain; it holds standing water in a way that forms a seal to prevent sewer gases from entering a room through a drain line. Venting of the gases into the atmosphere is provided through *soil* and *waste* stacks (vertical plumbing runs) that extend to the roof of the structure. Vacuum breakers and air gaps are installed at the fixtures to prevent any accidental and deadly cross-connection between the fresh-water and sewage systems. The plumbing system is composed of varying sizes of pipes that get larger where they connect to the main drain in order to handle the branching series of drains that feed them.

The designer may not be involved with the design, details, and intricacies of the sanitary plumbing systems, but he or she must be aware of their basic functions and space requirements. For example, if a sink is to be added on a wall, the designer should be aware of the location of the available drains and vents, in order to ascertain whether

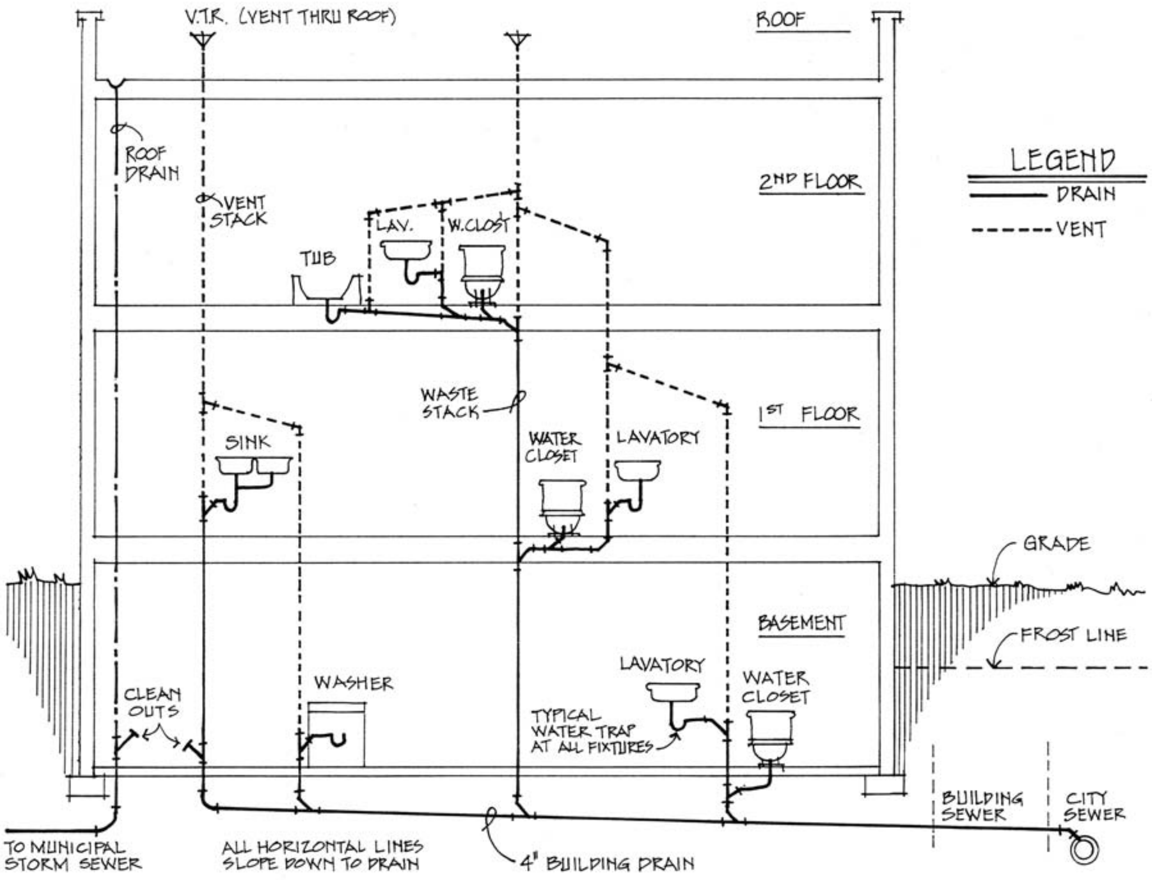

FIGURE 11.19 Sanitary drainage system showing vent and soil stacks. Note the separate storm water removal system.

the installation is possible. Since the drainage system is controlled primarily by gravity flow, piping runs and sizes must be designed with certain maximum limitations on distances and vertical drops. Plumbing walls are aligned vertically between floors, where possible, to keep the runs straight and to decrease costs by angling between floors. Fixtures are installed on common plumbing walls, where possible, to reduce the amount of piping needed to connect fixtures. Piping for drains and vents ranges in size from 1¼ inches (32 mm) to 4 inches (102 mm), which might require additional wall thicknesses to accommodate them.

Fire Detection and Protection Systems

As discussed in Chapter 10, fire protection is an important issue in the design, construction, and occupancy of buildings. Fire detection, alarm, and suppression are integral parts of the fire-safety systems in a building. Most structures use water as a fire extinguishing medium and distribute it through an independent system of pipes and sprinkler heads. Water is held in a pressurized state in the piping and released automatically to the interiors through a sprinkler head that detects a high temperature of 135°–160°F (57°–71°C). This system is commonly called a wet pipe system. There is also a dry standpipe system, which is filled when necessary by the fire department during an emergency. The International Building Code (IBC) provides trade-offs to encourage installing sprinkler systems in buildings. For example, in some unsprinklered buildings, corridors must have a 1-hour rating, but if the building is sprinklered, the corridor does not need to be rated.

The interior designer may not be directly involved with the mechanics of these systems, but he or she often has to design around them when placing light fixtures or deciding on ceiling treatments, finishes, and other items that must accommodate the sprinkler pattern system. Generally, the sprinkler system is drawn on the reflected ceiling plan and coordinated with architectural soffits, lighting fixtures, finishes, and other ceiling elements, as seen in Figure 11.2.

Mechanical Conveying Systems

Buildings sometimes contain mechanical conveying systems to move people and other objects vertically and horizontally from one level to another. Elevators, escalators, automated ramps, and dumbwaiters are powered by electrical or hydraulic means to move people or objects, depending on their functions.

Elevators and Escalators

Elevators and escalators are automated vertical transportation systems used as auxiliaries to stairways. Elevators might stop at each floor of a building or operate as a high-speed express to specific upper floors. These arrangements of low- and high-speed elevator groupings allow for more efficient transporting in very tall structures. Elevators can also be designated as passenger or freight elevators or a combination of the two. Elevator types, number, speed, size, and load-carrying capacity are dependent on the type of occupancy, amount of people/objects to be carried, speed needed, and vertical distance to be traveled. Elevators are either fully enclosed or have glass walls for view and emphasis. Designers are involved with the elevator cab finishes, call buttons, and lighting, as well as with lobby design if elevators are grouped.

Elevators are powered either by electrical motors and cables or by hydraulic piston lifts, depending on the height of the building and the speed required. Electrical types are used in tall buildings; hydraulic lifts are usually limited to about five stories due to the piston length and slower speeds. The equipment to run electric elevators is either in the basement or on the roof of a building. Hydraulic operating equipment is located in a pit or basement below the cab.

Elevators can be dangerous in case of a fire. Their operation is affected by smoke, flames, and excessive temperatures, which can cause stalling or opening to a burning floor. For these reasons, elevators are not classified as escape routes and must be backed up by stairways.

Another type of elevator is the dumbwaiter, a small cab used only for moving freight. Dumbwaiters can be electrically driven or manually driven, like the one Thomas Jefferson invented for Monticello. Dumbwaiters are often used for transporting food, dry goods, and soiled dishes in multilevel restaurants.

Escalators are power-driven moving staircases for passengers and can be strong design elements in a space (Figure 11.20). They can move large numbers of people between levels with a minimum waiting period, because they are in constant motion. These units are generally installed in pairs, one up and one down. Escalators are restricted in widths and runs, according to the various building codes, and must have stairways as a backup escape route in case of an electrical failure.

FIGURE 11.20 Escalators are primarily transportation devices but can be designed as exciting visual elements in a space.
Sean Pavone / Alamy

Moving Ramps and Sidewalks

Moving ramps are sometimes called moving sidewalks, people movers, or moving walkways. They can transport people and equipment efficiently and quickly either horizontally or on gradual inclines. The first example of an automated people mover was shown in the 1893 Exposition in Chicago, Illinois. Many examples of these can be seen in airports and large manufacturing plants.

Acoustics

Acoustics is an interdisciplinary field that deals with the introduction, transmission, reception, and manipulation of sound. The latter function can be controlling sound and/or enhancing it. Controlling acoustics is not usually perceived as a system, but floor or ceiling assemblies (Chapter 14) can be designed in such a manner that they will provide acoustical or sound blockage from floor to floor.

The interior designer is concerned with controlling sound in a space by eliminating (or reducing) unwanted noise and preserving (or enhancing) desirable noise. The designer becomes involved with acoustics in specifying finishes, furniture, equipment, and specially designed assemblies to control sound waves.

Air is the most common medium for sound waves, although they can also move through building materials. A sound wave is kinetic energy that radiates spherically from a vibration source until it hits an obstacle or surface. Sound waves are then absorbed or reflected, depending on the surface and density of the material. Generally, soft, porous materials absorb sound, and hard, rigid ones reflect it. Examples of absorbing materials include carpets, rugs, drapery, fabrics, and special products, such as acoustical ceiling tiles. Hard materials, such as wood floors, ceramic tile, glass, plastered walls, and brick, tend to reflect sound. However, thick, dense, and heavy materials also will tend to block sound from traveling through them.

To control unwanted sound, we can (1) isolate it at its source, (2) locate the source far away from the desired "quiet" environment, and (3) eliminate the paths of airborne or material-borne sound waves. The first method involves selecting quiet operational equipment or sources, which can be enhanced by using special isolator mountings and connections to reduce transmission of excessive noise, particularly from machinery. The second method deals with the design of the building and the separation of "loud" and "quiet" zones through basic planning of the building configurations. Closets and corridors can be used as sound buffers between zones of conflicting acoustics. The third method can be accomplished by selecting heavy, rigid materials to resist sound transmission or by reducing the continuity of the construction assembly. Generally, the greater the mass of a material (concrete, stone, brick, and so forth) that is impervious to air, the more the material serves as an effective sound barrier.

SOUND RATINGS The sound energy of a given source is represented by a number on the decibel (dB) system of measurement. This decibel scale is a logarithmic ratio of sound pressures. A jet airplane might generate 140 dBs, a lawnmower can produce 100 dBs, and a whisper can be about 10 dBs. Sound levels above 130 dBs can cause pain and discomfort, while those below 0 are beyond the threshold of hearing.

To help designers control unwanted sounds, various materials have been tested and rated with a noise reduction coefficient (NRC) (Figure 11.21). NRC is a scaled representation of the amount of sound energy absorbed as it strikes a particular material's surface. The higher the NRC rating, the more a material absorbs sound. An NRC of 1 equals a perfect absorption, and a rating of 0 indicates perfect reflection. For example, carpet (NRC of approximately 0.15 to 0.65, depending on its composition and the padding used) is more effective than a concrete floor (NRC of .05) in absorbing noise. However, the carpet NRC in this case is not as important as the fact that carpet reduces noise at the source—a chair scraping or shoe soles clicking. When the sound absorption coefficient of a material exceeds 0.5, it is generally considered an effective sound absorber. Although the NRC is being replaced by the sound absorption average (SAA), many manufacturers continue to use the NRC system.

Sound transmission from one space to another can be controlled by using a particular building assembly (walls, floor, ceilings, or partitions) to prevent the transfer of the noise. Various assemblies have been designed, tested, and rated for their ability to prevent noise transfer. They are assigned an STC (sound transmission class) rating according to their individual composition of materials and construction (Figure 11.22). The higher the STC, the greater the ability of a material or construction assembly to isolate sound. Outside the United States, a sound reduction index (SRI) is used, which is similar to the STC, but results in different numerical results.

For example, a typical wood stud wall with ½-inch (25-mm) gypsum board on both sides produces an approximate SC rating of 33. This assembly does not offer a large degree of sound privacy. Extra layers of gypsum panels can be added to increase the STC rating, but this is not as effective as isolating the panels from each other with resilient steel channels, staggered wood studs, or a double stud wall. In other words, doubling the mass of the gypsum panels (more layers) does not double the STC rating.

FIGURE 11.21 Various building materials and components have been tested and assigned NRC ratings to assist in selection for acoustical control.

NOISE REDUCTION COEFFICIENTS (NRC) OF VARIOUS MATERIALS*	
Marble or glazed tile	0
Concrete, brick, concrete block	.05
Glass, heavy plate	.05
Gypsum board, ½ inch thick	.05
Wood flooring	.10
Fabric, light	.15
Plywood paneling, ⅞ inch thick	.15
Carpet, heavy	.45
Carpet, heavy on pad	.55
Heavy drapes	.60
Ceiling, acoustical	up to .90

*An NRC rating of a material (.00 to 1.00) indicates the effectiveness of it to absorb sound. Material with a .90 rating or higher is a very efficient absorber, 0.5 and above is effective, and lower than .05 reflects sound back to the space.

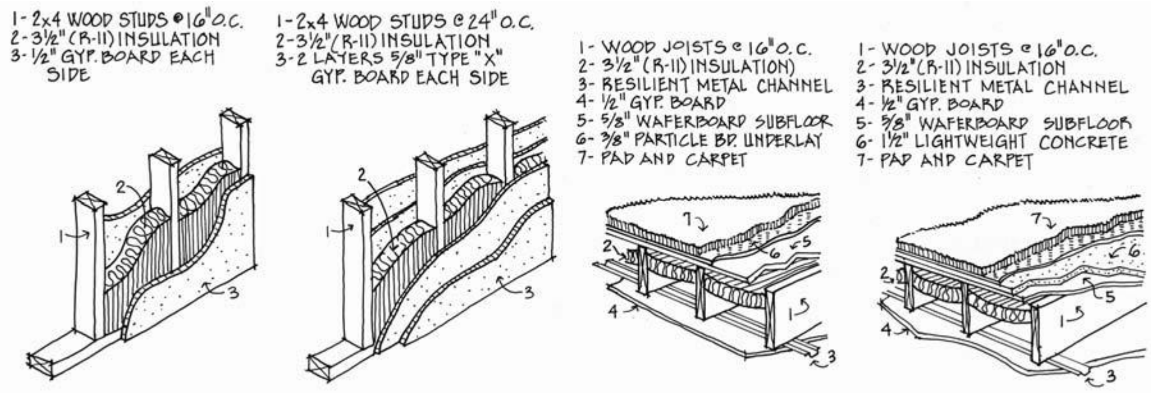

FIGURE 11.22 Manufacturers publish sound transmission class (STC) ratings and drawings of their products as used in various building construction assemblies.

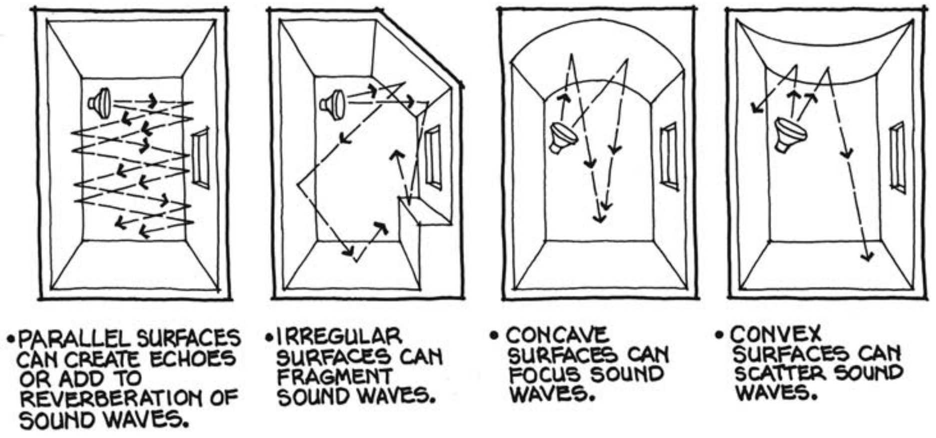

FIGURE 11.23 The shape of reflective surfaces in an interior space will direct sound waves in a number of different directions.

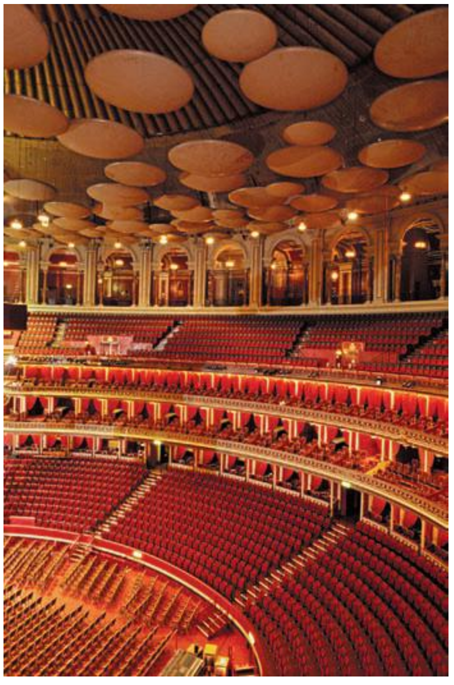

FIGURE 11.24 The interior of the Royal Albert Hall in London features large saucers that are installed near the ceiling to improve acoustics of performances and to combat echo problems.
Lebrecht Music and Arts Photo Library/Alamy

Acoustical problems or desirabilities can be caused by the shape of an interior space (Figure 11.23). The principles of size and shape of space can be combined with materials and assemblies to achieve "good" acoustical control. Architects, interior designers, and acoustical consultants work together in theaters, ballrooms, concert halls, and large meeting rooms to produce environments that manipulate sound for better results (Figure 11.24). In some installations where sound amplification is needed, an assortment of microphones, electrical amplifiers, and other electronic equipment to boost, filter, and direct the sound is used. Movie theaters, large lecture halls, and spaces for musical performances use these devices to help the ear appreciate the level and quality of sound.

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Lighting for Interiors 12

Light brings interiors to life and is important to our activities and perception of the world around us. By controlling and designing with natural and artificial light, the interior designer can create striking design concepts in interior spaces and provide for the visual needs of user activities.

Light is important as a form of art and design. It is similar to the other basic design elements of space, line, form, color, and texture, since it stimulates our perception of these elements. Light not only guides our seeing for visual tasks but affects our behavior and attitudes. Lighting contrasts of brightness and darkness can create dramatic effects and emphasize certain characteristics within a space or on objects (Figure 12.1). Bright light is stimulating, and low levels of illumination can be quieting and soothing. Warm-colored light tends to be cheerful, and cool-colored light, restful.

Lighting design is a combination of an applied science and an applied art. It is necessary, then, to discuss its scientific properties as well as its aesthetic qualities in order to understand how light can be manipulated within an interior space.

Light is a form of energy, a special segment within a range of electromagnetic energy capable of stimulating receptors in the eye that permit vision. This range is called visible energy (Figure 12.2). Light and vision are dependent upon each other, since one cannot see if there is no light. Light is not visible by itself, but light falling on an object or color makes that object or color visible. The appearance, definition, and character of objects and spaces are greatly affected by the kind of light that makes them visible. When it strikes an object, light may be reflected, absorbed, or allowed to pass through, depending on the degree of transparency or opacity in the material and on its surface qualities. For example, light reflected from smooth surfaces, such as polished metal, is bright and sharp, compared to light reflected from dull surfaces, such as brick, that produce more diffuse light. The shape of objects can also be emphasized or subordinated according to the strength and direction of the light source—sharp and bright or dull and diffuse.

Good lighting design also incorporates the conservation of energy by utilizing more efficient lamps and fixtures in combination with switching controls and systematic maintenance programs. The interior designer can make a difference by educating clients about energy efficiency and conservation. Numerous options are available to reduce energy demands without sacrificing the quality of light within an interior space.

The designer needs to understand the different kinds of light available and how to control them efficiently. To do this, he or she should study the luminous environment, which can be divided into two categories, natural light and artificial light.

FIGURE 12.1 This showroom uses dramatic lighting effects and forms to create a striking interior and image for their products.
Courtesy of Knoll, Inc.; Photographer: Eric Laignel.

NATURAL LIGHT

Our primary source of natural light is the sun. People derive great physical and psychological pleasure from sunlight, since it is our principal source of vitamin D and full-spectrum light. Sunlight contains all visible wavelengths of radiant energy plus invisible infrared (heat) and ultraviolet wavelengths. Some research has proposed that a wide variety of health problems are linked to the lack of full-spectrum light and the absence of ultraviolet light in some artificial light sources.

There has been a renewed interest in harnessing natural light. Daylight is viewed as a free source of light, offsetting escalating energy costs and health concerns. Learning to control free light is important, since it generally is

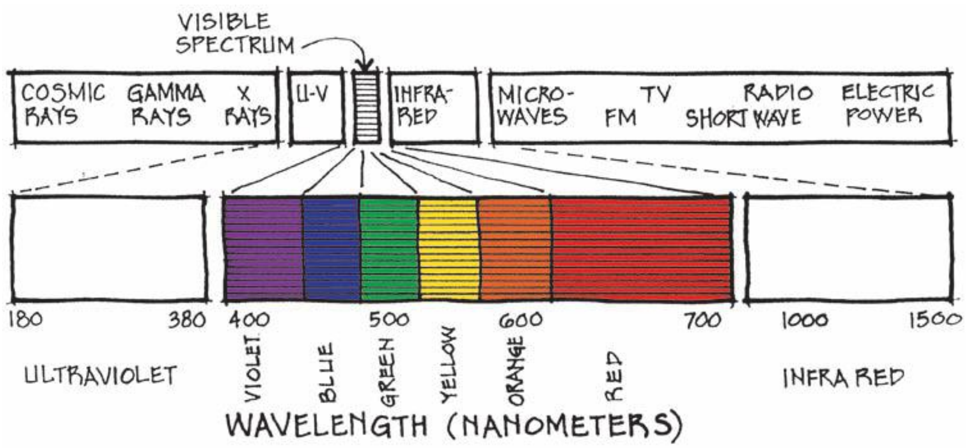


FIGURE 12.2 The visible energy of the electromagnetic spectrum lies between 380 and 780 nanometers.

accompanied by excessive heat and glare. Discomfort within an interior space can be caused by too much heat or glare due to excessive contrast. Direct sunlight can also cause interior fabrics and materials to deteriorate and colors to fade. Designing with daylight means controlling the admission of natural light into a space. With good lighting design, utilizing daylight can eliminate electric light and conserve energy.

Another form of natural light is combustion light, which can be produced from gas lights, fireplaces, and candles. However, gas lighting has almost become obsolete, except for decorative purposes. The flickering flames from candles and fireplaces can be used to create low-lit atmospheres, particularly in restaurants and residences.

Controlling Daylight

Daylight offers significant energy saving by offsetting the electric lighting load, when it is designed for properly and integrated with the electric lighting system. Studies have shown that daylight improves occupant comfort and satisfaction within an interior space. Research has been conducted that shows a connection between daylight and improvements in productivity and health in schools, offices, and healthcare facilities. Having daylight available in healthcare facilities can improve patient recovery when a connection to the natural environment is provided.

In order to control daylight, it is first necessary to understand the pattern of the sun's movement, which is related to the time of day and year and to the latitude of the observer. In the summer in northern latitudes, the sun comes up toward the northeast and arcs high in the sky, setting in the northwest. Days are longer, and there is a greater amount of daylight available in the summer months than in the winter. The winter sun rises south-southeast, is low in the sky, and appears to set quickly in the south-southwest. By understanding these solar principles, a designer can utilize maximum penetration of daylight and heat into the interiors during the winter season and constrict it in the summer (Figure 12.3).

The quality of daylight is also affected by its compass direction. North light is generally a cool and consistent light that casts few shadows, making it desirable for artists' studios. East light is strong and bright in the morning but becomes less brilliant and more neutral as the day progresses. South light is generally the most favorable in terms of brightness, pleasantness, and control. It is more consistent throughout the day but may need to be controlled during the summer months. West light is usually very strong in the late summer afternoons; from the exterior it can be controlled by plants, awnings, or trellises, and in the interior it can be moderated by window treatments or filtered by tinted glass. Careful planning and control of sunlight is the basis for the design of solar energy buildings that optimally capture or repel the sun's energy.

One of the main ways to maximize daylight is to manipulate it to penetrate deeply into an interior space, which can be accomplished by various types and placements of windows and skylights, as illustrated in Figure 12.4.

Other strategies are to use light colors as reflectors. Putting a high-reflectance, matte white finish on ceilings and walls will cause the window's light to be reflected and distributed more evenly and deeply into the interiors. Another interior element that can be used is a light shelf. A light shelf is a horizontal, light-reflecting overhang placed above eye level, with a transom window placed above. Light shelves are most effective when placed over south-facing windows, because the ceiling is the most light-reflecting surface; the light shelf bounces the daylight deep into the room.

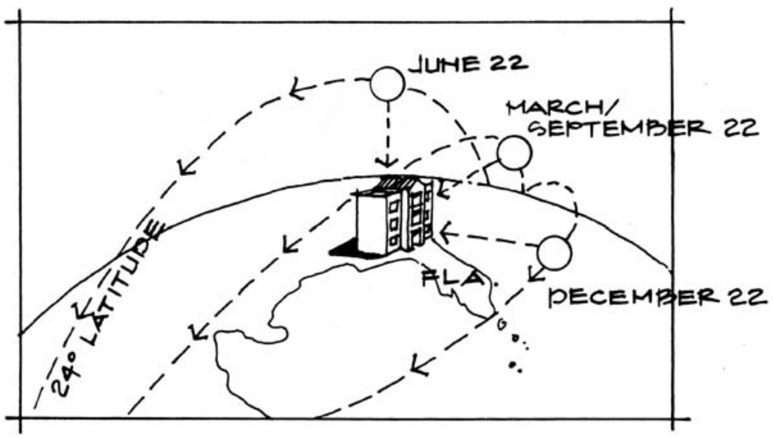


FIGURE 12.3 Most south-facing windows in the northern part of the United States will receive a deeper penetration of sunlight than this southernmost location in Florida.

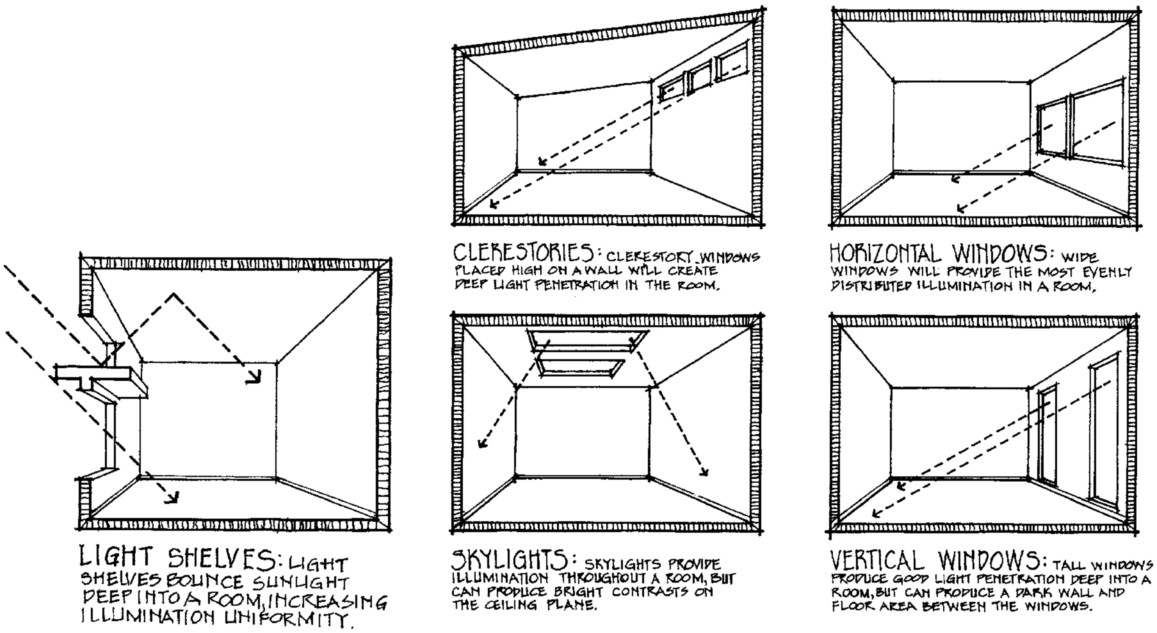


FIGURE 12.4 These diagrams illustrate how different sizes and shapes of windows can control the amount of light that enters an interior space.

ARTIFICIAL LIGHT

Artificial light is generally associated with electric light. In the 1800s, several inventors developed incandescent lamps, but the first to use a high-resistance carbon filament vacuum was Thomas Alva Edison, in 1880. Since that time, a wide variety of electric light sources and lighting systems have been developed. When well planned, artificial illumination enables us to see at night, helps prevent accidents, and contributes to the overall character and mood of an interior space. Artificial light is extremely important to the interior designer, since it affects the brightness, placement, color, and quantity and quality of the light in an interior environment. Varying the light can change the mood of a space from intimate to formal, as well as visually expand or shrink a space. Objects or areas within an interior can be highlighted or deemphasized with the placement and quantity of light.

When lighting is designed in relation to the architecture, activities, furnishings, and people in a space, it can become dynamic. Theaters have long used artificial lighting as a mood setter for dramatic productions. Techniques such as dimming and increasing light, using footlights and colored lights, and providing differing degrees of sharpness and diffusion to focus attention where it is needed create exciting lighting effects. These techniques can also be used within many other types of interior environments.

The Measurement of Light

To effectively design with light, the designer must understand some of the basic principles and terminology used in measuring light. There are four basic units of measurement for light: footcandles, footlamberts, lumens, and candelas.

Footcandles

The amount of light falling on a surface is measured in footcandles (fc), the basic unit of illumination. One footcandle is equal to the amount of light falling on one square foot of surface one foot away from a candle flame. Footcandles can be measured by a standard light meter. The actual illumination level (amount of footcandles) that should be provided within a space depends on (1) the age of a worker/user (as the eye ages, it requires more light for visual tasks), (2) the importance of the task (how critical speed and accuracy of seeing are), and (3) the difficulty of the task (what the size and contrast of the details are).

FIGURE 12.5 Recommended light levels for various activities

Type of Activity	Ranges of Illuminances in Footcandles, Depending on the Age of Occupants
Public spaces with dark surroundings, very low activity	2–5
Simple orientation for short temporary visits, such as corridors	3–12
Working spaces where visual tasks are only occasionally performed, such as lobbies or dining	10–20
Performance of visual tasks of high contrast or large size; general office work and retail	20–50
Performance of visual tasks of low contrast or very small size	50–200
Performance of very special visual tasks of extremely low contrast and small size, such as in healthcare, industrial, or sports facilities	150–600

For example, in interior spaces where visual tasks are only occasionally performed, such as lobbies, reception areas, corridors, stairs, or washrooms, only 10 to 20 footcandles would be necessary. However, in areas that require performance of visual tasks of low contrast or very small size, such as reading poorly printed matter, 50 to 200 footcandles might be necessary. Figure 12.5 lists some recommended footcandle levels for various activities within interior spaces.

The Illuminating Engineering Society of North America (IESNA) has developed more extensive recommended footcandle levels needed for many standard seeing tasks, activities, and general illumination of spaces. They have based their recommendations on three various ages of observers, such as (1) less than 25 years old, (2) 25 to 65 years old, and (3) over 65 years old. More complete data are available from the Illuminating Engineering Society of North America's (IESNA) handbooks, or at www.ies.org/store.

Footlamberts

A footlambert (fL) is the basic unit of measurement for brightness or luminance; that is, it measures the amount of light reflected from a surface. Since the majority of what we see is due to reflected light from surfaces in a space, footlamberts reveal the nature of the space and objects within it. The amount of light leaving any surface is a product of the footcandles reaching the surface multiplied by the percentage of light reflected by it (fL = fc × % reflectance). For example, if 100 footcandles reach a surface and the surface is painted with an 80 percent reflective color, 80 footlamberts will be reflected from the surface (fL = 100 × .80, which equals 80 footlamberts). To find the percentage of reflectance of a surface, divide footlamberts by footcandles. For example, if 80 footcandles reach a surface and 40 footlamberts are reflected from it, the reflectance value will be 50 percent (40 fL ÷ 80 fc = .50, or 50 percent).

Brightness ratios or luminance relationships in the visual field of a person performing a task are important for efficiency, comfort, and safety. The visual field for a task consists of three zones: Zone one is the precise area in focus or the task itself (such as a printed page), zone two is the area immediately surrounding the task (such as the top of a desk or a work surface), and zone three is the general surrounding area (the walls and floor). For an effective lighting design, the designer should follow the optimum contrast ratios between these zones. Optimum comfort is achieved when the task is only slightly lighter than the surfaces that immediately surround it (zone 2). Zone 3 should be no more than five times, and no less than one-fifth, as bright as zone 1. The longer the task takes to complete, the more critical this luminance relationship becomes. In spaces where critical visual tasks are never performed, higher brightness ratios are acceptable. The percentage of reflectance of major surfaces in a space is important in achieving desirable luminance ratios. See Figure 12.6 for recommended surface reflectances.

Lumens

Lumens are the amount of light output produced by a lamp or light source; lamp manufacturers rate their lamps in lumens. Lumens are also used to determine the efficacy, or efficiency, of a light source. Efficacy is equal to the number of lumens of light produced per watt of electricity consumed; the higher the number the better. To determine the efficacy of a lamp, divide the lumens by the watts. For example, a standard 60 watt incandescent lamp,

FIGURE 12.6 Recommended room surface reflectances

IMPORTANCE OF SURFACE REFLECTANCE	
The right room surface reflectances are essential to obtain the brightness relationships required for visual comfort. These are the recommendations for various surfaces:	
SURFACE	**REFLECTANCES**
CEILING	.70 TO .50
WALLS	.40 TO .60
FURNITURE TOPS	.25 TO .45
OFFICE MACHINES & EQUIPMENT	.25 TO .45
FLOORS	.20 TO .40

which produces 680 lumens of light, has an efficacy of about 11 lumens per watt. By contrast, a 13 watt compact fluorescent twister lamp produces 900 lumens, which would have an efficacy of 69 lumens per watt—more than six times more. Since fluorescent lamps produce more light than incandescent lamps of the same wattage, the fluorescent lamps would have a higher efficacy.

Candelas

The candela measures candlepower, the luminous intensity of a light source or fixture in a particular direction. The candlepower measurement is the footcandle reading that describes how intense the light output will be at a certain point. A candlepower distribution curve is a graphic representation of the shape and direction of the light coming from a light source or fixture (see Figure 12.7). The candlepower distribution curve can be used to estimate how much light from a lamp or fixture will arrive at a specific location.

To carry out a good lighting design, it is important to understand the pattern and orientation of the beam spread. This information is critical for delivering brightness to specific surfaces and objects within an interior space. Distribution curves are available from lamp and fixture manufacturers. However, beam spreads can be categorized into seven general groups that describe the light distribution and direction of a light source or fixture (Figure 12.8).

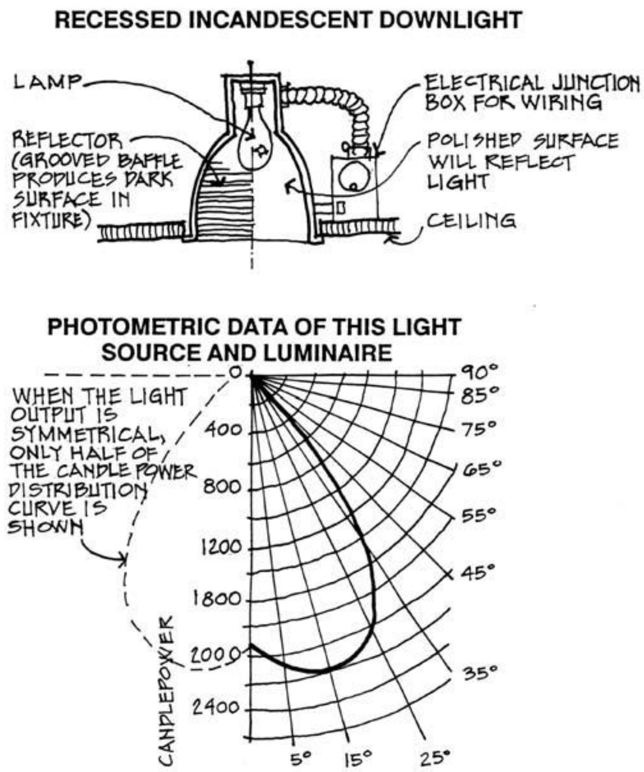
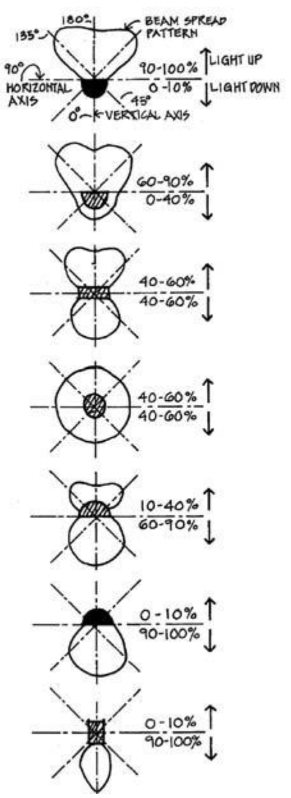


FIGURE 12.7 An example of a light distribution curve for a lamp and luminaire



TYPE	LIGHT DISTRIBUTION	CHARACTERISTICS
INDIRECT	90-100% ↑ 0-10% ↓	Most light output is directed upward to ceiling. Can prevent dark ceilings and create feeling of height.
SEMI-INDIRECT	60-90% ↑ 0-40% ↓	Although most light is directed upward, a translucent luminaire can direct some downward, softening shadows.
DIRECT-INDIRECT	40-60% ↑ 40-60% ↓	Light output is approximately equal to the ceiling and floor, with little to the sides. Direct glare is reduced.
DIFFUSE	40-60% ↑ 40-60% ↓	Equal light is provided in all directions. Diffuse enclosures can prevent direct glare.
SEMI-DIRECT	10-40% ↑ 60-90% ↓	A small amount of light output is directed upward, softening shadows from direct light downward.
DIRECT WIDE BEAM	0-10% ↑ 90-100% ↓	Direct light can be used for emphasis by highlighting. Some background illumination on surfaces such as walls, ceilings, and other planes can prevent high brightness ratios.
NARROW BEAM	0-10% ↑ 90-100% ↓	

FIGURE 12.8 This chart shows various lamp and luminaire beam spread patterns and the percentages of light directed towards the ceiling or floor.

ARTIFICIAL LIGHT SOURCES

Before a designer can plan an effective lighting design, he or she must understand what kind of light sources are available. There are three main sources of electric light: incandescent lamps, electric or gaseous-discharge lamps, and solid-state lamps. "Lamp" is the correct term for what is commonly called the light bulb. The bulb is the actual housing or enclosure of the filament and gases. Lamps come in a wide variety of types, sizes, shapes, and colors. They are designed for an equally wide variety of purposes and effects. For the designer to select the correct lamp for a given situation, he or she must consider energy consumption, efficiency, length of life/hours expected, quantity of light produced, and qualitative factors such as color and brightness. Functional, decorative, or psychological effects must also be considered. Because the two categories of light sources produce light in such different ways, the properties of each will be discussed individually.

Incandescent Lamps

In the incandescent lamp, light is produced by heating a material (usually metal) to a temperature at which it glows. Most incandescent lamps have a tungsten filament or other material vacuum-sealed in a glass bulb that becomes hot and intensely bright when electricity is passed through it. See Figure 12.9 for a diagram of a typical incandescent lamp.

The glass enclosure, generally made of common lime glass, comes in a variety of shapes and is identified by a letter (Figure 12.10). A number following the letter indicates the size or maximum diameter of the lamp. To determine the diameter of the bulb in inches, the number is divided by eight. For example, a lamp designated by A-21 indicates a standard bulb shape with a maximum diameter of 2⅛ or 2⅝ inches. A PAR-38 would be a parabolic aluminized reflector lamp with a maximum diameter of 38/8 or 4¾ inches.

The finish of the glass bulb determines the brightness and appearance of the light produced. Standard lamps are generally available in clear or frosted finishes. In clear lamps, the light is intense and bright, and the filament is visible. Frosted lamps (also known as soft white) are coated on the inside with a silica powder that diffuses the

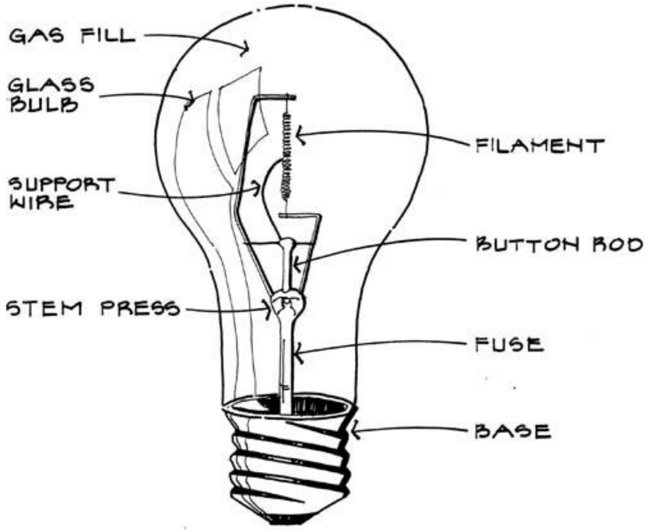


FIGURE 12.9 Typical parts of an incandescent lamp

intense brightness, giving the appearance of a uniformly illuminated bulb. However, light output from a frosted bulb is approximately 1 percent less than that from clear bulbs.

Since incandescent lamps are the oldest and most familiar, they have been the preferred source. They produce a warm light, similar to sunlight, since they consist of a continuous spectrum that includes all colors of light to form white. However, this white light contains more red and yellow wavelengths, and less blue and green, than daylight. Because this warm light tends to be flattering to human skin, suggesting feelings of comfort and warmth, incandescent lamps are preferred for makeup mirrors and most home environments.

Incandescent lamps are also a point or near-point source, tending to form bright highlights and cast sharp shadows useful to emphasize objects, textures, shapes, and forms. The variety of wattages available and the ability to dim incandescent light make it easy to control its quality and quantity.

Generally, incandescent lamps and fixtures cost less than fluorescent lamps. However, they have a low efficacy factor in terms of producing light related to the amount of energy consumed. Because their light is produced by heat, a considerable amount of heat is transferred to the air and can create extra loads on air-conditioning and energy consumption demands during warmer seasons. Incandescent lamps have a short life expectancy (750–1,000 hours), and exposed lamps can provide an uncomfortable source of glare. Because the incandescent lamp has such a low efficacy in terms of energy consumption, the Energy Independence and Security Act (EISA) of 2007 has demanded that they be more energy efficient. This act is intended to move the United States toward a higher level of energy efficiency and security nationwide, and it includes changes to the performance of our cars, appliances, and, now, light bulbs. The goal of the EISA legislation is for every light bulb, including incandescent, to convert a substantial portion of electricity into visible light. At the time of this writing, the traditional incandescent lamp only converts about 1/10 of incoming energy into visible light; the rest is emitted as heat. This law targeted 100 watt incandescent lamps first, requiring them to use 27 percent less energy while remaining approximately as bright. Therefore, 72 watt incandescent lamps will be listed as "100 watt equivalents." The ordinary 75 watt lamps will begin to phase out in 2013, with the 40 watt and 60 watt lamps phasing out in 2014.

Incandescent lamps are rarely used in large offices, factories, or other large buildings for uniform lighting because they require large amounts of electricity and have a short life expectancy. However, because of their point-source characteristics, they are used in retail establishments, where the light is attractive for the merchandise and can be used to highlight displays. In restaurants, the warm light makes the food more appetizing and flatters people's complexions.

Incandescent lamps can be divided into two basic groups: the standard incandescent and the halogen lamps. Standard incandescent lamps use nitrogen or argon gas and operate on 120 volts. These lamps can be general service, rough service, silver or white bowl, or a complete optical system with built-in reflectors. Examples of the latter include the elliptical reflector (ER), reflector (R), and parabolic reflector (PAR).

Halogen lamps use halogen gas and are the next generation of incandescent lamps. They may be operated at regular voltage (120 volts) or low voltage (12 volts), which requires a transformer. Halogen light is whiter than

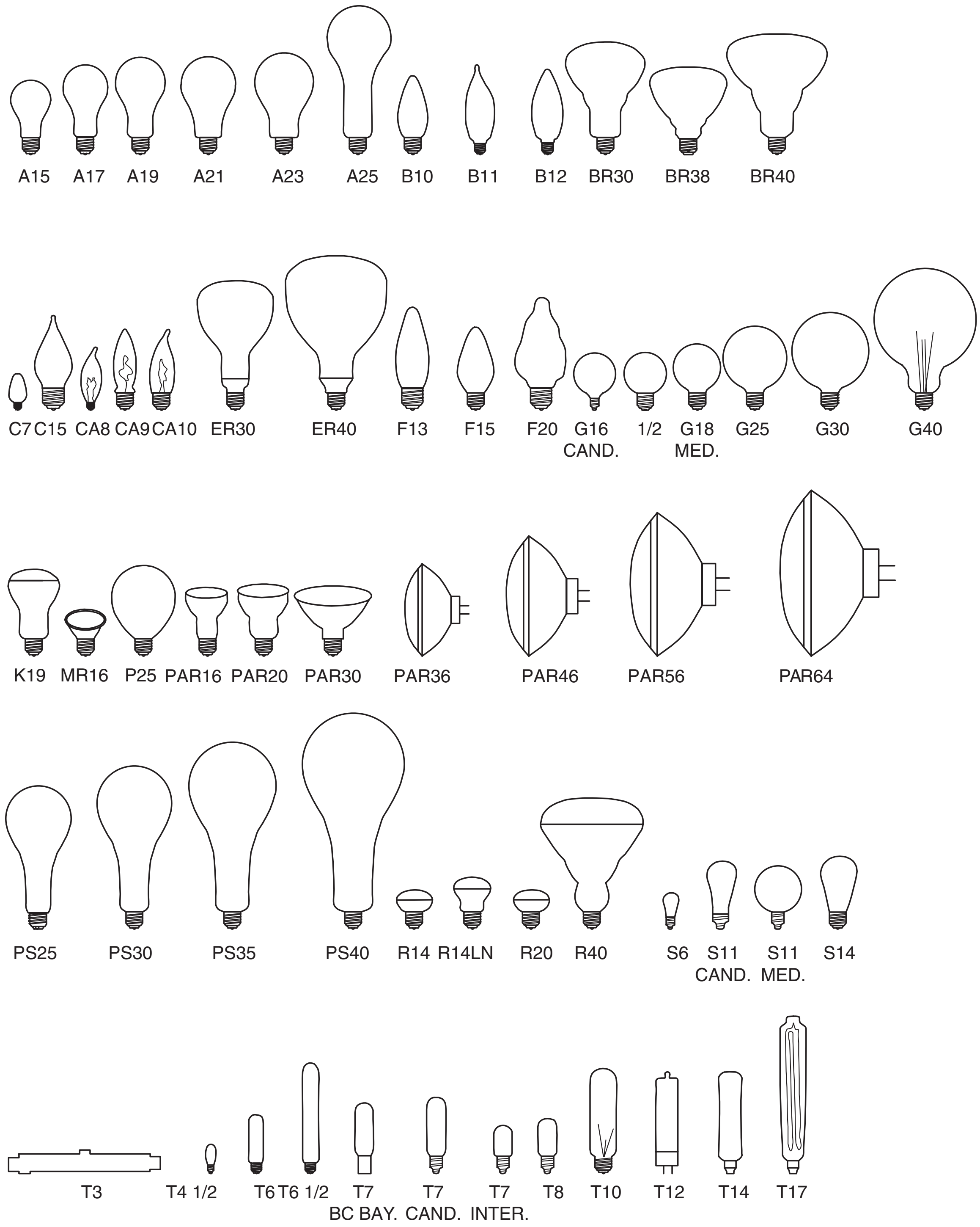


FIGURE 12.10 Lamps are available in a variety of styles to serve various functions. The size and shape of a bulb (not actual sizes) is designated by a letter or letters followed by a number. The letter indicates the shape of the bulb, while the number indicates the diameter of the bulb in eighths of an inch.

standard incandescent light because of the halogen gas, which makes it burn at a very high temperature. The halogen gas reacts with the tungsten filament to regenerate itself so that it doesn't burn out as fast as a standard incandescent lamp.

It is not possible to cover all the many different types of incandescent lamps available within the scope of this book. However, a few warrant mentioning in detail, and Figure 12.11 lists the most common types and their characteristics.

FIGURE 12.11 Most common types of incandescent lamps and their characteristics

TYPE	WATTAGE	CHARACTERISTICS
STANDARD		
A and PS	15–300	General-service lamps are available with clear or frosted bulbs. These are the most economical incandescent lamps but not as energy efficient as compact fluorescent lamps (CLF) or LED lamps.
BR, ER, R, PAR	15–500	Bulged reflector (BR), Elliptical reflector (ER), reflector (R), and parabolic reflector (PAR) lamps are manufactured with built-in reflectors to better direct light. They are available in a wide variety of beam spreads for different lighting purposes. The wide-beam or flood lamps provide a more uniform light without producing "hot spots"; these are suitable for general or wall-washing purposes. Spot lamps have narrow beam patterns and are primarily used to highlight a specific object or to concentrate light. Generally, PAR lamps have a more precise control of light than the R or ER lamps. The ER lamp is more efficient than the R lamp since a great amount of light emitted by the R lamp is trapped inside the luminaire. These lamps cost three to four times more than general-service lamps of the same wattage.
TUBULAR	6–750	Tubular lamps are long and cylindrical. They also are available in the "showcase" model with a single screw base at one end, or in the "lumiline" model that has one disk at each end. Tubular lamps are available in various lengths and diameters. The lumiline is similar to a small fluorescent lamp and can be used where linear light sources are needed.
LOW-VOLTAGE	11–75	Low-voltage lamps are designed to operate at 12 volts rather than the standard 120 volts. They use a much smaller filament that offers superior light control, longer life, and somewhat higher amounts of light per watt. Low-voltage MR and PAR lamps are very small and can project a "pin spot" of a brilliant and very precise light at a great distance. They are excellent for display lighting, downlighting, and spotlighting. They generate less heat than standard incandescent lamps, but require a transformer to step down standard voltage.

Electric Discharge Sources

Electric or gaseous discharge lamps produce light by passing an electric current or arc through a gas vapor sealed in a glass tube. These lamps are filled with different kinds of gases and are kept at either a low or a high pressure. The type of light produced is "cold" or "luminescent," meaning not produced by heat. All these types of lamps require a ballast, which regulates the amount of current used and provides the proper starting voltage. This ballast is generally installed between the power line and the lamp. The most common types of electric discharge lamps used in interior environments are fluorescent, high-intensity discharge (HID), and neon.

Fluorescent Lamps

Fluorescent lamps were developed in the 1930s and are the most popular of the low-pressure electric discharge lamps. They became popular very rapidly because they had a much higher efficacy in terms of light output in relation to energy consumed than did the incandescent lamp. Fluorescent lamps are economical for use in large offices, factories, schoolrooms, and other areas where low operating costs are important.

The typical fluorescent lamp (Figure 12.12) is a long glass tube filled with vaporized mercury and argon gases under low pressure. When electric current activates the gases, invisible ultraviolet light is produced. So that the invisible light rays can become visible, the inside of the tube is coated with phosphors that fluoresce, or transform the ultraviolet rays into visible light.

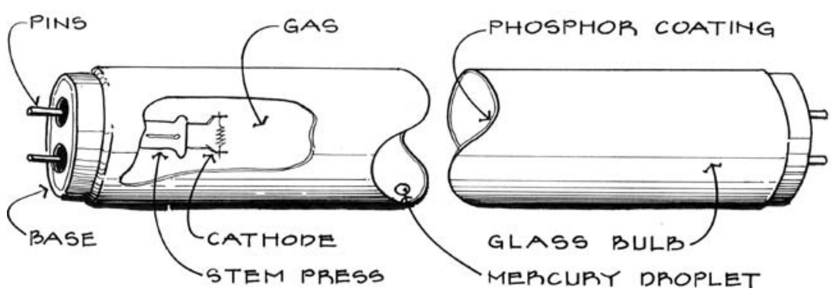


FIGURE 12.12 Typical components of a fluorescent lamp.

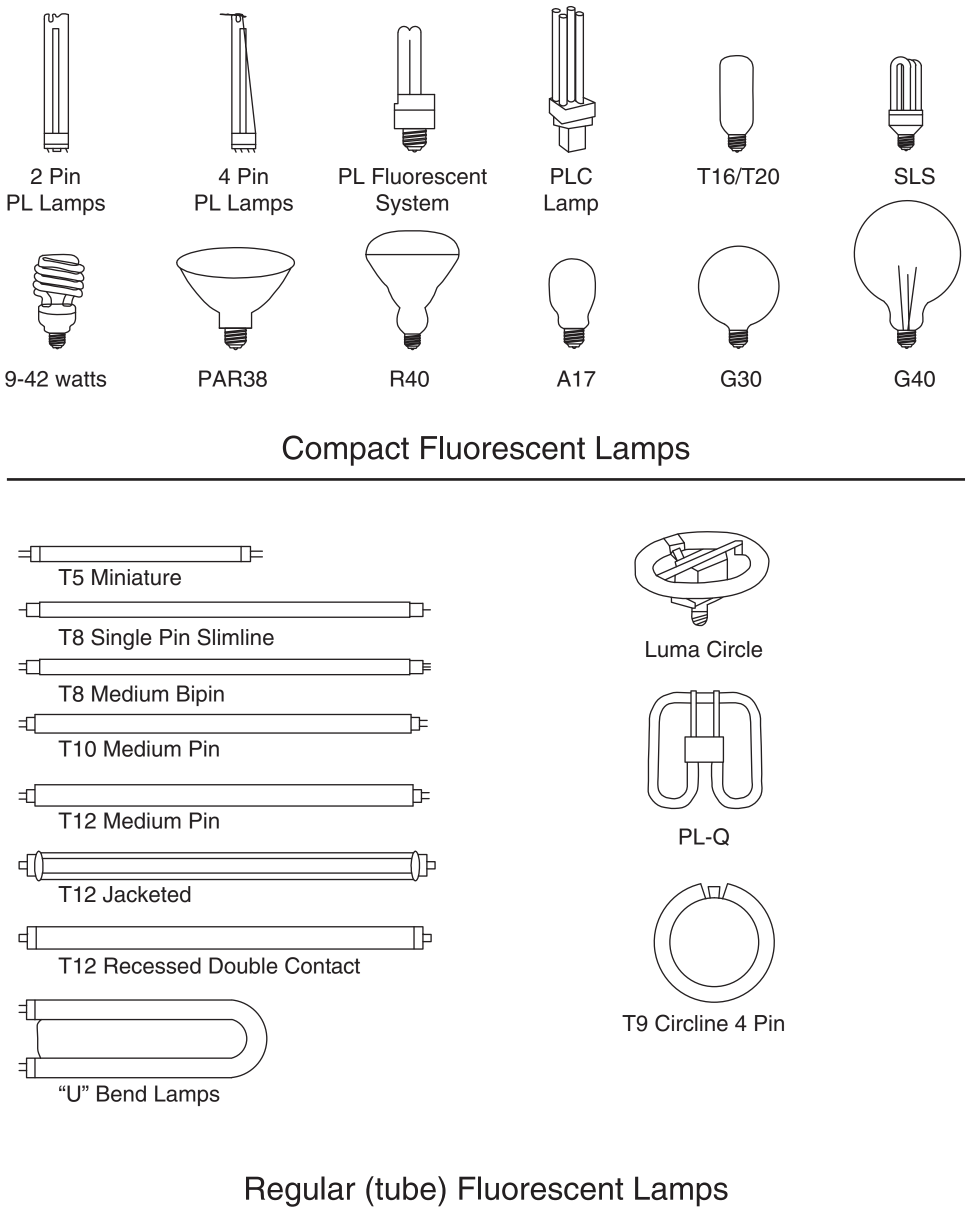


FIGURE 12.13 Fluorescent and compact fluorescent bulb shapes (not actual sizes). The size and shape of a bulb are designated by a letter or letters followed by a number. The letter indicates the shape of the bulb, while the number indicates the diameter of the bulb in eighths of an inch. For example, "T-12" indicates a tubular shaped bulb having a diameter of 12/8 inches, or 1½ inches.

Fluorescent lamps are coded to designate wattage, shape, diameter (in eighths of an inch), color, and type of lamp circuiting. For example, F40T12/WW/RS indicates a fluorescent lamp of 40 nominal watts, a tubular bulb of 12/8 or 1½ inch diameter, warm white color rendition, and rapid-start circuiting (Figure 12.13).

The most common fluorescent bulbs are straight glass tubes; other popular shapes include the compact, U-shaped, and circular (see Figure 12.14 for their characteristics). Tubes range in length from 8 inches to 8 feet and vary in diameter from ⅝ to 2⅛ inches. The most commonly used fluorescent lamps are 4 feet (1,219 mm) long, placed inside a 4-foot (1,219-mm) fixture of varying widths. However, the 2 × 2 foot (610 × 610 mm) luminaire is becoming more popular in commercial applications and can be fitted with U-shaped bulbs or two 2-foot (610-mm) straight bulbs.

The color of a fluorescent lamp is produced mainly by the phosphor used inside the bulb; light that phosphor produces is full-spectrum, with all colors present. However, the gases in the tube emit light of a single color. The combination of the phosphor coating and gas causes our color perception to be off balance. Although fluorescent light gives the illusion of normal white light, in reality it distorts the natural color of many objects. To alleviate this distortion, fluorescent lamps are available in a variety of colors, such as cool white, deluxe cool white, warm white, deluxe warm white, white, and daylight. Generally, cool white, warm white, white, and daylight lamps are weak in red wavelengths and appear bluish-green. Deluxe lamps are improved in red tones but have a lower efficacy.

FIGURE 12.14 Most common types of fluorescent lamps and their characteristics

TYPE	WATTAGE	LENGTH	CHARACTERISTICS
THE LOWER WATTAGE T5 and T8 FLUORESCENT LAMPS HAVE REPLACED THE F40T12	25–42	2′–8′	The standard four-foot rapid-start fluorescent is the most widely used lamp in large commercial projects. They are the most practical source because they offer low brightness, high efficiency, long life, low overall cost of light, and a variety of colors. They are more energy efficient and offer cost savings.
U-SHAPED T-12	25–40	2′	Most popular choice for 2′ × 2′ fixtures. Available in 3″ or 6″ leg spacing.
CIRCLINE LAMPS	20–40	6½″–16″ diameter	Mainly used with circular or square luminaires. Also available with screw-in adapter ballast for use with incandescent fixtures.
COMPACT FLUORESCENT LAMPS (CFL)	5–42	16½″–22½″	Higher efficiency, higher light output, and lower cost of light in 2 × 2 fixtures compared to T-8, and U-shaped fluorescent lamps. The T5 tube (⅝″ diameter) does not drop in light output due to the warm temperatures found in luminaires, as do larger-diameter lamps. Available in wide variety of colors and shapes. Can replace incandescent lamps for higher efficiency.

However, with advanced phosphor technology, fluorescent lamps are available with a tri-phosphor coating that combines excellent color rendition with high light output. When putting together a color scheme for an interior environment that will be illuminated with fluorescent lamps, it is important to match the color of the lighting with the materials and finishes. Generally, cool color schemes, such as blues or greens, should use lamps in the cool spectrum or a triphosphor lamp (with the good color rendition).

Fluorescent lamps are further classified by one of three types of circuiting used for their starting operation: preheat, instant start or slimline, and rapid start.

PREHEAT Fluorescent lamps with preheat circuiting require a starting circuit for preheating the cathodes to aid in starting the lamps. This method is the oldest and the slowest.

INSTANT START OR SLIMLINE The fluorescent lamps that are the quickest to start have an instant-start or slimline circuiting, and have a single pin at each end. They do not need the starter and starting circuit; however, they are slightly more expensive to operate.

RAPID START Fluorescent lamps with rapid-start circuitry are the most widely used for commercial applications. They incorporate the principles of both the preheat and the instant-start circuits, although starters are not required. These are the only kind of fluorescent lamps that can be dimmed or flashed.

Fluorescent lamps have several advantages compared to the incandescent lamp. Fluorescent lamps last 10 to 15 times longer; produce about 4 times as much light per watt, which conserves energy; and produce almost no heat. Because the light source of fluorescent lamps is considerably larger, it gives off diffuse, shadowless light and produces less glare.

However, there are some drawbacks to fluorescent lights: Because they produce diffuse light, which promotes good vision, they also tend to create a flat, monotonous lighting effect; some of the color renditions of fluorescent lamps are not complimentary to skin tones and can make people and objects appear sallow and unattractive; and fluorescent lamps can be annoying if they flicker and/or hum. However, the newer electronic ballasts have eliminated this problem. Some manufacturer's rate ballasts on the amount of sound produced. For example, ballasts with an *A* rating are quieter than those rated *B* or *C*. For areas that require minimum external sound, the ballast may have to be installed in an adjacent area. A designer must also be aware that ballasts (both fluorescent and HID lamps) produce heat. Sometimes it is necessary to install a ventilation system to constantly remove the ballast heat from the space.

In spite of these problems, fluorescent lamps remain a good, economical lighting choice. New tubes of improved color characteristics are being developed. Mixing fluorescent light with daylight can make a satisfactory lighting environment.

Compact Fluorescent Lamps

A compact fluorescent lamp (CFL) produces light in the same way as the linear fluorescent lamp. It has phosphor coatings inside the tube, which causes it to glow when electricity runs through the bulb. The main difference is the shape of a CFL lamp. The compact fluorescent lamp folds or twists the thin glass tube tightly to save space without sacrificing the tube length necessary to maximize the light output. The compact fluorescent lamp was developed to fit into light fixtures formerly used for incandescent lamps. The two shapes are a tubular-type and a helical (three-dimensional spiral) shape.

Compared to standard incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last 8 to 15 times longer. A CFL has a higher purchase price than an incandescent lamp, but can save over five times its purchase price in electricity costs over the lamp's lifetime.

When CFLs first appeared on the market, they were not well received because of the harshness of their color; they were expensive, and slow to come to their full brightness. Today, most CFLs render colors much more accurately, which is attributable primarily to better phosphor coatings inside the glass tube. Some sources rate the "soft white" CFLs as similar in color to the standard incandescent lamps.

Another concern is that, like all fluorescent lamps, CFLs contain mercury (less than 1/100 the amount in a mercury thermometer), which complicates their disposal. In many countries, governments have established safe recycling sites for all fluorescent lamps.

Because the CFLs are in the general electric discharge family of lamps, they too require a ballast to regulate the amount of current used. There are two categories of CFLS, one with an integrated ballast and one without. Integrated lamps combine the tube and ballast in a single unit. These lamps allow consumers to replace incandescent lamps easily with CFLs. Integrated CFLs work well in many standard incandescent light fixtures, reducing the cost of converting to fluorescent. Nonintegrated CFLs have the ballast permanently installed in the luminaire, and only the lamp is usually changed at its end of life. Since the ballasts are placed in the light fixture, they are larger and last longer compared to the integrated ones, and they don't need to be replaced when the bulb reaches its end-of-life. Nonintegrated CFL housings can be both more expensive and more sophisticated. They have two types of tubes: a bi-pin tube designed for conventional ballast, and a quad-pin tube designed for an electronic ballast or conventional ballast with an external starter. Refer to Figure 12.13 for examples.

Compact fluorescent lamps can lower your electricity bill and save energy. They are available in a variety of shapes and sizes for table lamps, recessed lighting, and decorative fixtures.

High-Intensity Discharge Lamps

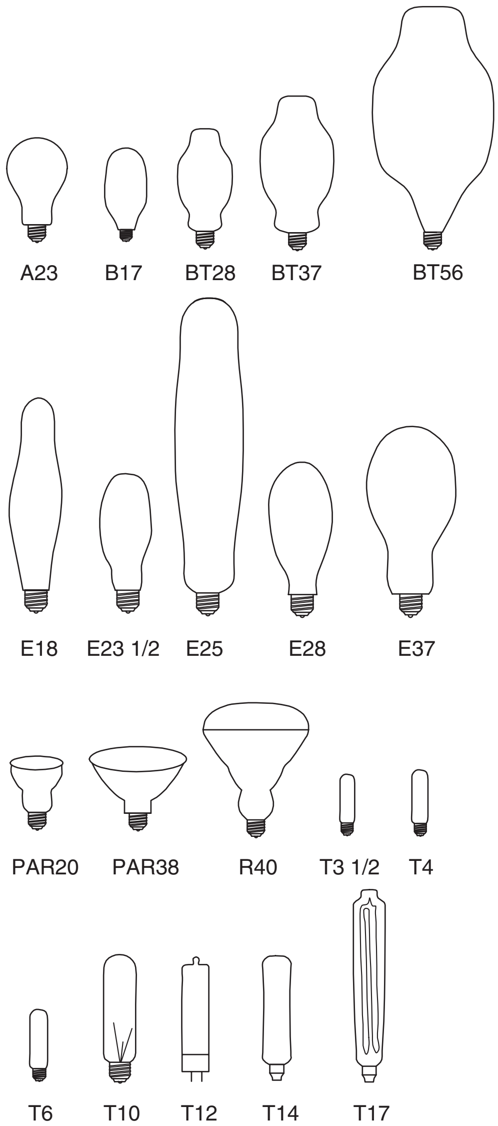
High-intensity discharge lamps produce light in much the same way as fluorescent lamps, by establishing an arc between two electrodes. The main difference is that the HID lamp is similar in shape to an incandescent bulb but is generally much larger (see Figure 12.15). Also, the two contain different types of gases under a high pressure. In general, HID lighting combines the advantages of incandescent and fluorescent light. HID lamps have a high efficacy—up to twice the output of fluorescents, and 10 times that of incandescent lamps. They have long lives, ranging from 15,000 to 24,000 hours. Their greatest disadvantage has been poor color rendition. They lack a well-balanced spectral distribution of color, which results in color-perception problems. They give a point or near-point light but can cause intense glare and uneven light patterns. Compared to fluorescent lighting systems, their ballasts are noisier and they have a very slow start-up time, 5 to 7 minutes (10 to 15 minutes for restrike after being turned off). HID lamps can be dimmed but are slow to respond.

HID lamps can be classified according to the type of gas vapor and phosphor coating used, and are commonly available in three types: mercury vapor, metal halide, and high-pressure sodium. See Figure 12.16 for characteristics and uses of each type. In the past, HID lighting was used primarily for industrial applications and outdoor lighting because of its poor color rendition. However, new developments are rapidly improving HID lighting, and it is now being used extensively in public spaces, offices, and retail spaces. It is particularly useful in spaces with very high ceilings and as indirect lighting sources.

Solid-State Lamps

Another form of light sources for interior lighting is the LED (light-emitting diode) lamp. LEDs are part of the solid-state lighting family that uses light-emitting diodes as the source of light. The emission of light is produced when electricity passes through semiconductors, which is known as solid-state electroluminescence. LED lamps didn't enter the applied lighting field until the 1960s, because they were mainly used as long-lasting, colored lights in traffic signals, electronic displays, flat-screen TVs, and indicator lights, such as on a car dashboard. The light output

FIGURE 12.15 Some of the more popular high-intensity discharge (HID) bulb shapes and sizes (not actual sizes)



of each light-emitting diode is small, because they are only about one-eighth inch long, compared to larger incandescent and compact fluorescent lamps. LED sources are compact, which gives flexibility in designing lighting fixtures and good control over the distribution of light with small reflectors or lenses. Because the diodes are small, for most interior applications, multiple diodes are assembled together inside a larger bulb (Figure 12.17). However, the efficiency of LED lamps continues to improve, with some chips emitting more than 100 lumens per watt.

FIGURE 12.16 Common types and characteristics of high-intensity discharge (HID) lamps

TYPE	WATTAGE	EFFICACY – LUMENS/WATT	CHARACTERISTICS
MERCURY VAPOR	100–1000	22–60 (efficacy increases with wattage)	Blue-green color rendition; deluxe white & warm deluxe white have improved color, but still low in red rendition. Mainly used for exterior landscape lighting.
METAL HALIDE—Tubular, PAR & Elliptical lamps	20–1500	100	Well-balanced color rendering properties. Higher light output and smaller size for precise control. Used in office, retail, and public interiors.
HIGH PRESSURE SODIUM	35–1000	50–127	Most efficient HID lamp; provides excellent optical control due to linear shape. Light output is yellow-tinted, thus affecting color rendition qualities. Used for roadways and parking lots.

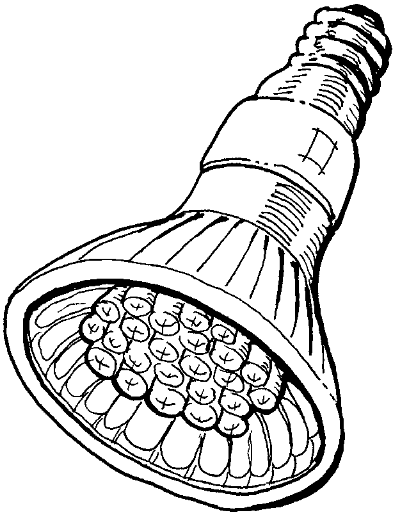


FIGURE 12.17 A typical LED lamp with multiple diodes

LED lamps have no glass tubes to break; however, some models have an enclosing decorative glass bulb, and their internal parts are rigidly supported, making them resistant to vibration and impact. LED lamps can also be made dimmable over a wide range, as there is no minimum current needed to sustain lamp operation. They have no harmful UV radiation, and they won't fade colors in an interior environment.

Different frequencies produce different colors of light. A wide range of colors can be emitted by LED lamps, such as red, blue, green, amber, and a bright, cool white. Full color mixing is possible in lamps with LEDs of different colors. The key to using solid-state lighting in interior environments is the development of white LEDs that can emit warmer color tones. Some white versions of LEDs emit a bluish light, but most lamp manufactures are combining phosphor coatings in the bulb with blue LEDS to make the light a softer white. This is similar to the phosphor coatings used in fluorescent lamps.

A concern with solid-state LEDs is that their light emission tends to be directional, but it makes them an excellent choice for close-range task light, general accent light, directional spotlighting, and hard to reach locations, such as high ceilings. For applications where nondirectional light is required, either a diffuser can be used, or multiple individual LED emitters can be grouped together to emit light in different directions.

For LEDs to operate properly, heat dissipation is very important. Most LED lamps must incorporate extra elements, such as an array of fins or small fans, which act like radiators to help conduct heat away from the circuitry. Because excess heat will affect the operation of LED lamps, they cannot be used in fully enclosed luminaires, or even some airtight recessed cans that may be in contact with insulation.

Because of the high efficacy (lumens per watt) and long life of LED lamps, they are made to be interchangeable with incandescent and compact fluorescent lamps. They are manufactured in standard light bulb shapes with a standard screw base, an MR16 shape with a bi-pin base, or a bayonet base. They also are available in a T8 shape/size, which is ideal for hiding as cove and undercabinet lighting. See Figure 12.18 for an example of some of the shapes.

Other Light Sources

Other light sources have been developed for specialty and decorative lighting needs (Figure 12.19). These types permit the interior designer to create a variety of special effects and a type of light not possible with the aforementioned units. These specialized types include neon, cold cathode, fiber optics, and laser light.

NEON Neon lights are another type of low-pressure electric discharge lamp used primarily for display or decorative purposes. They have a very long life, are available in a full range of colors, can be bent to any shape, and can be mounted on walls or ceilings. A neon lamp produces a low amount of uniformly distributed light throughout its length. Neon lamps are low energy consumers and can be dimmed and flashed, but are fragile, requiring a special ballast for starting at high voltage and for staying lit. The ballast for a neon lamp is about 1.5 to 2 times as large as that of a fluorescent and can be noisy unless mounted in a remote or concealed area. Neon lamps have endless potential for creative interior lighting, since they can be shaped to fit any contour. They can be used for special visual effects, decoration, highlighting, and dramatization or as lighting sculptures.

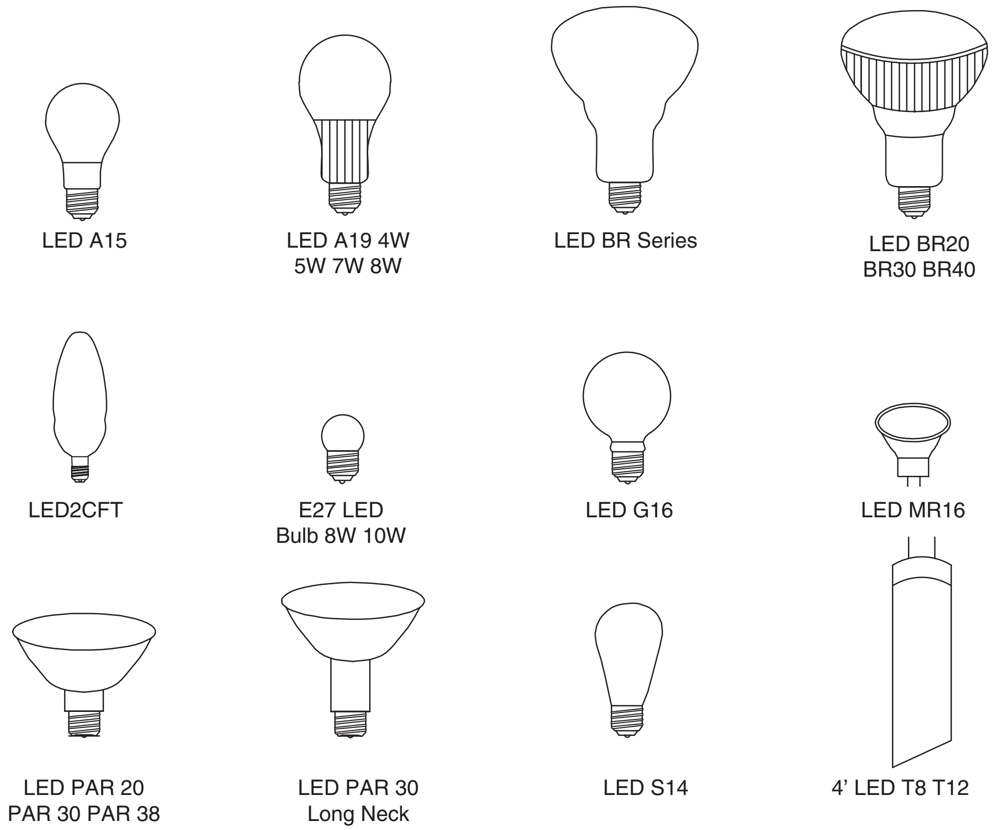


FIGURE 12.18 Common types and shapes of LED lamps.

FIGURE 12.19 Specialized lighting is used to highlight this dynamic light sculpture in the Haworth's Toronto showroom.
Photo Courtesy of Haworth, Inc.

COLD CATHODE Cold cathode lamps operate like instant-start fluorescents but are similar to neon in that the tube can be bent to conform to any shape. Cold cathode lamps have a very long life and are generally used where long, continuous runs of light are required, such as in built-in structural lighting.

FIBER OPTICS Fiber optics are thin, cylindrical glass or plastic fibers that do not produce light by themselves. However, when a ray of light is passed through one end and emerges from the other, in a process called total internal reflection, intense pinpoints of light are produced. Typically, a large number of fibers (50 to 1,000,000) are bonded into bundles at one end. The ends of the bundle are then bonded together, ground, and highly polished to minimize interference in the path of light. When a light source is placed in a precise location at the input end, the optic fibers and bundles will produce intense points of light. Fiber optics are used to create decorative effects, such as starlight patterns in the ceiling, under the treads of a staircase, or interlaced through plants to create three-dimensional shadows that crisscross over adjacent walls and ceilings. Because the light from fiber optics travels only a short distance once it has left the fiber, this type of lighting has been used in decorative, rather than functional, ways.

LASER LIGHT The term *laser* means "light amplification by stimulated emission of radiation." A laser is a device containing a crystal, gas, or other substance in which the atoms are stimulated by focused light waves, amplified, and concentrated, then emitted in a narrow, very intense beam. Laser beams were formerly used only in scientific and medical fields, but are now being used for a variety of purposes. Although laser beams can be dangerous, since a high-powered beam can burn the skin or can damage the retina of a person who looks directly into it, they can be applied effectively in special interior and theatrical environments. Lasers can be used to produce moving, three-dimensional objects in space or on a screen, as well as to move like a pencil in space, drawing figures in the air with a continuous line. For the interior designer or lighting designer, laser light offers the opportunity to produce and direct a cast of light beams, creating physical planes or sheets of light in midair. Laser light opens up a whole new field of visual experiences and communications.

Color Appearance of Light

The perceived color of materials and finishes within an interior space varies depending on the type of light source used. The best choice of lighting is one with good color-rendering properties and a moderate color temperature (Figure 12.20).

FIGURE 12.20 Lighting with good color-rendering properties is very important in healthcare facilities, such as this hospital's nurses' station.

Photo Courtesy of Haworth, Inc.

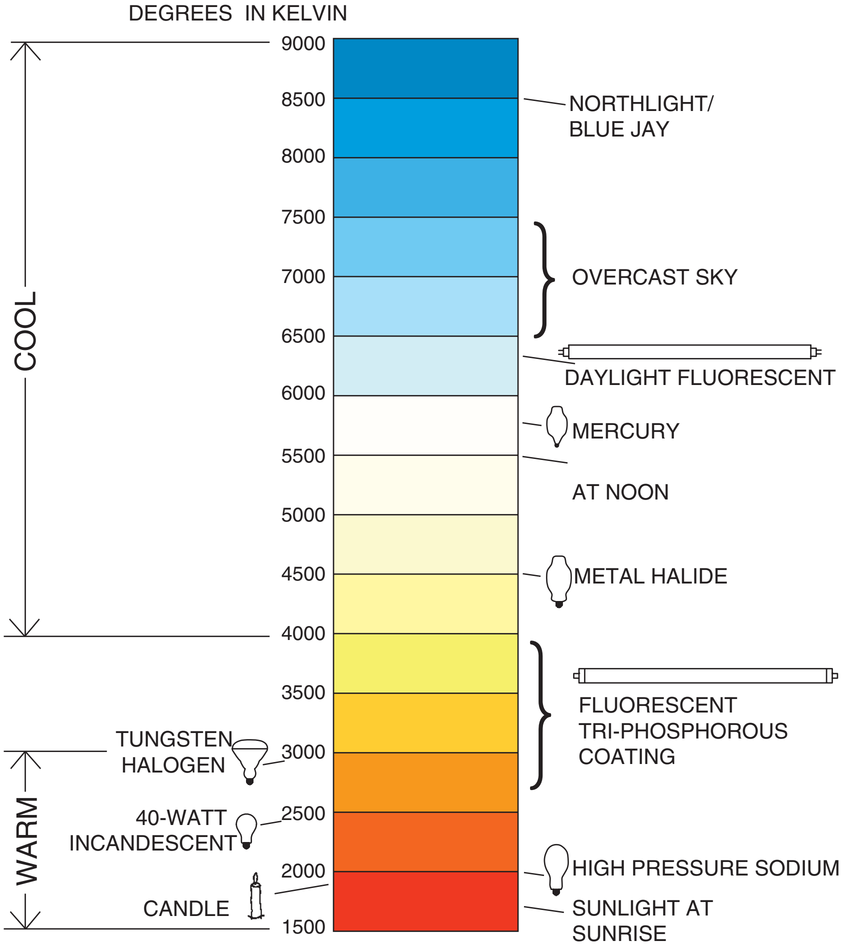


FIGURE 12.21 Color temperature is measured in kelvin degrees and ranges from 9,000 K (which appears blue) down to 1,500 K (which appears orange-red). Light sources fall in between these ranges with those of a higher color temperature, 4,000 K or more, appearing more blue or "cool," and those 3,100 K or less considered to be "warm," as they appear more orange-red.

Two measures of light source color have been established and are commonly used to describe color characteristics of lamps. These are color temperature and the color rendering index (CRI). Color temperature, measured in kelvin degrees, describes the actual appearance of the light produced in terms of its visual warmth or coolness. Kelvins range from 9,000 K (which appears blue) down to 1,500 K (which appears as orange-red). See Figure 12.21 for a comparison of natural and artificial light sources expressed in kelvins. Color temperature is related to the tasks that will be performed in an interior. For example, in residences, lamps of 2,700 K to 3,000 K should be used; office environments should range between 3,500 K and 4,000 K. A space with lots of available daylight, such as an atrium, can use lamps with 4,000 K to 5,000 K.

The color rendering index is a measure of how well colored objects appear under different light sources. The CRI is a number (from 0 to 100) representing how color samples appear when compared to a reference light source with the same color temperature. Generally, the higher the CRI number, the better the color appearance. An incandescent lamp generally has a CRI close to 100. Fluorescent lamps (2,700 K to 6,300 K) vary in CRIs from 48 to 90. See Figure 12.22 for some general light sources and their effect on color.

LIGHTING NEEDS AND APPLICATION

The first step in lighting design is to analyze lighting needs in terms of the user(s) and the activities that will take place in the space. Good lighting depends on careful planning, beginning with an analysis of needs, the selection of lighting fixtures and lamps to suit those needs, and a drawing indicating the location of the fixtures, to achieve the lighting levels and effects desired. The drawing is discussed later under "Interior Applications of Lighting."

Because human vision differs widely, a designer must analyze user needs according to age, experience, and perception in terms of brightness, color, and satisfaction. The primary way we see is through sensitivity to contrast. The human eye can adapt to an enormous range of brightness and still distinguish fine detail. However, the perception of space is interpreted differently depending on many factors, especially age and experience.

FIGURE 12.22 Color-rendering properties of a lamp are an important influence on the color appearance of an object. Generally, the higher the CRI, the less distortion of an object's color by the lamp's light output. However, CRI values should only be compared between lamps of similar color temperatures.

LIGHT SOURCE	COLOR TEMPERATURE	COLOR RENDERING INDEX (CRI)	CHARACTERISTICS	EFFECT ON COLOR
STANDARD INCANDESCENT	2,750–3,400 K	95+	Warm, inviting light. Standard light source. Relatively inefficient.	Brightens reds, oranges, yellows. Darkens blues and greens.
TUNGSTEN HALOGEN	2,850–3,000 K	95+	Brighter, whiter light than standard incandescent. More efficient than regular incandescent.	Brightens reds, oranges, yellows. Darkens blues and greens.
FLUORESCENT:				
Tubular and Compact Fluorescent	2,700–6,300 K	48 to 95	Wide selection of phosphor colors—select warm to cool lighting atmosphere. Generally high efficiency. Much longer life.	Wide range of color temperatures and CRIs to light effectively any (basically indoor) area with a "warm" to "cool" environment, as décor or task dictates.
HIGH INTENSITY DISCHARGE:				
Metal Halide	2,700–4,000 K	62 to 92	Different gases and phosphor colors create a variety of atmospheres.	Metal halide lamps provide excellent color rendering. Mercury and high-pressure sodium provide poor color rendering. Mercury gives a blue-green coloration, and high-pressure sodium imparts an orange-yellow color.
High-Pressure Sodium	2,000 K	21 to 1850	High efficiency.	
Mercury Vapor	3,600–6,800	20 to 40	Very long life.	

Lighting for Special Groups

The fastest-growing segment of our population is the elderly. As people grow older, they experience a great many changes in their lives that are affected by the interior environment. As a person's eyes age, that individual's color vision, depth perception, visual acuity, peripheral vision, glare and flicker tolerance, and size of the visual field all change. When these changes in vision begin to occur (generally, a reduction in a person's visual ability begins about the age of 40), eyeglasses can help to improve vision, but generally more light is needed for performing detailed visual tasks. A good designer must be in tune with the life process of aging and design in a subtle and visually harmonious way so that older people do not feel segregated or degraded because of their physical disabilities.

Designers can help compensate for visual loss through creative and flexible lighting design, such as adding special accent lighting to keyholes, switches, and electrical outlets. Other lighting techniques can be designed to warn and guide the elderly at doorsills, steps, and pathway obstructions. Designers can also plan for higher light levels than normally recommended and provide dimmers so individuals can adjust the light level for their particular situation. Elderly fingers can manipulate slide dimmers fairly easily or push buttons on master switching systems.

Aging eyes also cannot distinguish colors very well. As the cornea of the eye begins to yellow and cloud, things begin to appear more amber. The sensitivity to contrast declines and the ability to discern simultaneous contrast, which is important in distinguishing color vibrancy, is decreased. The elderly need highly saturated primary hues in contexts of high contrast. Also, blues should be used sparingly because the ability to see blue and mixtures containing it is reduced with aging.

General or Ambient Lighting

Lighting for visual functions or activities can be categorized as (1) general or ambient, (2) task, and (3) accent or special-emphasis lighting.

General or ambient lighting brightens an entire space fairly uniformly. It provides a comfortable level of light, allowing people to find their way around, locate objects, and be able to see other people or objects easily. General illumination also provides a soft background or glow throughout a space.

FIGURE 12.23 Indirect lighting is achieved in this waiting room in the ceiling cove that reflects the carpet pattern below, and other curvilinear elements.
Courtesy of EnviroMed Design Group

General or ambient lighting can be produced by either a direct or an indirect method. Direct lighting means that light shines directly from the luminaire downward, generally from recessed, ceiling-mounted, or suspended fixtures. Indirect light shines against a surface, usually the ceiling, and is reflected down into the space indirectly. Indirect light generally produces a softer effect than direct light. Indirect light can be provided by suspended fixtures, wall sconces, or architectural built-in lighting systems, such as coves that are placed high on a wall with the light concealed (Figure 12.23).

High levels of general lighting can make an area seem lively and cheerful, causing the people within to be inclined toward activity. However, uniform lighting can be monotonous and is seldom bright enough for reading or close work unless a high level of illumination is used. When the general/ambient lighting level is low, a feeling of restfulness, relaxation, and intimacy is created. However, the lighting should be strong enough to avoid excessive brightness contrast between the general illumination and bright task lighting.

Task Lighting

Task lighting is direct, functional lighting that provides illumination for specific visual tasks or activities. Adequate and suitable light must be provided for every activity that takes place within a space. Typical tasks that may require special lighting considerations include reading, writing, preparing food, eating, and grooming. Task lighting is used in most environments such as offices, factories, medical facilities, retail establishments, museums, galleries, theaters, recreational facilities, and residential interiors.

Direct light is the best type for task lighting. However, proper placement is also very important to avoid the generation of shadows and glare. Task lighting can be placed high or low and can be recessed, ceiling mounted, suspended, or portable (for example, floor, desk, or table lamps).

Accent or Special-Emphasis Lighting

Accent lighting is used to highlight art objects or special structural features within a space (Figure 12.24). Low-voltage halogen lamps or other types that produce narrow beam spreads are a good choice for these effects.

FIGURE 12.24 Small spotlights and downlights are used in this small bar/kitchenette area to highlight the structural features and elements, the waterfall on a polished granite wall, and art pieces within the space.

Courtesy of National Kitchen & Bath Association

Special effects can also be created by fixtures that break light into many small, bright spots. Accent lighting can take the form of a candle on a restaurant table or flexible strips of miniature lights that can bend and conform to any shape.

Special-emphasis lighting can be used to create interesting pools of light within a space and attract people to a certain area, or to break up a large room into smaller islands of space. It can also be used to direct traffic or to set a mood or illusion.

LIGHTING FIXTURES AND TECHNIQUES

The lighting fixture, called the luminaire, is the housing for the lamp and is an integral part of a building's electrical system, transforming energy into usable light. Luminaires are available in a variety of shapes and sizes that can determine the shape and direction of the light beam. Since there are thousands of luminaires on the market, it is helpful for a designer to know what criteria to look for when making a selection. The first consideration is that the fixture must be suitable to the particular purpose or activity. Luminaires should be scaled to the overall design of a space in terms of size, proportion, and character. Luminaires can become focal points within a space or be subordinate and concealed.

Manufactured Luminaires

The best way to determine what kind of luminaires to select for a particular purpose is to consider the desired direction of the light beam and the method of mounting. The form of the light beam can be generally classified as point, linear, and volumetric sources. Point sources are used to give focus to a space by providing areas of brightness. They are also used to highlight an area or object of interest and can be arranged to create rhythm or sparkle. Linear sources can be used to emphasize the perimeter of a space, outline an area, or provide direction. If linear sources are placed parallel to each other, they create a plane of illumination. Volumetric sources are diffuse point sources that have been expanded by the use of translucent materials to create illumination patterns in the form of spheres, globes, or other three-dimensional forms.

Five common types of mounting methods for manufactured luminaires determine the direction of the light beam: recessed, ceiling mounted, wall mounted, suspended, and track mounted (Figure 12.25).

Recessed

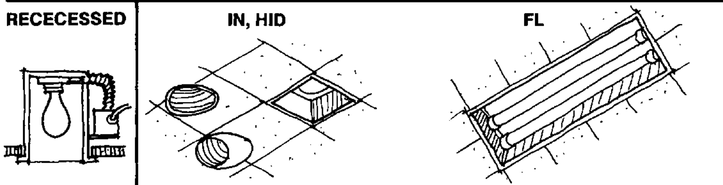
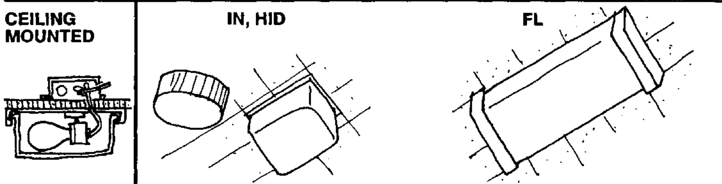
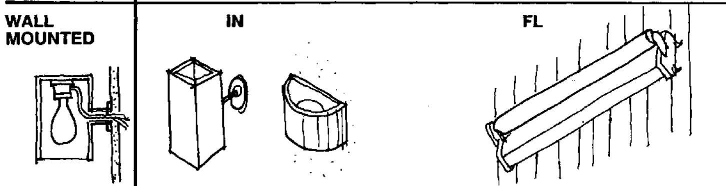
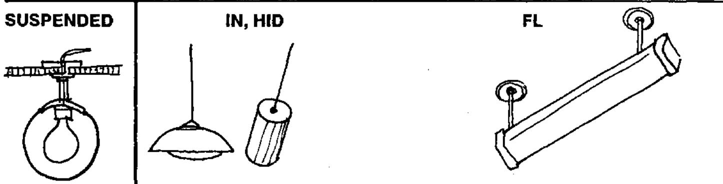
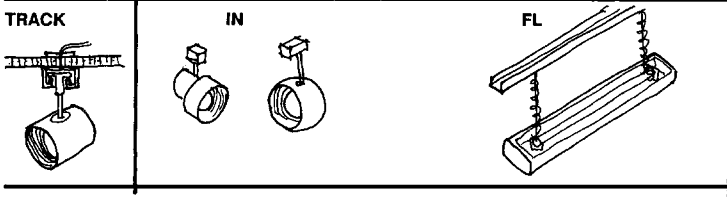
Recessed luminaires provide direct light. They are mounted above the ceiling line, the bottom generally flush with the ceiling. These are popular luminaires for general lighting using all types of lamps. They can also be used for wall washing or accent light.

Ceiling Mounted

Ceiling-mounted luminaires produce direct light and are very efficient, impeding neither light nor heat. This type is mounted directly on the ceiling; its light beam can be directed in a wide pattern. Installation and re-lamping are generally easy and relatively inexpensive. One disadvantage is that ceiling-mounted fixtures can lower the effective height of a ceiling.

Wall Mounted

Wall-mounted fixtures, often called sconces, provide direct, indirect, diffuse, or direct-indirect light. These fixtures are used mainly for decorative purposes and tend to bring down the line of sight in a space with a very high ceiling. If a ceiling is very low, however, the clearance for passersby may be impeded with a wall-mounted fixture. Some wall-mounted luminaires incorporate a reflector plate against the wall to reflect any lost light and to create a focal point of brightness.

TYPE	LAMP(1)		LIGHT(2)	CHARACTERISTICS
RECECESSED 	IN, HID	FL	D	GOOD FOR GENERAL LIGHTING. ALSO USED FOR WALL WASHING AND ACCENT LIGHT
CEILING MOUNTED 	IN, HID	FL	D	CAN PROVIDE GENERAL LIGHTING OR BE DIRECTED. EASY INSTALLATION AND RE-LAMPING.
WALL MOUNTED 	IN	FL	D I D/I	OFTEN USED AS DECORATIVE ACCENTS, BRINGS ATTENTION DOWN FROM CEILING. CAN SHINE UP, DOWN, OUTWARD, OR A COMBINATION.
SUSPENDED 	IN, HID	FL	D I D/I	CAN BE ADJUSTABLE IN HEIGHT, USED AS SUSPENDED/ LIGHTED ORNAMENTS. LIGHT CAN BE GENERAL OR DIRECTED, SHINE UP, DOWN, OR BOTH.
TRACK 	IN	FL	D I D/I	EXCELLENT FLEXIBILITY IN EFFECTS, LOCATION, AND DECORATIVE ACCENT. TRACK CAN BE ON SURFACE, RECESSED, OR SUSPENDED.

(1) IN = INCANDESCENT; HID = HIGH INTENSITY DISCHARGE; FL = FLUORESCENT
(2) D = DIRECT; I = INDIRECT; D/I = DIRECT/INDIRECT

FIGURE 12.25 Luminaires can be mounted by five basic methods.

Suspended

Suspended, or pendant, luminaires can produce direct, indirect, diffuse, or direct-indirect light beams. These fixtures are suspended below the ceiling and can be adjustable, depending on the ceiling height. One major advantage of these fixtures is their appearance—they become lighted ornaments when suspended in an interior space. Some large suspended luminaires may also form a canopy effect. Some building codes require large suspended fixtures to have "earthquake" hangers so the fixtures will sway but not fall in the event of an earthquake or other disaster.

Track Mounted

Track-mounted luminaires can provide direct, indirect, or direct-indirect light. A track-mounted lighting system consists primarily of two parts: the track and the luminaire. This type of lighting system is very popular because it offers optimum flexibility in a vast range of lighting effects and can be economical. The track itself is an electrical raceway that supplies power to the luminaires. The luminaires can be mounted anywhere on the track and moved horizontally or vertically. The track can be surface mounted, recessed in the ceiling, or attached to a wall, or can have pendant fixtures hanging from it. Track-lighting systems come in a variety of sizes and shapes and can be mounted practically anywhere to serve a multitude of purposes.

Spatially Integrated Lighting Systems

Spatially integrated lighting systems can be defined as lighting that is built in and integral to the construction of a building. This type is relatively invisible and can be controlled to enhance the brightness within a space without creating glare in the field of view. Figure 12.26 shows some of the more common types of integrated lighting systems used in both residential and nonresidential facilities.

Cornice Lighting

Cornices are mounted at or near the ceiling and direct light downward. Cornices can be used to give dramatic emphasis to textured walls, such as stone, brick, or wood, or to create a visual line of sight with light. Cornices are used to conceal the actual light source and provide a reflected ambient effect for a space.

Cove Lighting

Cove lighting is concealed in a continuous trough that is usually directed toward the ceiling. Coves are a good choice to give a feeling of height or to emphasize a cathedral or vaulted ceiling. Cove lighting provides a soft, uniform, nonglaring light and is best used as a supplement to other lighting.

Valance Lighting

Valances are traditionally located directly above windows, usually with draperies or other window treatments. They provide both direct and indirect light to emphasize the texture of the window treatments and to reflect light off the ceiling into the rest of a space.

Bracket Lighting

Bracket lighting is similar to valance lighting, but it is not located over windows. It can provide both direct and indirect light and can be placed high or low on a wall. Bracket lighting can be used for general ambient lighting, task lighting, or a combination of the two. Brackets can be placed above work areas, beds, or shelving units for emphasis.

Soffit Lighting

Soffit lighting is common and inexpensive. It is often used in a dropped or "furred-down" area of a ceiling and can provide a high level of direct light. It is generally placed over work areas, such as a kitchen sink or a mirror in a dressing room. It also can be placed around the perimeter of a room or along one wall to visually expand a space or draw attention to it. Either fluorescent, incandescent, or LED lamps can be installed in a soffit, with or without a diffuser or louver at the bottom.

Specialty Lighting

Specialty lighting, such as luminous panels, can be used on ceilings or walls. A continuous diffusing or louverlike material with light sources mounted above might cover all or most of the ceiling. Generally, fluorescent light sources are used to produce an evenly distributed, diffused, soft light The luminous panel system is practical for general light if it is installed 8 to 10 feet (2,438 to 3,048 mm) above the floor; if placed above 10 feet (3,048 mm),

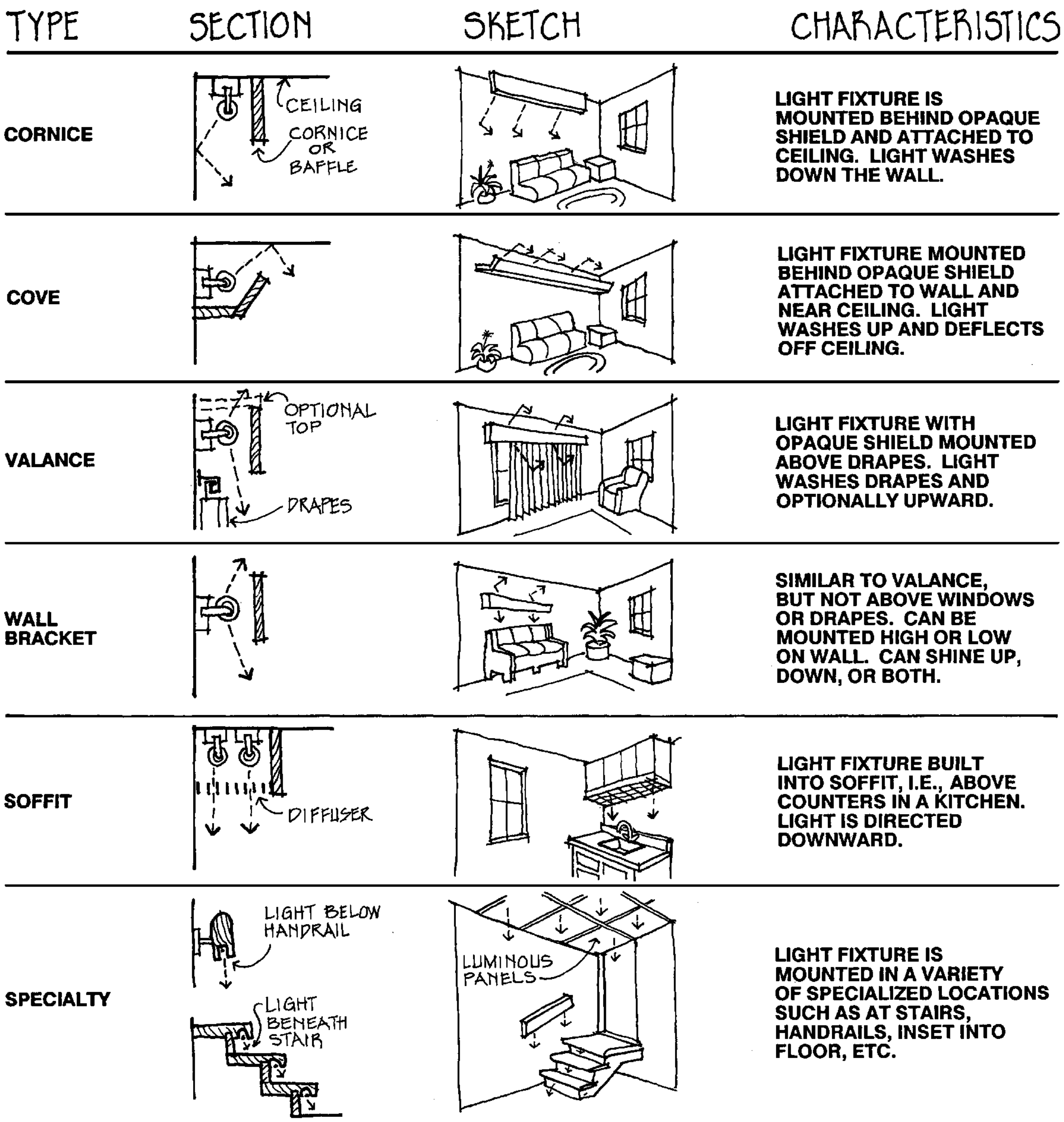


FIGURE 12.26 Spatially integrated lighting systems are those that are built into the building as an integral part of the architecture.

it becomes mostly decorative. Luminous panels can be used to simulate a skylight effect in interior environments, such as in restaurants or shopping malls.

Luminous wall panels or columns are based on the same concept as luminous ceilings but are fluorescent lamps placed within the wall surface or installed inside columns and covered with a translucent panel. Both applications are used for decorative purposes or graphic displays. These panels and columns can be most effective in drawing attention to a display or defining structural elements within a space, since they produce an ambience of natural light.

Other types of specialty lighting can be incorporated into handrails, stairs, or floors.

Portable Lighting Fixtures

Portable lighting fixtures are available in an infinite variety of sizes, shapes, and styles (Figure 12.27). Portable fixtures originated in the home as floor or table lamps to provide working light close to a task. However, in the 1970s, the concept of task lighting was modified and adapted to the office environment in the form of portable workstations that incorporated task lighting under a shelf or storage unit (Figure 12.28). Miniature and powerful fluorescent, incandescent, and HID lamps have become stylish floor and table portable fixtures in homes and office environments across the nation.

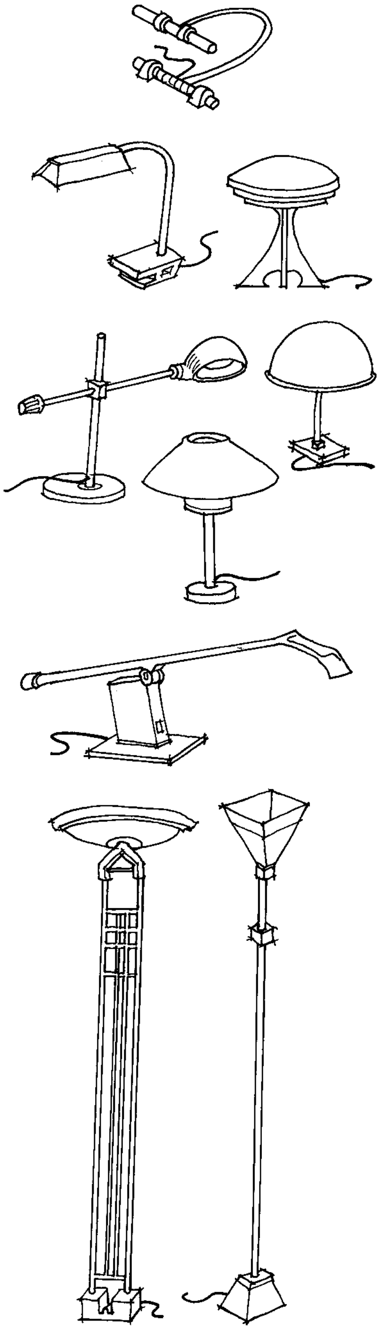


FIGURE 12.27 Some popular types of portable light fixtures

FIGURE 12.28 Under-shelf task lighting is incorporated within these workstations.
Courtesy of Kimball Office

ELECTRICAL CONTROLS FOR LIGHTING

A lighting system must have electrical controls for turning light off and on, dimming it, or moving it. Traditionally, lighting controls have been provided to allow lighting flexibility or dramatic lighting effects. However, today's lighting control is also being used for energy management, such as turning lights off automatically when a space is unoccupied. The most common method of switching control is the manually operated wall switch; however, other types, such as the push-button, the slide plate, photocells, sensing systems, and wireless systems, are available.

Dimming a light source, which controls the electrical input, is an excellent way to provide the required amount of light within a space without wasting energy. Dimmer controls can adapt the level of light to a particular task or mood and offer great flexibility to the lighting designer. The key to proper application of lighting controls is the selection of the proper control device, as well as the careful planning of how the control is to be used. Several dimming methods are available today, depending on the type of lighting system to be produced. See Figure 12.29 for the most common types and characteristics of electrical controls.

Good lighting control in residential applications requires every space or area to have a light switch adjacent to the latch side of a door or access. Depending on the type of space and activities, more than one switch is sometimes required for lighting flexibility. In commercial applications, lighting control systems may be controlled by individual switching, or in large facilities, by the use of a time clock or other sensitive switches. However, where possible, individual switching is generally preferable in spaces, so the users can turn off lighting where and when it is not needed. Wireless lighting systems can save energy by allowing the lights to be turned on or off remotely. A wireless system also allows the lights to be set to come on or off at certain times of the day or night.

For safety purposes, stairs should have switches at the top and bottom, and hallways should have them at both ends. The mounting height of switches should be no higher than 48 inches (1,220 mm). However, for better access by the handicapped, some codes recommend that switches should be mounted 30 to 40 inches (762 to 1,016 mm) above the floor, with 36 inches (914 mm) preferred by wheelchair users.

FIGURE 12.29 Most common types of electrical controls for lighting systems

TYPE OF SWITCH	CHARACTERISTICS	COMMON USES
TOGGLE/SNAP	Most common and least expensive. Connection made by snapping one metal contact to another.	Typical for most residential and commercial applications.
MOMENTARY CONTACT	Switch opens or closes a circuit. Actually a push-button switch.	Often used as elevator call button. Generally accompanied by an integral light to indicate if circuit is on or off.
DIMMER	Allow variable voltage to a lamp circuit, producing dimming effect.	Used in most residential and commercial applications to dim light fixtures.
ELECTRONIC	Variety of switching methods triggered by heat, sound, touch, motion, radio waves, and light.	Used for security installations, switching for daylight/ nighttime phases.
MERCURY	Vial of liquid mercury is tilted and conducts electricity between contacts. Often called "silent action switches."	Used in thermostat controls and as silent action switches.

INTERIOR APPLICATIONS OF LIGHTING

Lighting design involves selecting and locating the appropriate lamps and fixtures to satisfy stated needs. The designer develops a concept to determine what the lighting should be, not only to satisfy the needs of users but also to complement the occupants, the architectural features, and the character of the interior space. After exploring several alternative sketches, the designer should develop a lighting plan to accomplish those goals. A lighting plan is part of the construction drawings (Chapter 18) and is sometimes referred to as an electrical or reflected ceiling plan. However, each of these has distinct characteristics.

A lighting plan is used in residential and small commercial projects to show types and locations of light fixtures and controls (Figure 12.30). It is often used to communicate the concepts of the lighting design to the client and the contractor.

A reflected ceiling plan (Figure 12.31) is used primarily in large commercial work or complex ceiling systems that have several changes in elevations, materials, and soffits. It also shows such items as HVAC registers and sprinklers and can indicate where switches are located.

An electrical plan (Figure 12.32) is a floor plan that shows wall and floor electrical outlets, telephone outlets, and other devices using power. Service panels, electrical line diagrams, and light-control switches can be added. In residential and small commercial projects, the electrical and lighting plans can be combined into one drawing (see Chapter 18).

A lighting detail (Figure 12.33) is drawn whenever more precise information is needed to explain the light fixture or how it is to be installed.

Although every lighting project and situation is different, we can look at some guidelines for a few specific applications in commercial interiors.

Office Lighting

Research has shown that improved lighting is directly related to increased worker productivity and efficiency. Lighting should be designed to make worker tasks as efficient and enjoyable as possible. Generally, successful office lighting must provide high-quality task lighting at the task surface, glare-free ambient lighting, and interesting perimeter or other lighting for visual relief. More than one lighting system should be incorporated, with regular or dimmer switches available at each task area in order to create visual balance when necessary (see Figure 12.34). Direct glare can be minimized by using a low-glare-producing lens, such as parabolic louvers in fluorescent luminaires, or indirect lighting (Figure 12.35).

A variety of meetings and associated activities might take place in conference rooms, creating the need for a flexible lighting system. Quality task lighting should be available directly on the conference table, with a separate switch for its control. To create a pleasant environment, perimeter lighting is a good choice for wall-washing effects. Supplementary lighting, on a separate dimmer switch, should be provided for presentations or displays on or near a predetermined wall.

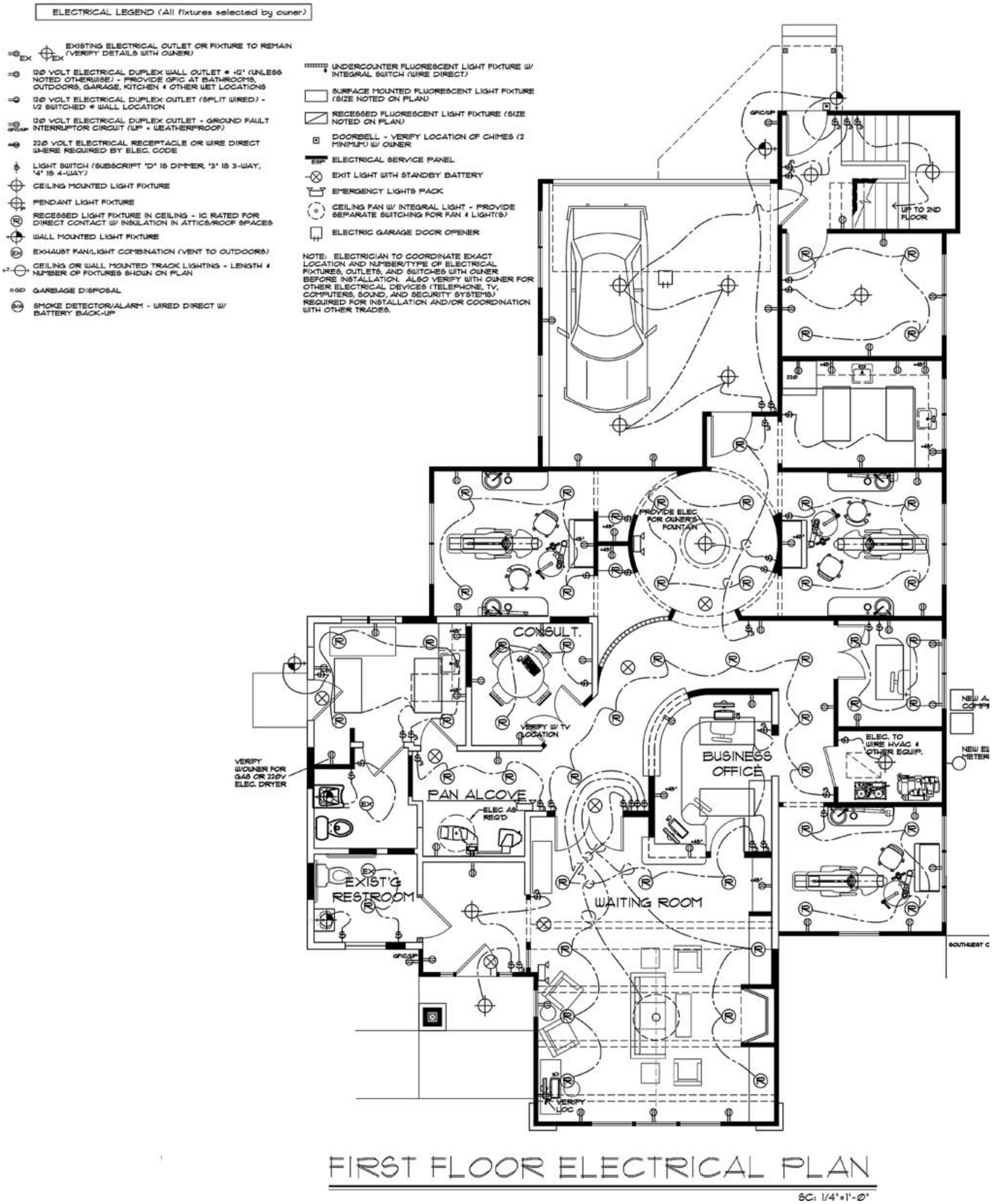


FIGURE 12.30 Example of a lighting plan.

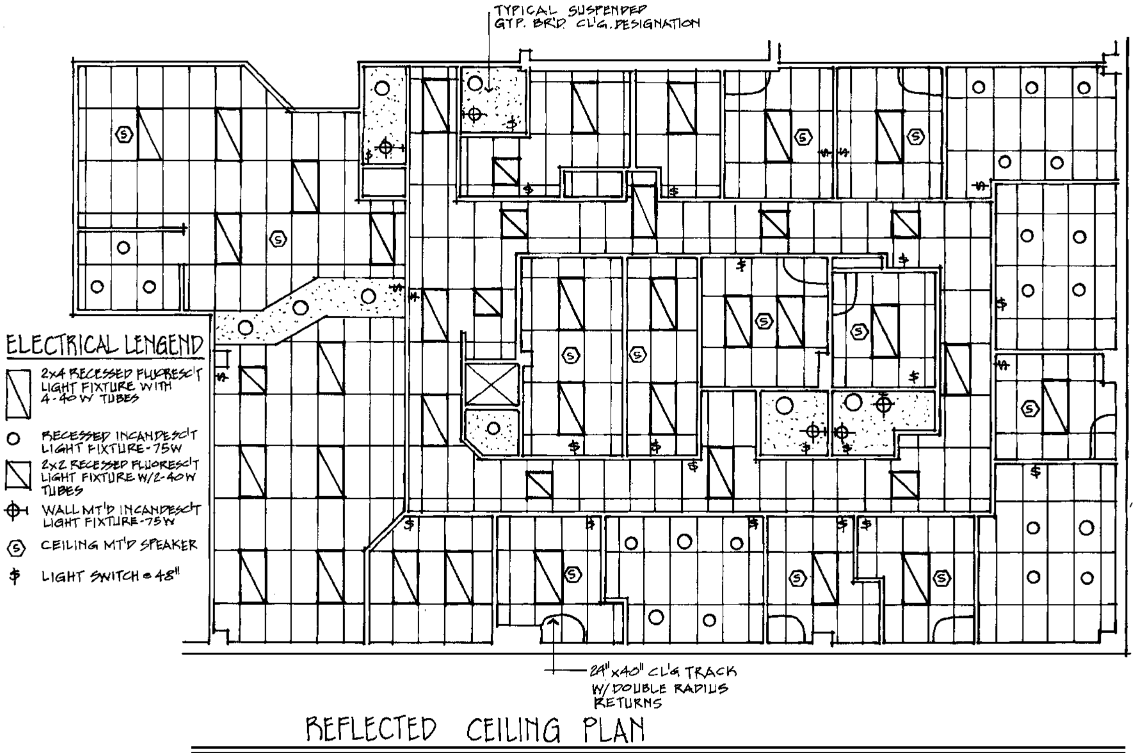


FIGURE 12.31 Reflected ceiling plan for a commercial space

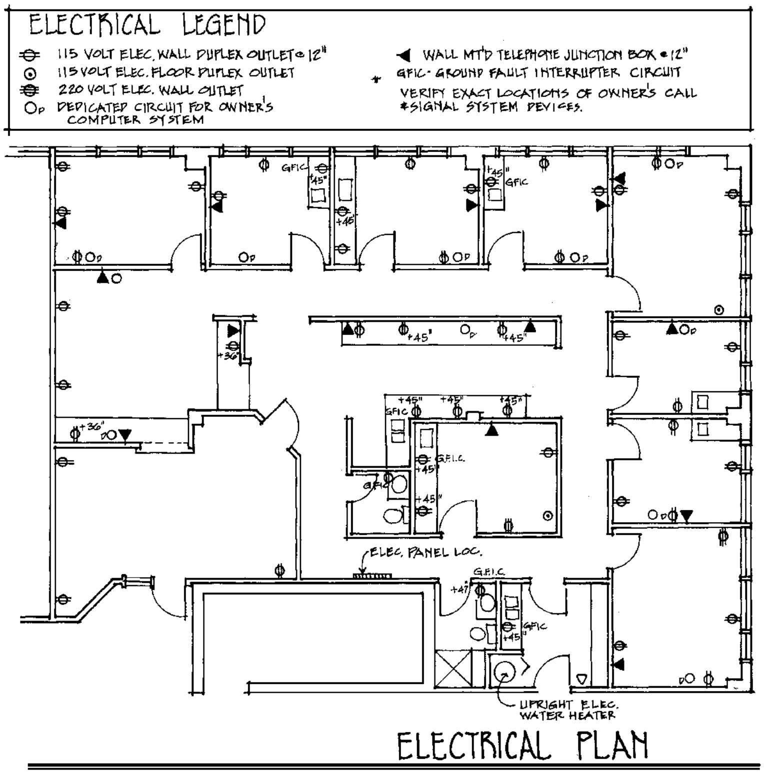


FIGURE 12.32 Example of an electrical plan

FIGURE 12.33 Examples of lighting details

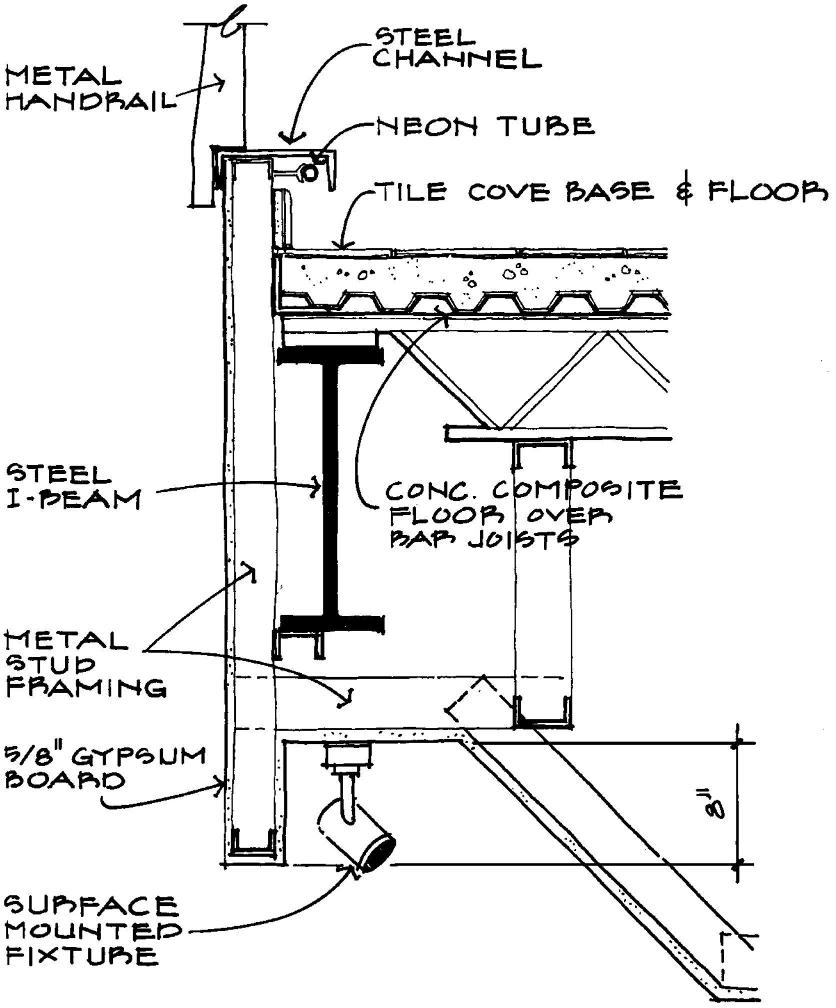


FIGURE 12.34 General ambient lighting and task lighting are provided over this reception counter in this dental office.

Courtesy of EnviroMed Design Group

FIGURE 12.35 Successful office lighting incorporates more than one type of system for interest and visual relief, including indirect lighting to reduce direct glare.
Courtesy of Kimball Office

Retail Lighting

Good lighting is a positive sales tool that can help attract customers and sell merchandise by enhancing the retail environment. Whether focusing attention on specials in the aisles or highlighting primary display areas, effective lighting can produce a pleasant atmosphere that will foster both spontaneous and repeat sales in a variety of commercial settings. It is critical that buyers in retail spaces be able to see the color of the merchandise accurately and with enough light.

Three basic categories of lighting are needed in a store environment to provide efficient and comprehensive store lighting: general, accent, and perimeter (Figure 12.36). General lighting is needed to provide optimum quantity, distribution, and light direction of appropriate color to establish overall visibility and character. Accent lighting is needed to add visual impact to displays and to draw the customers' attention to them. Perimeter lighting is used to draw attention to wall displays as well as contribute to the pleasantness of the store's environment. The level of light to accent merchandise is generally two to three times as high as that for general circulation areas. For featured displays, this level should be five times higher than that for general merchandise.

Recommended illumination levels depend on the type of store and its activity level. Activity levels can be categorized as high, medium, or low. High-activity areas are where merchandise is displayed under a uniform, generally high lighting level, as in a big box store. General lighting would range from 50 to 100 footcandles. Medium-activity stores usually require time and/or help to evaluate the quality or use of a product. Footcandle levels for general illumination would range between 30 and 50. Low-activity stores tend to be more intimate or upscale. Assistance and time are usually necessary for a customer to reach a buying decision. General illumination for low-activity areas range from 10 to 30 footcandles.

FIGURE 12.36 General, accent, and perimeter lighting are needed in retail spaces to provide efficient and comprehensive viewing.
Courtesy of Knoll, Inc. / Richard Caden

Fluorescent, halogen, LED, and high-intensity discharge light sources can be used for retail lighting; however, each has unique characteristics and should be selected to fit the lighting, merchandising, and economic objectives.

Restaurant Lighting

Lighting for restaurants must fulfill the two major requirements of function and mood. Diners must have enough light to read the menu comfortably and to see their meal and each other; employees must have adequate lighting to serve the diners. Lighting also must enhance the mood established by the overall design concept and the type of food service offered. For example, in fast-food restaurants a fast-paced atmosphere is created by bright light, whereas a leisure dining restaurant would use subdued lighting to foster a slow and relaxing pace (Figure 12.37).

Although the mood or atmosphere may differ, functional lighting for serving counters, workstations, and public facilities is generally the same. To create a specific mood, the designer must consider the type of food served, the type of accommodation, and the potential trade or audience.

As in other types of facilities, the best general guideline is to mix different types of lighting for different activities and moods. General lighting is needed for circulation, orientation, and cleaning after hours. Task lighting should be added for specific activities, and accent lighting for interest and mood. General lighting for a restaurant ranges from 10 to 50 footcandles, depending on the type of facility. Major sources of light, such as luminous ceilings, ceiling panels, or large fixtures, need to produce soft, not harsh, light. Luminaires that hang below the ceiling, such as chandeliers or pendants, should relate to the architecture of the space if the furniture is movable; if the furniture is fixed, pendant or other suspended fixtures can relate more specifically

FIGURE 12.37 Daylighting and bright pendant lighting accent the brightness of this breakroom dining facility.
Courtesy of Kimball Office

to the furniture. Luminaires mounted on the ceiling should relate to the design of the space. Intense downlights should not be placed over customers' heads, since they create unflattering and harsh shadows under the eyes and nose.

Direct light (downlight in pendants or recessed fixtures) over tabletops is a good way to create sparkle on table items. Wall-mounted fixtures can add to the decoration of a space but do not produce sufficient light for most restaurants. Wall washing is a good technique to emphasize a wall finish and reflect some light to add to the overall illumination. If low illumination is the design goal, higher illumination should be provided as a backup for cleaning the restaurant.

Dimmers should be incorporated in any restaurant lighting system, since the illumination level will generally need to change according to the time of day, available daylight, and varying atmospheres.

Healthcare Facilities Lighting

Lighting requirements for medical offices and other healthcare facilities can differ greatly, depending on the specialty and the size of the practice and environment (Figure 12.38). Lighting in all areas must be flexible to

FIGURE 12.38 The use of wall sconces in the corridor of this dental office provides general lighting and serves as accent lighting.

Courtesy of EnviroMed Design Group

accommodate the physicians, nurses, patients, family members, and visitors. However, some general guidelines apply.

Most examination rooms need at least a maintained general light level of 50–100 footcandles. For closer examination purposes, a doctor will generally require a high-intensity portable lamp in each room.

Nurses' stations require at least 50 footcandles of maintained illumination, and minor surgery rooms require from 100 to 150 maintained footcandles, depending on the procedures performed. In addition to the maintained illumination, surgery rooms usually have a ceiling-mounted high-intensity surgical light available.

A lower light level, between 20 and 30 footcandles, is appropriate for waiting rooms. Although task lighting is needed for those who wish to read, overall lighting can be designed to create an inviting atmosphere. Lighting in these areas can be achieved by direct or indirect luminaires. In many healthcare spaces, a variety of incandescent, halogen, LED, or fluorescent lamps might be used, depending on the type of activity and needs (Figure 12.39).

LIGHTING CODES AND REGULATIONS

Because protecting the health, safety, and welfare of the general public is a major concern for the interior designer, it is important for the designer or the design team to know which codes will be applicable to a given lighting system. There are three main areas of codes that relate to lighting. One is energy conservation and the power-budget limitations. The second area is the requirements for emergency lighting and illuminated exit signs highlighting the means of egress from the building. The third area is related to the fire rating of a building and the selection of light fixtures that may penetrate a rated ceiling or wall.

FIGURE 12.39 A variety of task, general, and accent lighting is used in this healthcare setting. *Image Courtesy of Herman Miller, Inc.*

Lighting standards and codes are set by various authorities, depending on where the building is located, the type of building, and whether it is government owned. The U.S. Department of Energy (DOE) and the General Services Administration (GSA) are two federal agencies that have specific requirements for lighting for federal buildings. Lighting standards and regulations are also set by the National Fire Protection Association (NFPA) codes, which include the National Electrical Code, as well as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Illuminating Engineering Society of North America (IESNA), and the National Institute of Science and Technology (NIST).

Because lighting uses 20–30 percent of a commercial building's electrical energy usage, good light design can save up to one-half of the electrical power used for lighting. ASHRAE/IESNA Standard 90.1, *Energy Efficient Design of New Buildings*, developed a set of standards for light power credits for lighting control systems designed with energy-conserving controls. Lighting levels and energy power budgets set by these standards affect the type of lighting source, the luminaire selection, the lighting system, furniture placement, and maintenance schedules. These codes limit the amount of watts per square foot of lighting permitted in new and remodeled installations. Most codes consider 3 watts per square foot reasonable; however, some codes are setting lower levels, such as 2 or even 1 watt per square foot, for maximum energy conservation.

Typically, commercial codes require that in the event of a power failure, sufficient emergency lighting must be available to safely evacuate building occupants. Emergency lighting is designed to lead occupants to exit doors, fire-rated stairwells, or fire escapes. Emergency lights must have the capability to remain illuminated for up to 90 minutes either by battery, internal illumination, or connection to an emergency power source. Emergency lighting requirements for means of egress require a minimum lighting level of 1 footcandle (11 lux) at the floor level upon initial operation.

Illuminated exit signs are required in most commercial buildings at each exit door and at each door leading to an exitway. Exit signs must be directional at corridor intersections and where a corridor changes direction.

If a building is fire rated and the selected luminaires will penetrate the rated ceiling or walls, the luminaire must also be rated accordingly to prevent fire or smoke from spreading through these penetrated areas.

FOR FURTHER READING

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Materials—Characteristics and Applications

13

INTRODUCTION TO SELECTING MATERIALS

Materials are the basic building substances architects and interior designers use to create built environments and to give form, shape, variety, and distinction to interior spaces. Materials provide the physical and psychological form to the space, structure, finishes, and contents for human beings to use. Some materials are an integral part of a building structure; others are applied as a surface treatment or used on components, such as furniture or cabinetry. For example, materials such as stone and wood can be used as construction elements to enclose space and provide protection and privacy, yet supply color, texture, pattern, and durability as a finish to the space.

Materials change from period to period as technology advances. Not only do new materials appear in each generation, but new ways of using old materials also emerge. New technology and materials also give rise to new design ideas.

This chapter will introduce materials, describing their intrinsic (integral) characteristics, how they are produced (manufactured), and how they can be used as design elements. Chapter 14 will show how these materials serve a specific function within a building, for example, how wood is used in different applications, including as a flooring material or wall covering.

Before the nineteenth century, most common buildings were constructed of local or indigenous materials; that is, if the region was wooded, buildings were primarily made of wood. For temples, churches, monuments, palaces, and similar structures, however, high-quality materials such as marble were imported from great distances, because these buildings and their use symbolized wealth, power, and luxury. After the nineteenth century, better manufacturing processes and transportation modes created greater opportunities for materials to be used beyond their regional borders and in all types of buildings.

Materials, Environmental Concerns, and Sustainability

The selection and use of "green" building materials help reduce the environmental impact associated with the extraction, processing, fabrication, shipping, and installation of most materials used for buildings and their interiors. The use of these materials also promotes conservation of nonrenewable resources and encourages reuse and recycling practices.

Another concern for material acquisition is the reuse or recycling of materials. Although we think of creating or using newly manufactured materials and ultimately discarding them, many can be recycled. For example, used brick and timber are often reclaimed from former structures to be used in new or remodeled structures. Newspapers can be recycled into building insulation, such as cellulose, that is used in attics and walls. Glass, aluminum, and steel can be reclaimed and reconstituted into new materials.

Biodegradable materials are another major concern for the preservation of our environment. The primary impact comes from consumer products that are thrown back into the environment in landfills. The packaging used for building materials and leftover materials, such as foam packaging, compound the problems of waste. Discarded wood, however, can often be turned into sawdust and refined into particleboard and other products, burned for fuel, or allowed to disintegrate into the environment eventually.

The designer must be aware of the impact that the overuse of some rare natural materials will have on our environment. For example, the dark, exotic woods, such as ebony, come from the tropics, and the rapid destruction of the rain forests where they grow is a global problem. The designer can help to save our environment by not specifying these exotic woods for unnecessary uses where more plentiful and renewable woods would suffice.

The "sick building syndrome" is caused by low levels of indoor pollutants, and in turn causes occupants to experience eye, nose, throat, and lung irritations, as well as headaches, lethargy, and difficulty in concentrating. Many common types of hazardous gases polluting interior environments are produced from such seemingly innocent materials as paints, carpets, glues, particleboard, and man-made textiles. Manufacturers are continually trying to improve the quality of their materials in order to reduce air pollution hazards. The interior designer must understand the potential hazards of some materials before specifying them for use in these closed environments.

Today, materials come from worldwide locations. However, some indigenous materials are still used regionally as a distinct design element. The adobe material used in the Southwestern regions, for instance, gives the architecture there a look not common in other regions of the country.

Materials are used in their natural, converted, or artificial state. Some building elements might be constructed of a combination of these, such as a stone facing (natural) over a concrete wall (converted) that has integral steel (artificial) reinforcement (Figure 13.1).

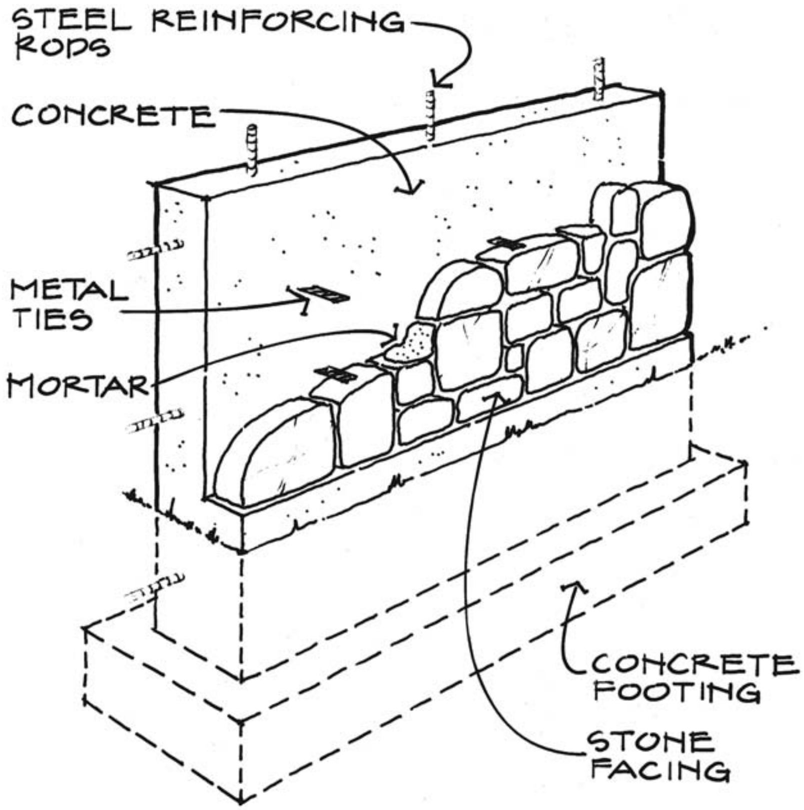

FIGURE 13.1 This composite wall is made of a natural material (stone) secured to a converted material (concrete) that is reinforced with steel (artificial material).

Natural Materials

Natural materials are those found in nature, either as organic or as inorganic substances. Organic materials are those that come from plants and animals; inorganic (nonliving) materials are those, such as soil, clay, and stone, that exist in a natural state. Although either type might be modified, such as by cutting a tree (plant) into lumber or the stone into rectangular blocks, both are nevertheless considered natural materials.

Converted Materials

Converted materials are materials processed or manufactured into different forms. For example, clay exists as a natural substance, but when it is fired at high temperatures, it is converted into a new material called ceramic. In this converted state, clay possesses new characteristics and offers uses not possible with its original state.

Artificial Materials

Artificial materials are created by man-made processes that produce new substances. Plastics are one of the best examples, since they are artificially created from petroleum and chemicals. Plastics cannot be found in nature as a distinct product but are made from a combination of natural elements.

Materials that are created with artificial properties that may not be found in nature are termed *metamaterials*. A lot of these are found in specialized fields such as aerospace and electrical engineering, including smart solar power management and acoustical controls.

Material Selection

The interior designer must be knowledgeable about the intrinsic qualities and practical values of materials and must also have the sensitivity and aesthetic judgment to select the most appropriate material for the intended use. Materials can be chosen for their surface appearance, such as color or texture; however, this is in most cases not the best criterion. Materials should first be selected for their functional qualities, such as durability; sustainability, insulating, acoustical, or fireproofing qualities; and ease of maintenance.

A prime consideration in the selection of materials is the intended use of the space and the material's visual suitability for the intended atmosphere or mood to be created. Heavy, rough textures and dark colors would be inappropriate for a children's play area but might create a rustic mood in a restaurant.

A designer should select materials according to the following checklist of criteria for function, aesthetics, and ecological and economic factors:

1. Functional Characteristics
   — Appropriateness and suitability to use
   — Durability and resistance to damage
   — Ease of maintenance
   — Safety and fireproofing where required
   — Insulation and acoustical properties
   — Regulations/codes that govern
2. Aesthetic Considerations
   — Appropriateness to the design concept
   — Surface qualities, such as texture and pattern
   — Color and light reflection and absorption qualities
   — Visual suitability to intended mood or atmosphere
   — Balance, size, and proportion of the space
3. Ecological Considerations
   — Environmental impact for acquisition
   — Efficient manufacturing processes
   — Recyclable content (postindustrial and postconsumer)
   — Renewable resources, such as sustainably managed sources
   — Capability to be recycled or reusable
   — Nontoxicity to users, minimal chemical emissions
   — Moisture resistant and inhibiting growth of biological contaminants

4. Economic Considerations or Life-Cycle Assessment
— Initial cost of material, shipping, and installation
— Availability of material
— Cost of maintenance and possible replacement, recycling, or minimizing waste (if discarded)

WOOD

Because of its abundance in nature and the relative ease with which it can be obtained and worked, wood has been used for centuries as a major material for buildings and furniture. Wood is also an excellent insulator and a renewable material. Although thousands of different species of trees exist, only about 100 species are used commercially as building materials.

Wood is organic, renewable, biodegradable, and recyclable. Former forestry practices of clear-cutting large swaths of old forests are giving way to more sustainable forest operations. These practices now strive to create well-managed forests and encourage tree growth to match or exceed annual harvesting of trees.

Sawmills cut tree logs into lumber as boards of various sizes. When both the width and the thickness of lumber exceed five inches (127 mm), these boards are called timber and are used mostly as posts and beams for structural support.

In former times, many buildings used heavy timber for construction and even expressed some of the timber structure, creating a visual style of half-timber buildings. Today, lumber is cut smaller and used more efficiently for construction, but there still exists some activity in the timber construction methods.

Physical Properties

The structural makeup of wood consists of longitudinal bundles of cellulosic fibers and pores (Figure 13.2). These fibers run parallel to the length of the tree; medullary, or pith, rays radiate from the center at right angles to these fibers. When wood is cut, the figure and grain are exposed, resulting in distinct patterns for each tree type and method of cut.

A tree grows new wood in the spring and summer in concentric annual rings over the older wood, thus increasing the tree's girth. In locations with little or no seasonal fluctuations, the growth rings are not as distinct. The outer layers (sapwood) usually are softer and lighter in color than the center section, called the heartwood. Heartwood is generally the preferred wood but is more expensive, in redwood trees, for example.

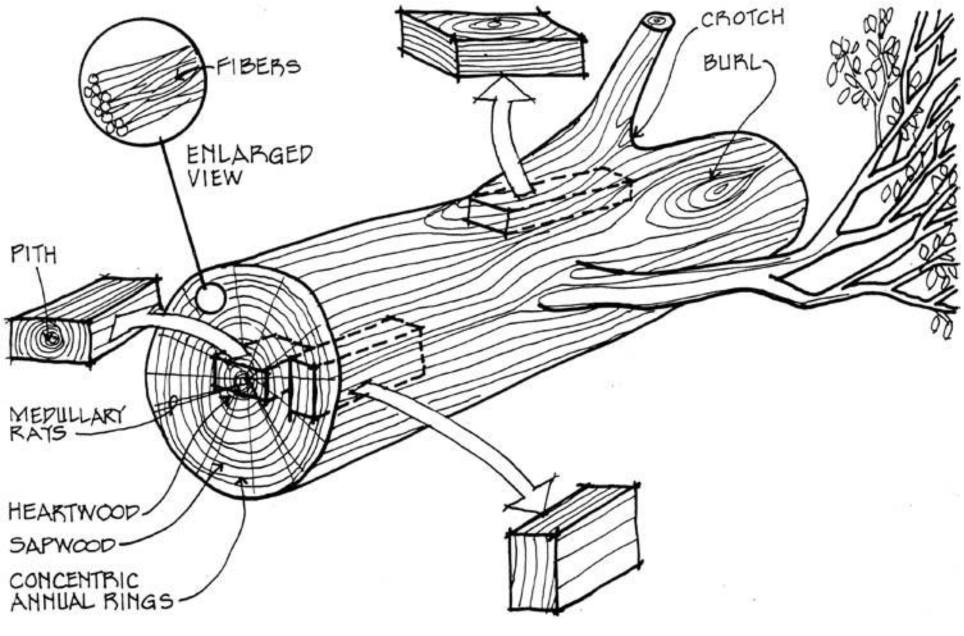

FIGURE 13.2 The visual appearance and strength of lumber sawn from a tree will vary according to the location and direction of the cut.

The way in which a tree grows also has a marked influence on its strength characteristics. The wood can easily be split in a vertical or longitudinal grain direction, but must be sawed across the grain. For these reasons, wood has good physical strength; it is used for both tension (resistance to bending) and compression (resistance to loads of pressure). This versatility allows wood to be used both for beams to span long distances and for vertical posts to hold up floors or roofs. Its tensile (tension) strength allows it to be used in cantilever construction, such as in wood decks suspended from a building (Figure 13.3).

For construction purposes, wood is graded according to its appearance, strength, use, and defects (knots and pitch pockets). A knot in a tree is generally the base of a side branch and can affect the technical and visual properties of the wood. In grading lumber, knots are graded according to their size, form, and firmness of holding in place. But, knots might be desirable in decorative applications of wood, such as burl wood. Aesthetic possibilities for the use of wood are seemingly endless. The many different wood types, their grains, and their colors offer a variety of possibilities for natural appearance and for finishing. Finishing includes both the natural weathering properties of wood and applied finish coats, such as oils, paints, and plastics.

FIGURE 13.3 Wood has good properties to be used in framing the cantilever construction in this balcony.
Fotosearch/Getty Images

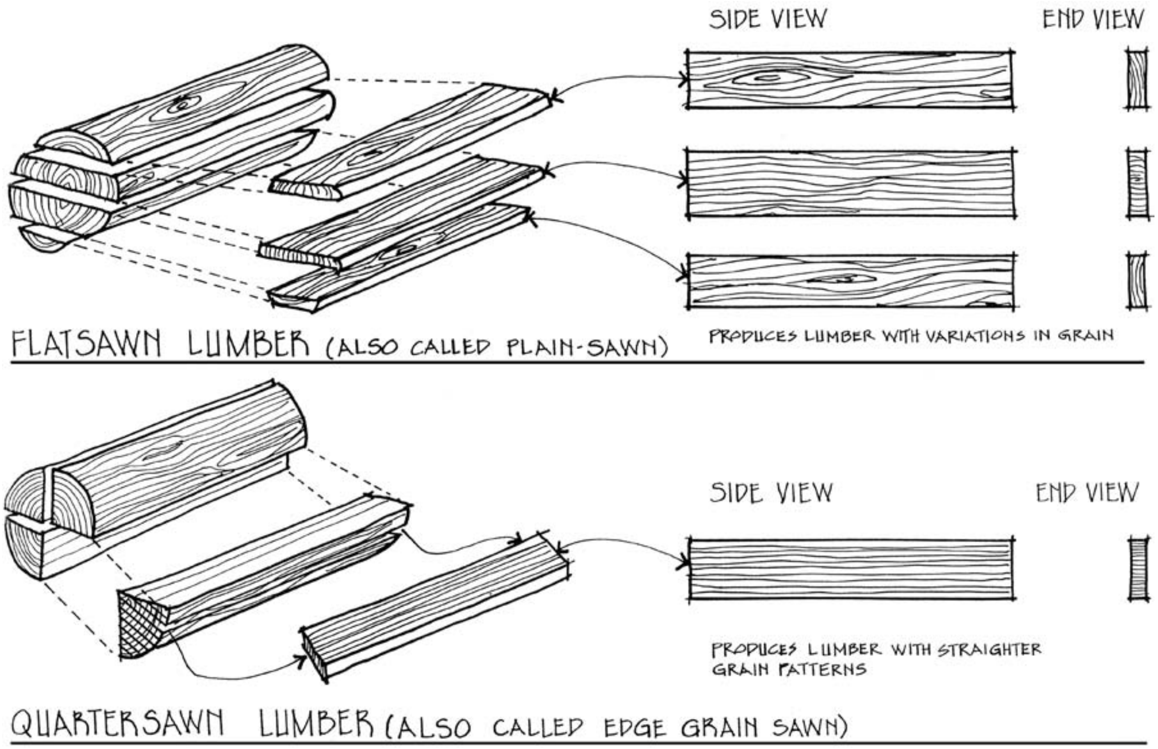

FIGURE 13.4 Plainsawn lumber has a variety of grain patterns and twists (or warps). Quartersawn lumber is more stable and produces more even grain patterns.

Sawing of Lumber

Wood shrinks tangentially to growth rings and lengthwise from drying after it is cut. The methods of sawing produce different characteristics in the resulting lumber. The two basic ways of cutting wood are flat-sawing and quartersawing (Figure 13.4). Flat-sawn lumber (most common method) consists of longitudinal cuts parallel to the log diameter, producing a variety of grain patterns, some displaying a cathedral-like effect. This wood tends to wear unevenly and to bend or twist when drying. Quartersawn lumber is produced by quartering the log and cutting each section in pieces parallel to the radius. This method is more expensive but produces more even, straight-line grain patterns; is more stable; and wears more evenly, having less twist as it dries.

Standard Lumber Sizes and Units

Lumber (termed dimensional lumber) is cut to specific sizes and designated by its nominal size, not its actual size. Rough lumber is larger than surfaced lumber, although both are referred to as the same nominal size. The surfaced size of a nominal 2 × 4 is actually 1½ inches by 3½ inches (38 × 88 mm). Lumber designated as 1 inch (25-mm) thick is actually ¾ inch (19 mm) when seasoned. However, in the United States, hardwood dimensional lumber varies in size from the softwoods and often a bit smaller in dimensional sizes. Standard lengths for lumber are generally produced in 2-foot (609-mm) increments, such as 8, 10, and 12 feet (2,438; 3,048; and 3,657 mm).

The unit measure for lumber is the board foot. This is the amount of lumber equal to 1 inch (25 mm) thick, 12 inches (304 mm) wide, and 1 foot (304 mm) long. Lumber less than 1 inch (25-mm) thick is considered to be 1 inch (25 mm).

Moisture and Seasoning

Wood expands when it absorbs moisture and contracts when it loses moisture. This loss can cause checking or cracking. It is necessary to dry the wood properly before using it because it can also twist, cup, bend, or warp as it dries. A drying process called seasoning is used to improve the wood's strength, stability, and resistance to attack from fungi, decay, or insects.

Wood can be seasoned by stacking and drying it naturally with air, but this procedure can take months to remove the moisture from cut lumber. Kilns are used to dry lumber quickly; with this procedure, wood reaches optimum dryness. Lumber is generally considered dry when its moisture content does not exceed 19 percent.

Even if wood is seasoned, it can still absorb or lose moisture depending on the section of the country it is shipped to for use. This variation in moisture can cause problems of checking and warping if the wood is not properly protected in its final form by using various preservatives or paint finishes.

Hardwoods and Softwoods

Wood is classified into hardwoods and softwoods (Figure 13.5). Hardwoods come from broad-leafed or deciduous trees that lose their leaves in the winter, such as oak, maple, and walnut. Hardwoods generally have a finer grain and are used in interior trim, paneling surfaces, furniture, and finished flooring. They are more expensive than softwoods and harder to shape; however, they take finishes better.

FIGURE 13.5 Common wood species and typical uses

SPECIES	HARDNESS	CHARACTERISTICS	USES
ASH, White	Hard	Creamy white to light brown; open grain similar to oak	Cabinetry, trim, furniture
BASSWOOD	Soft	Creamy white; closed grain	Carvings & decorative molding
BEACH	Hard	Reddish brown to white; good utility wood; closed grain	Cabinetry, furniture
BIRCH	Hard	White to reddish brown; strong, heavy; closed grain	Cabinetry, paneling, furniture, flooring, trim
CEDAR, Western Red	Soft	Lightweight, weak strength; easily worked; reddish brown to white; closed grain	Mostly used on exterior for decay resistance; shingles, siding, paneling
CHERRY, Black	Hard	Reddish brown; durable strong; beautiful color; closed grain	Furniture, veneer, paneling, cabinetry, trim
CYPRESS	Soft to Medium	Yellowish brown; resists decay; weathers well; closed grain	Exterior siding, trim, posts, frames
FIR, Douglas	Medium	Reddish tan; good utility wood; closed grain	General framing, trim, paneling, plywood, cabinetry
MAHOGANY, African & Tropical American	Medium-Hard	Reddish brown; strong, dense; low shrinkage; open grain	Cabinetry, frames, trim, furniture, veneer
MAPLE, Sugar & Hard	Medium-Hard	White to light brown; dense; good utility hardwood; closed grain	Cabinetry, furniture, flooring, veneer
OAK, Red & White	Hard	White or pale gray to reddish brown; carves well; open grain	Cabinetry, furniture, flooring, paneling, trim
PINE, Sugar	Soft	Creamy white; easily worked; general usage; closed grain	Cabinetry, doors, paneling, trim, windows
PINE, Eastern & Ponderosa	Soft	White to cream; wide range of applications; closed grain	Carving, cabinetry, paneling, trim
POPLAR, Yellow	Medium	White to brown; easily worked; good utility wood; closed grain	Cabinetry, furniture, siding, trim, paneling
REDWOOD	Soft	Reddish, high resistance to decay; closed grain	General construction, outdoor furniture, paneling, trim
TEAK	Hard	Yellow to dark brown; expensive; open grain	Cabinetry, furniture, paneling, trim
WALNUT, Black	Hard	Light to dark chocolate brown; fine, strong wood; open grain	Furniture, cabinetry, veneers, paneling, trim

Softwoods come from evergreen or coniferous trees that keep their leaves or needles throughout the year. These include cedar, pine, and redwood varieties. Softwoods are used mostly for structural members and general-purpose construction. They are often the hidden parts in the framework of a building or the subframe of cabinets. Although hardwoods in general are harder than softwoods, this terminology does not necessarily refer to the actual strengths of wood; some softwoods can be harder than some hardwoods. The softwood of yellow pine is actually harder than the hardwoods of balsa and basswood.

The designer selects the category of wood that best suits the aesthetic needs and purpose of the task. Hardwoods are reserved for durable door and window trims, for fine furniture, or where custom finishes are needed. In some cases, many softwoods can be used in place of hardwoods if maximum strength or other fine finish characteristics are not needed.

Wood Layering

In addition to being used as boards and timbers, wood is layered in various ways to achieve different strengths and appearances, such as in veneers, plywoods, fiberboards, and laminated wood (Figure 13.6).

Veneers

Veneers are thin sheets of wood sliced from a log; these vary from paper-thin slices to ⅛-inch (3 mm) thick. Veneers can be trimmed from a log as a continuous sheet (rotary cutting) or sliced as flitches. Veneer flitches are edge trimmed, matched in grain pattern, and glued to thicker backings, such as plywood or particleboard. Veneers that come from a particular log are kept in order so they can be matched later in various grain patterns. The part of the tree and the manner of the cut will produce different veneer patterns. Cuts can be made from the crotch, stump, or burl of a tree to produce many grain patterns. Burl occurs where the tree has healed itself from damage and exhibits a swirling pattern where it is cut across.

Veneers are taken from logs by rotary cutting, slicing with a knife, or sawing (a method not used much anymore). Rotary cutting (Figure 13.7) is accomplished by rotating a log on a lathe against a long knife to produce a continuous, thin sheet, much like pulling wrapping paper from its roll.

In addition to rotary cutting, there are four slicing methods of cutting veneers, each producing a distinct grain pattern. These are flat slicing or plain slicing, quarter slicing, half round slicing, and rift cut (actually a slicing process).

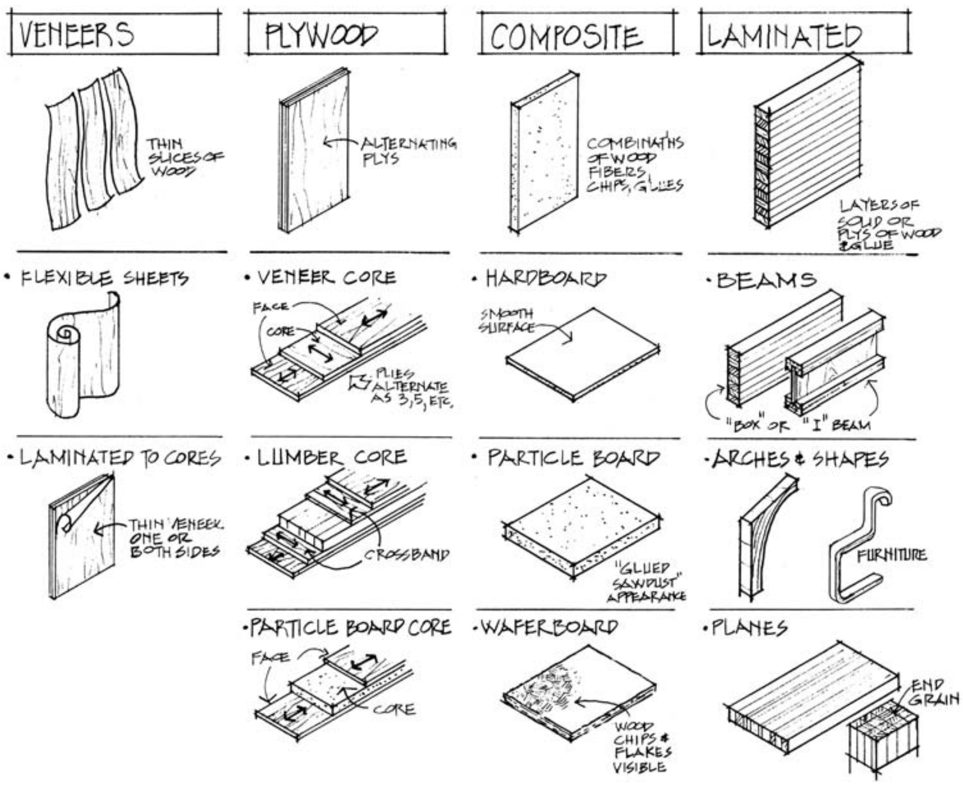

FIGURE 13.6 Wood can be cut, modified, and combined in many ways to serve specific purposes or feature advantageous characteristics.

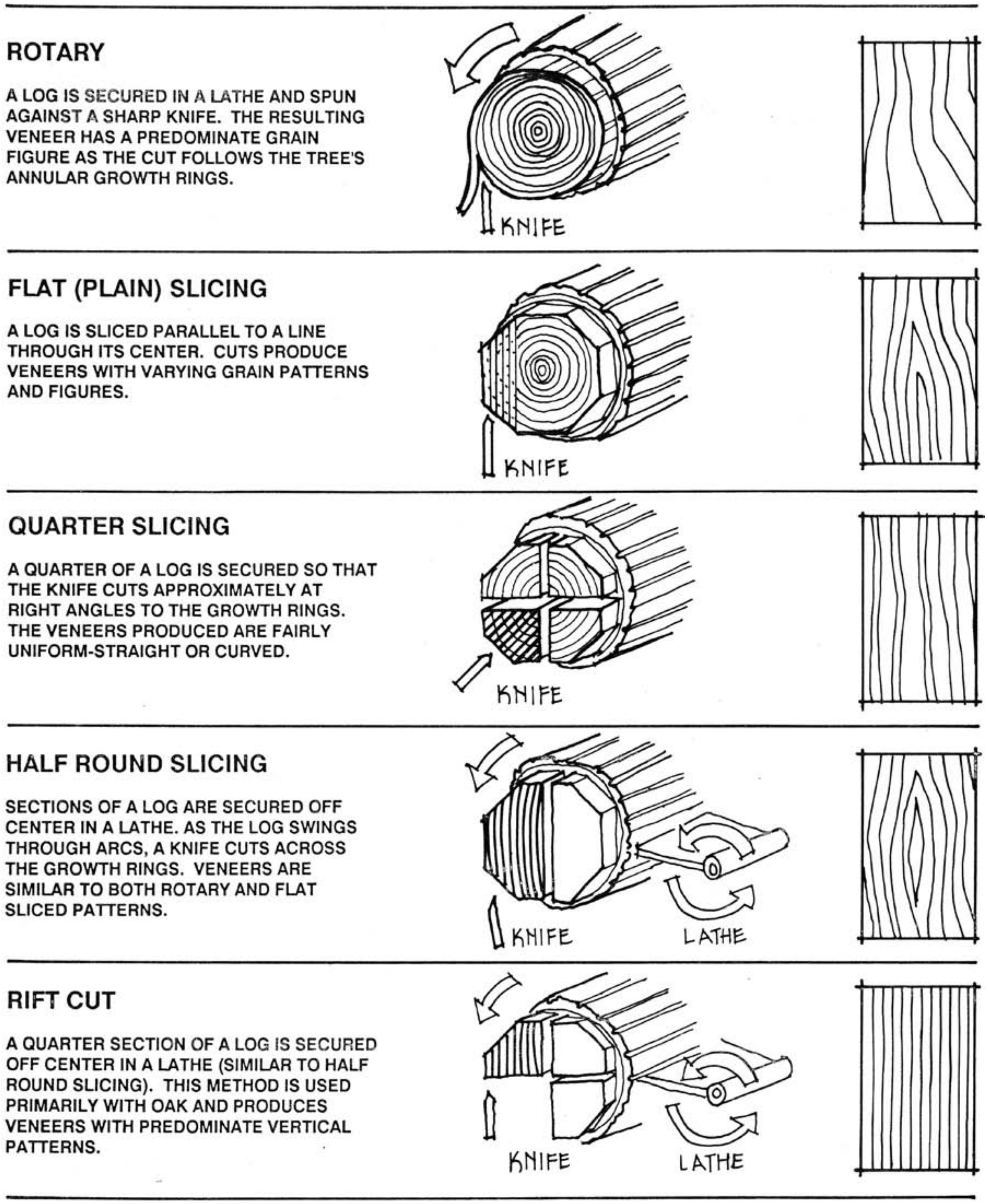

FIGURE 13.7 Methods of cutting wood veneers.

Veneer flitches are trimmed and glued to panels to produce different visual effects of matching (Figure 13.8). These are:

1. Book matching, which turns over every other flitch like the leaves of a book and produces a matching grain pattern at the edges, emphasizes maximum continuity of the grain. This method and slip matching are the most common for premium assemblies.
2. Slip matching, which retains the veneer sequence without flipping the pattern. It joins the pieces side by side to repeat the grain figure. However, the joints are not matched.

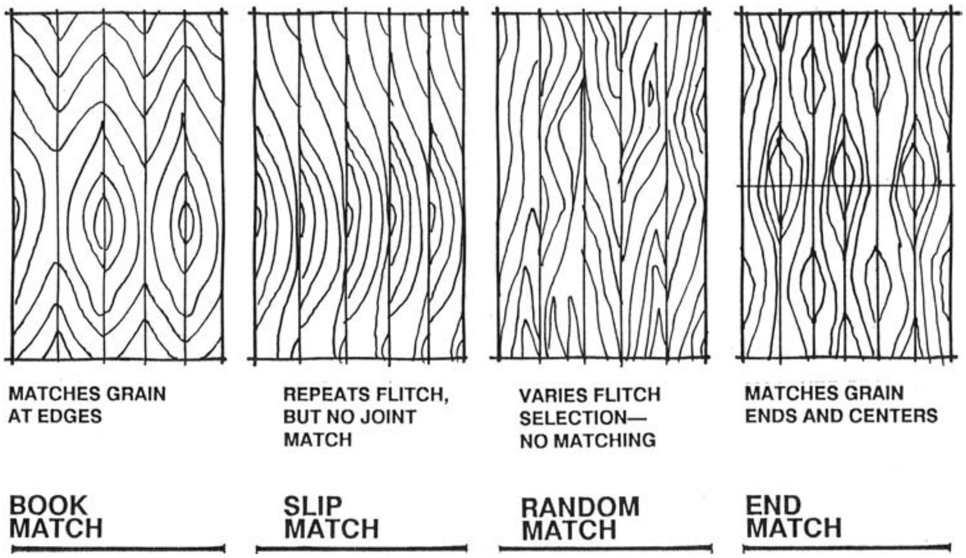

FIGURE 13.8 Wood flitch veneers are cut and glued to panels by various methods to produce different grain patterns.

3. Random matching, which results in a flitch mismatch through random selections of varying flitches, producing a boardlike look with large variations in pattern. It is usually done with lower grades of veneer.
4. End matching, which book-matches the grain ends as well as the centers, producing uniform grain looks both vertically and horizontally. It essentially splices one veneer leaf end to end with another to produce a longer veneer panel.

Plywood, Fiberboard, and Composite

Plywood is a laminated or layered wood panel composed of veneers or wood plies, the grains running at right angles to one another. Most plywood is manufactured as three, five, or seven plies, depending on the panel thickness. This alternation of plies (always an uneven number) gives added strength in two directions to reduce warping, splitting, and shrinking of the panel. This stability is useful for construction of floors, walls, roof sheathing, paneling, and even furniture. The outer layers can be of rough construction-grade finish, finely sanded, or attractive wood veneers. Plywood panels are made with various wood species and range from 1⁄8 inch (3 mm) thick to more than 1 1⁄8 inches (28 mm). These panels are produced with three basic core types: wood veneers, lumber cores, and particleboard. Panels are made for interior or exterior use and commonly are 4 feet (1,219 mm) in width. Lengths vary, although 8, 9, and 10 feet (2,438; 2,743; and 3,048 mm) are the most common.

Molded plywood is produced when the wood layers are pressed between curved molds, producing a finished work in the shape of the mold. This technique can often be found in the furniture industry in the form of chairs and the specific parts, such as the backs or seats.

Composite board is made of wood particles and glue of varying types. It includes hardboard (MDF), particleboard, and waferboard.

Particleboard is made from wood particles, such as sawdust, sawmill shavings, and wood chips bound together under pressure and some form of glue/resin. It is generally cheaper than plywood and denser. It is manufactured in different grades and can have a wood or plastic veneered surface for better visual and finishing techniques.

Medium-density fiberboard (MDF) is denser than plywood and made with wood fibers and binders to form panels denser and stronger than particleboard. It is useful for building assemblies that are strong, smooth, and very paintable. There are four product grades of MDF, ranging from very high density down to low density.

Hardboard is actually a very dense fiberboard, similar to MDF, but often produced with one or two very smooth faces. An example of hardboard is the product Masonite, made since the 1940s.

Oriented strand board (OSB) consists of thin layers of wood flakes and strips set in mats with glue and bonded/pressed together. It is also sometimes called waferboard, because of its rougher finish, and it is used mostly for rough framing of floor, wall, and roof sheathing. This material is almost as strong as plywood, is more resistant to water damage, and is less costly. Builders often prefer OSB waferboard for floor and roof sheathing (Figure 13.9).

FIGURE 13.9 Oriented strand board (OSB) is used for the wall and roof sheathing of this residential addition.

Engineered Lumber

In addition to dimensional lumber, wood can be designed for specific structural or trim purposes. This process uses the entire tree, including the waste wood (sawdust), often discarded. Engineered lumber is more structurally consistent than dimensional lumber and straighter. As seen in Figure 13.10, the most common types of engineered lumber are:

1. Finger-jointed lumber: Made by milling tightly fitted joints in short pieces of lumber (which are usually considered scrap) to produce long lengths of lumber.
2. Glu-lam beam: Made by gluing multiple layers of common-sized pieces of lumber together, so that they act as one large beam of lumber. They are typically stronger than similar-sized dimensional lumber.
3. Laminated veneer lumber (LVL): Produced by layering and gluing sheets of veneer peeled from logs and subjecting them to heat and pressure to achieve a permanent bond. They are used primarily as structural beams. Similar to LVLs, parallel strand lumber is engineered lumber made by aligning wood strands together and gluing/bonding into a structural beam.
4. I-beam (referred to as wood I-joists): Resembles the look of a steel I-beam, but made with a top and bottom chord of dimensional lumber and a flange of oriented strand board (OSB). They can be manufactured in long lengths up to 36 feet (10.9 m) and sometimes with pre-cut holes (knock-outs) for passage of small conduits of electrical runs or plumbing perpendicular to the span.

Designing with Wood

Wood has great diversity for use as a building material because of its strength, finish appearance, and shape. It can be formed, combined with other materials, and finished in numerous ways. It can be produced as rough-sawn, resawn, or smooth and in coarse to fine surface finishes.

Although wood is an excellent building material, some precautions need to be addressed in using it. Wood can be subject to decay from fungi in warm, moist areas. However, timber that is totally immersed in water can last

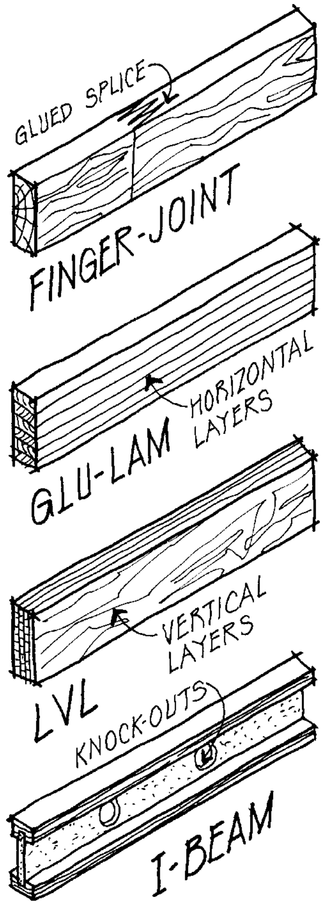

FIGURE 13.10 The four basic types of engineered lumber are finger-jointed, glu-lam, laminated veneer, and I-beams.

indefinitely, because the fungi lack air, which they must have to attack the wood. Another problem is that various insects, such as termites, can attack wood and cause considerable damage.

Designing and working with wood usually modify its appearance by cutting and shaping it; however, unique applications can be achieved by using wood in its natural state. Specialty woods, such as rattan and bamboo, can be used in their natural state as a distinctive building material for structural elements, interiors, and furniture making. Bamboo is actually a fast-growing grass but is often associated with wood products. It approaches the hardness of maple and oak, and is often used in flooring materials.

Wood can be shaped into forms by straight-line cutting, carving, laser cutting, burning, or turning on a lathe. These methods can produce shapes that are geometrical and precise or beautifully carved and free-form. Shaping can also produce long, narrow strips of wood, such as moldings, that are applied to walls, ceilings, windows, and doors (Figure 13.11).

Piecing

Wood can be pieced together in a variety of ways; for example, the end grain can be exposed for butcher blocks, or inlays can be made of different woods and other materials. These constructions can produce contrasting textures and color patterns, as in a mosaic in furniture or flooring. Another example of piecing wood, parquet, utilizes wood strips laid in various geometric patterns, as seen in tables and floors. (See Chapter 14 for more information on wood flooring.)

Joinery

Wood is joined in many ways for both general building construction techniques and interior paneling and trim, as well as for making casework and furniture. Many kinds of joints have been developed, and each has distinct advantages and disadvantages. Joints can be glued, nailed, bolted, or secured by specialized connectors. A designer needs a working knowledge of various joints and their applications to select a joint for its structural qualities, ease of production, and aesthetic appeal (Figure 13.12). Joints can be hidden from view, as in some cabinet and furniture construction, or exposed to show the beauty of the detail.

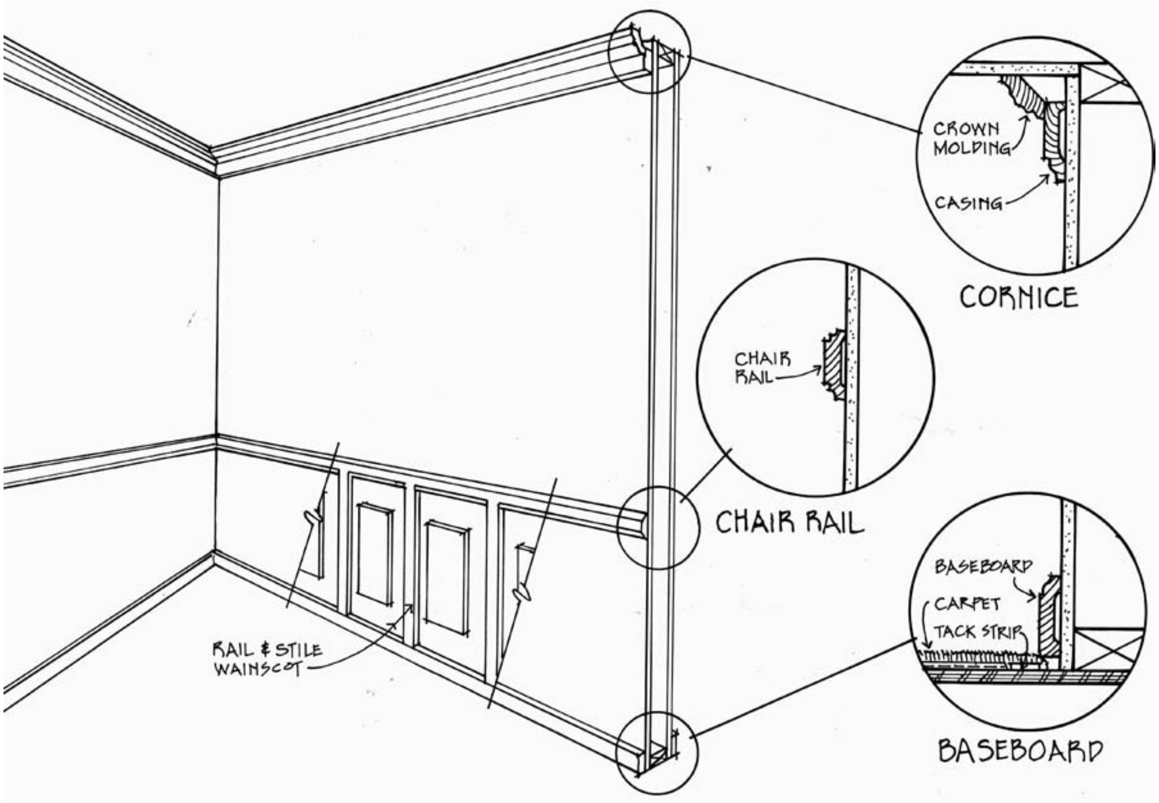

FIGURE 13.11 Wood is milled into various molding shapes for a variety of trimming purposes in interiors.

FIGURE 13.12 Wood is used as a design statement on the floors, walls, ceiling, staircase, and staircase guardrail, and for the benches with varying exposed joints.

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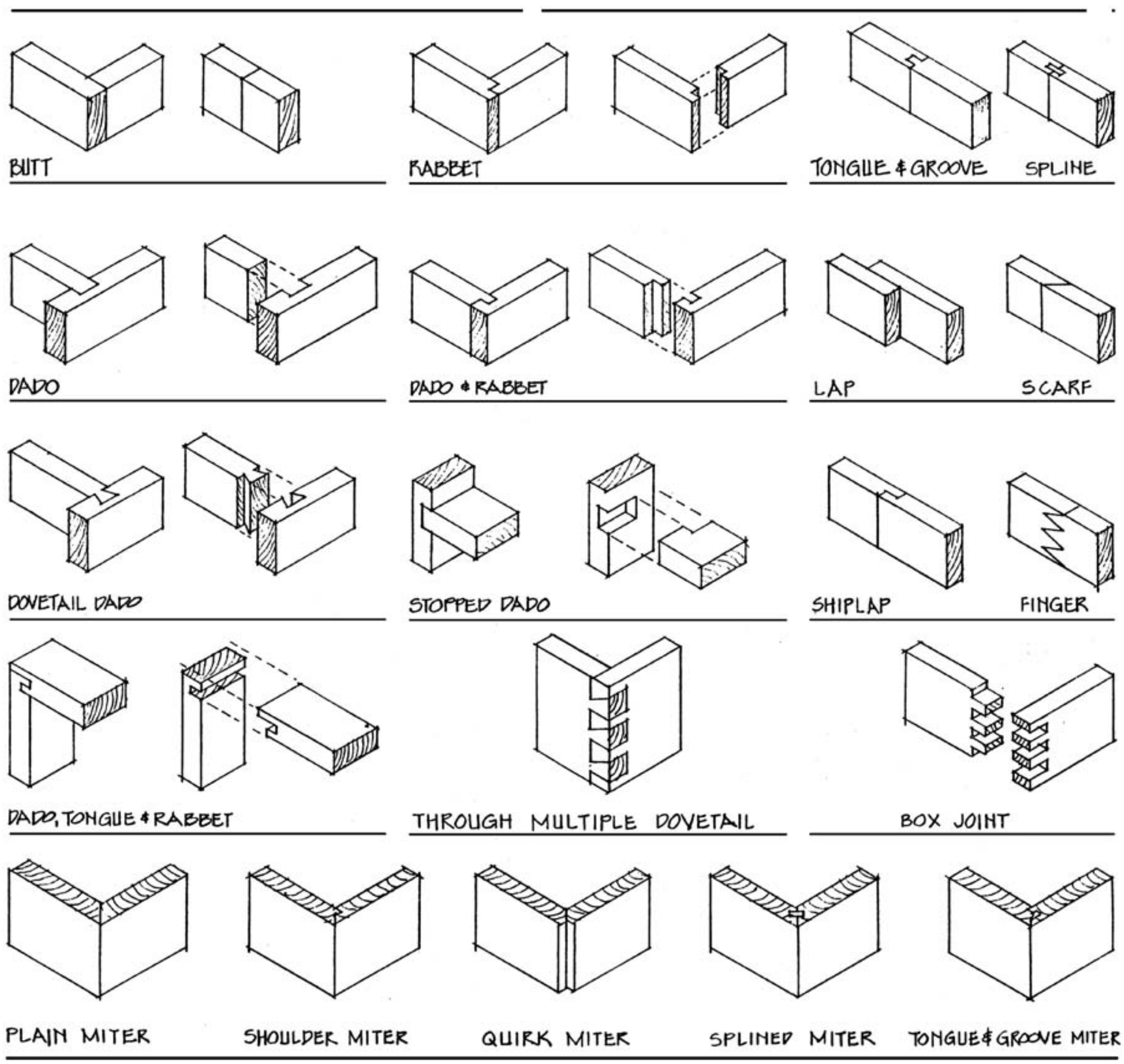

FIGURE 13.13 Common wood joints

Figure 13.13 shows many of the common joints used for general construction, cabinetry, and furniture. Using these joints requires an understanding both of the various forces that act on a joint and of the ability of that particular type (and its material) to hold together.

Wood Finishes

Most woods need a protective treatment or finish to protect their beauty, minimize moisture content fluctuations, and keep them usable. Figure 13.14 lists the most common wood finishes and their characteristics.

Finishes can vary from a high gloss to a satin or matte appearance, depending on the finishing agent and the appearance or durability desired. Generally, glossy finishes are harder and reflect more light. Matte finishes produce a soft glow of surrounding light and show the beauty of the surface sheen and wood. Finishes can penetrate or remain on the surface; they can be opaque or transparent, colored or colorless.

Wood Fillers

Some woods, such as oak and mahogany, have large open grains and pores, requiring filler before the final finish. Fillers are used on open-grain wood to prevent finishes (particularly stains) from accumulating more in some spots than others, which could result in a blotchy appearance. Liquid or paste fillers allow a more even finish texture and color.

FIGURE 13.14 Characteristics and typical uses of common paints and finishes

TYPE	CHARACTERISTICS	TYPICAL USES
ACRYLIC	Water-based synthetic resin; quick drying; durable; cleans up with soap and water	Wood siding and trim; cabinetry; combined with latex for more durable latex coating
ALKYD	Oil modified resins; most popular paint vehicle; dries faster than oils; hard; clean up with mineral spirits	Exterior and interior primers; wood; brick; metal; combined with enamel, oil, and silicone paints
ENAMEL	Pigments mixed with varnish, lacquer, or alkyds; durable; clean up with mineral spirits	Furniture; floors; metal
EPOXY	Resin materials produced as a paint (esters) or as a two-component mix (base and catalyst); hard, dense, film; clean up with special solvents	Tough finishes on most surfaces; waterproof
LACQUER	Nitrocellulose or acrylic resin based; fast drying; durable film finish; clear or pigmented; clean up with solvents	Furniture; cabinetry
LATEX	Water based; not as scrubbable as acrylics or alkyds—but can be produced with these and enamel for tougher coatings; clean up with soap and water	Wallboard; plaster; masonry; acoustical tile
URETHANE	Synthetic resins; often called polyurethanes; very tough, durable; pigmented or clear; clean up with solvents; similar to epoxy	Interior and exterior wood; wood floors; furniture
VINYL	Synthetic compounds of polyesters, vinyl's, polyurethanes; durable; resistant to abrasion; excellent flexibility; often factory applied	Furniture; wood paneling
VARNISH	Resins dissolved in alcohol or oil; clear or pigmented; tough, hard film; moisture resistant; mixed with epoxy, polyurethane, and others for very tough coatings, such as spar varnish; clean with mineral spirits	Wood products; furniture
SHELLAC	Made as lac resins in alcohol; dries quicker than varnish, but less durable; affected by heat, moisture, alcohol; clean up with solvents	Clear finish coats on wood; mostly used as undercoat and sealing of stains before overpainting
STAIN	Thin water or oil liquids with a colorant; brushed, rubbed or sprayed; sealed over with other finishes or mixed integrally; made as solid body or transparent.	Wood building products; furniture
WAX	Made as clear or staining as paste or liquid; used alone or over varnish, oil, stain; requires periodic renewal; most not resistant to heat or water	Wood finishes; furniture; walls; floors

Antiqued and Distressed Finishes

Antiqued and distressed methods are specialized wood-finishing techniques used for interiors and furniture. Antiquing is a faux painting technique that involves applying layers of paint or stain to a surface and then rubbing it off. This process produces an artificially aged patina.

Distressing imitates the appearance of insect damage to wood, such as wormholes and weathering over time. It is achieved through drilling, chopping, gouging, or denting with chains or other tools. This technique is sometimes used on wood floors, paneling, beams, and even furniture, often to make them look old and weathered.

MASONRY

Masonry refers to installing natural rock, stone, brick, tile, and other modular unit compositions. The impervious quality of masonry and its relative ease of stacking and binding with mortar have made it a timeless material. Today, it is still used widely for its appearance, low maintenance, and ability to withstand decay, insect damage, and combustion from fire.

All types of masonry have similar characteristics in that they are stacked, bound together by mortar, and installed by masons using techniques developed centuries ago. However, new methods of steel reinforcing and better materials that were developed in the nineteenth and twentieth centuries have improved today and have increased the strength of masonry while lessening its overall weight and mass.

Although masonry has some excellent uses, it also has some drawbacks. Masonry is not a good material for insulation in cold climates, but can be used for storing heat (if isolated) because of its thermal mass properties. Structurally, masonry is good only in compression (vertical loads), not tension (stretching or twisting). It is usually higher in cost than other building materials and techniques. In major earthquake zones, it must be reinforced with steel; it is subject to collapsing under its own weight, since it is not as resilient to ground movements as wood or steel framing is. Despite these drawbacks, it is an excellent material for both exterior and interior use. Masonry veneer is a layer of masonry units (such as brick) installed on one or both sides of a supporting structural wall and tied to the wall with metal straps or what is termed *masonry ties*.

Stone

Stone, or rock, is perhaps one of the oldest building materials. Stone masonry has been used for centuries to construct many of the ancient buildings and other structures. It is usually a combination of minerals made up of various inorganic chemical substances, but some rocks, such as sandstone, are composed of only one mineral.

Stone used for construction is classified as igneous, sedimentary, and metamorphic. Most stone is quarried and cut into blocks or slab sheets for building purposes. Stone is selected as an exterior or interior building material for its aesthetic appearance, durability, and maintenance. The three stone categories that follow discuss the common building materials derived from each.

Igneous (Granite)

Igneous stone is cooled molten rock found near the surface of the earth. It is very dense, hard, and durable; is fine- or coarse-grained; and is found in shades of green, pink, yellow, and light to dark gray/black. Igneous stone can be precision-cut and left with a coarse finish or polished to a highly reflective surface. Granite, an igneous stone, is used for wall veneers, tabletops, steps, flooring, and other applications that require considerable wear (Figure 13.15). Granite is harder than limestone, a sedimentary stone, and marble, a metamorphic stone, and is recommended for high-traffic uses.

Sedimentary (Sandstone, Limestone, and Shale)

Sedimentary stone is formed primarily by water, chemical action, and erosion. It is generally soft and easier than granite to cut but not as durable (Figure 13.16). However, many historic buildings, such as St. Peter's in Rome, were built of this stone and have withstood the test of time.

Limestone colors range from dark grays to white and tan. Travertine is a form of limestone that has various textures and pits. It is used for tabletops, fireplace surrounds, and special wall trims.

Shale is a fine-grained stone created from the natural compaction of clay mineral particles and silt. It sometimes can be found in stone wall construction, although it tends to break more easily into layers. Shale is also crushed and mixed with water to make objects from this clay-type material.

Metamorphic (Marble and Slate)

Metamorphic stone is formed by intense pressure and heat from igneous or sedimentary rock. Marble results from the crystallization of limestone and is a very hard (but softer than granite) and durable material (Figure 13.17). It comes in many colors and is usually polished into shiny, smooth surfaces. Marble is used for decorative wall panels, fireplaces, flooring, countertops, and tabletops.

FIGURE 13.15 A warm-colored granite countertop is used on this vanity for its durability and complemented with warm marble wall finish tiles.

Courtesy of National Kitchen & Bath Association

FIGURE 13.16 Sandstone is used for this outdoor fireplace addition, providing a rich textural quality to the setting.

FIGURE 13.17 Marble countertops provide for large preparation and serving areas in this expansive kitchen.
Courtesy of National Kitchen & Bath Association

Slate is a rather brittle rock that splits readily into thin sheets. Its color usually is blue gray, although black, green, and red are available. It is used mostly for tabletops, flooring, and roofing.

Installation of Stone

Stone can be installed as a floor, structural wall, column, or decorative element. It can be assembled with or without mortar, pinned with wire rods, or glued with synthetic resins. The method varies according to the strength, use, durability, and appearance desired. Stone can be stacked in rough rubble techniques or precision-cut and installed modularly in square and rectangular patterns. Stone textures, shapes, and the patterns in which they are laid vary greatly (Figure 13.18). Rubble is irregular and rough, uncut stone laid with mortar in a random pattern. Cobble or fieldstone generally has more round rocks than most other rubble exhibits. Ashlar is stone pre-cut into square or rectangular shapes and laid in random or coursed patterns. Trim is specialty-cut stone used for decorative elements, sills, lintels, and the like. Stone has many other applications as a building product. Crushed or graded stone is used as an aggregate for making concrete. Aggregate can be carefully graded by sizes and used as gravel fills or exposed on the surface of concrete walks and wall panels. Marble can be ground into chips and combined with cements and epoxies to create a tough material called terrazzo. For floors, this wet mix is poured over a subsurface, such as concrete. When the mixture dries, it is ground and polished to a glossy or satin finish that reveals a mosaiclike appearance. Terrazzo can also be cast into a variety of premade shapes, such as windowsills, shower bases, and stair treads.

Brick

Brick is an important building material that dates back more than 5,000 years. Early bricks were shaped from mud that had straw or hair added as a binder. These were dried in the sun and stacked with silt (mud) between the joints for wall construction. This method was improved with better clays and wooden forms and by baking the bricks in an oven. In the 1800s, machines were developed that mechanically shaped clay into standardized forms, allowing mass production of brick as a major building material.

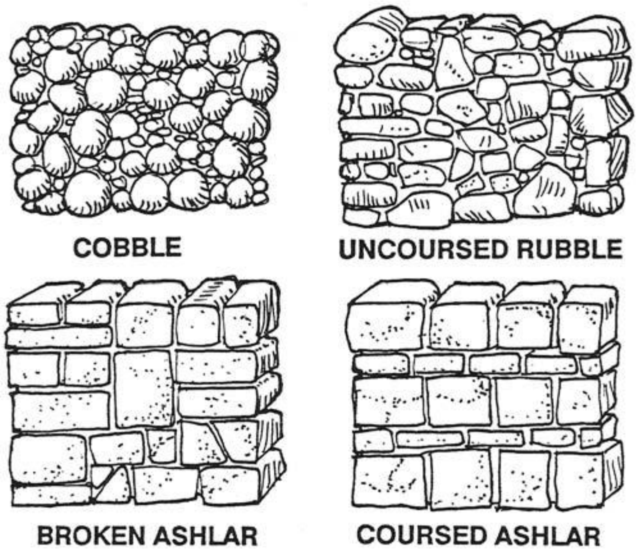

FIGURE 13.18 Stone can be installed as uncut cobble and rubble or pre-cut (ashlar) in random (broken) patterns or coursed patterns.

Bricks are made from a variety of clays and fired in kilns at different temperatures to produce different colors, textures, strengths, and glazes. Although brickwork is more expensive to install than wood panels or siding in terms of both materials and labor, it is still a very popular material. Many people prefer brick because it is durable, weather resistant, fireproof, and known for its high quality and permanence.

Types and Sizes of Brick

Brick is produced in many types—face brick, firebrick, glazed brick, and pavers—and many sizes. Each type has distinct features that make it suitable for a specialized purpose; each type is produced in common sizes referred to as nominal and manufactured. Nominal dimensions include the actual size of the brick plus the thickness of a mortar joint in wall or floor construction. These dimensions help to determine how many bricks are required for a particular panel size. For example, if a wall is 8 feet (2,438 mm) in length and made with a brick that is 12 nominal inches (304 mm), the wall will take eight bricks. Brick count can be calculated either horizontally or vertically for a wall. Reference tables in various publications estimate brick counts and dimensions for heights and widths of walls. Figure 13.19 shows the most common brick types and sizes.

Brick is also manufactured in a variety of thin-face slices, approximately ½ inch (12 mm) thick. These are sometimes used in interiors for a brick look without the weight and thickness of full brick dimensions.

Bricklaying

Construction with brick can achieve different strengths, durability, and appearance according to the method used, which is dependent on the pattern bond of laying (see "Pattern Bonds" for explanation), the strength of the mortar, and the finishing of the mortar joint. One of the limitations of brick work is that during seismic activity (earthquakes), the cement-based mortar that binds the brick together does not hold up well during the earth tremors. It is often reinforced with steel or tied to a more stable wall structure.

Most brick walls are facings applied to another structural wall surface, such as concrete block or wood-stud framing. In these cases, the brick is usually secured to the backer wall with steel ties. However, brick walls are also constructed as solid and as cavity brick walls, which are the true brick-wall construction. The latter method consists of two wall planes with an air space (called *cavity*) between.

Mortar and Joints

Mortar (plain or colored) is a plastic mixture of water, fine aggregates, and cementitious materials, such as portland cement. Mortar is used in bricklaying to bond the brick, seal the spaces between bricks, and allow for dimensional differences of the units.

COMMON NAME	NOMINAL DIMENSIONS (inches) Thickness	Height	Length	MODULAR COURSING (in.)
MODULAR	4	2 2/3	8	3C = 8
ENGINEER	4	3 1/5	8	5C = 16
ECONOMY or JUMBO	4	4	8	1C = 4
DOUBLE	4	5 1/3	8	3C = 16
ROMAN	4	2	12	2C = 4
NORMAN	4	2 2/3	12	3C = 8
NORWEGIAN	4	3 1/5	12	5C = 16
ECONOMY 12 or JUMBO UTILITY	4	4	12	1C = 4
TRIPLE	4	5 1/3	12	3C = 16
SCR BRICK	6	2 2/3	12	3C = 8
6" NORWEGIAN	6	3 1/5	12	5C = 16
6" JUMBO	6	4	12	1C = 4
8" JUMBO	8	4	12	1C = 4

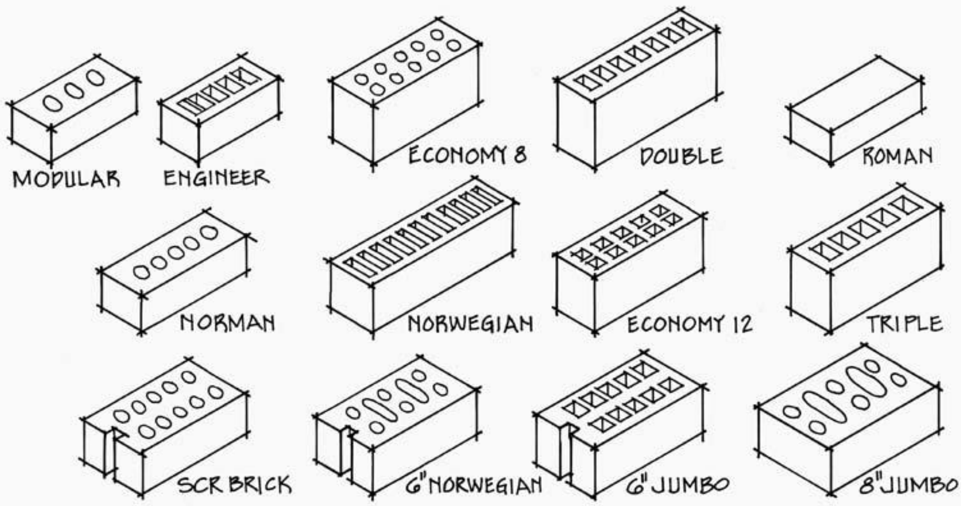

FIGURE 13.19 Modular brick sizes and their dimensions

Joints in mortar are finished by troweling away excess material or by tooling it into special shapes that compress the mortar into the joint (Figure 13.20). Each shape exhibits unique structural, visual, and tactile qualities, as well as unique weatherability characteristics.

Pattern Bonds

Pattern bonds consist of brick and other masonry products laid in various horizontal and vertical patterns for appearance and strength of interlocking (Figure 13.21). The direction and placement of bricks within these bonds are commonly termed stretchers, headers, rowlock, or soldier courses, as shown in Figure 13.20. Some patterns project masonry units beyond the surface for decorative effects.

Concrete Masonry Units

Concrete masonry units (CMU) are also made of concrete in hollow or solid blocks and bricks. These are usually less expensive and stronger than brick and can be lighter in weight, depending on the aggregate used. For these reasons, masonry units are generally used for structural walls or as subsurfaces for brick facings.

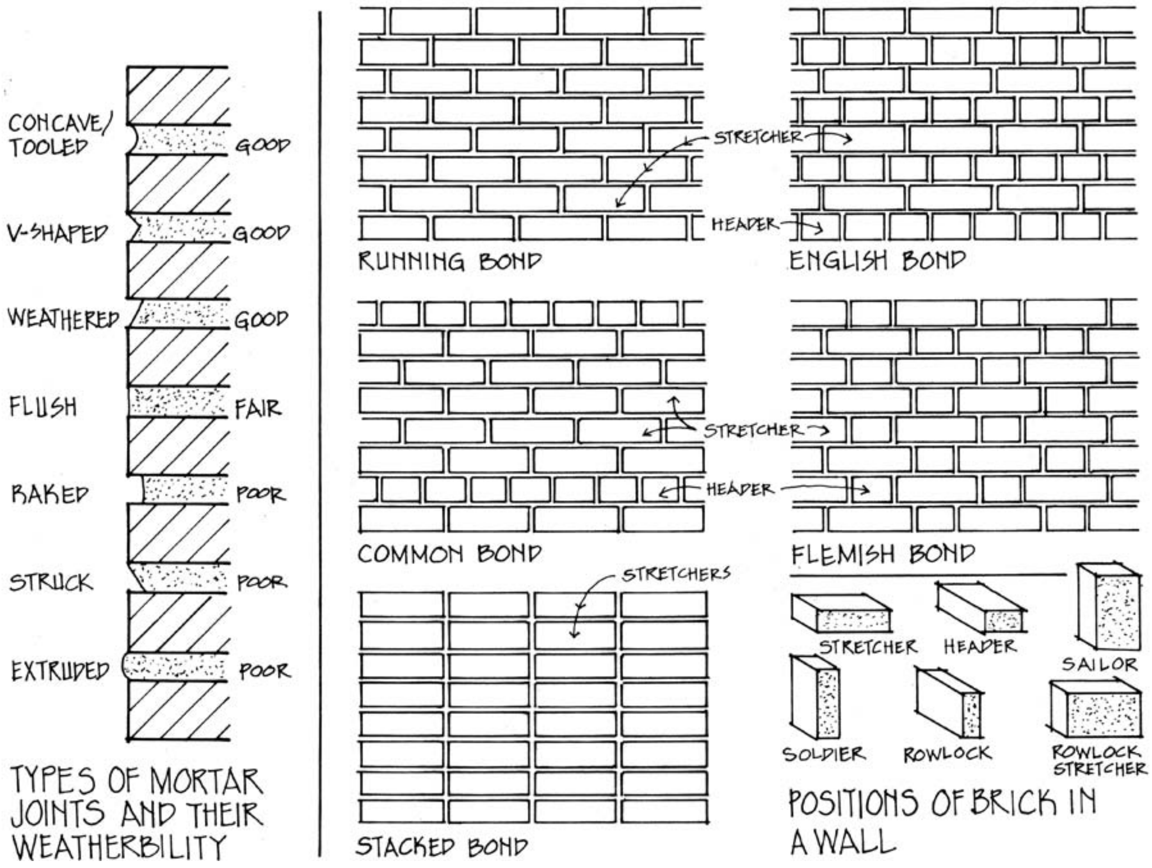

FIGURE 13.20 Common brick bonds and the names of brick positions used in a wall

FIGURE 13.21 These two brick walls in this reception area are laid with different brick types, bonding methods, and surface finishes. *Courtesy of Kimball Office.*

Concrete Brick and Cast Stone

Concrete brick is produced as slump brick or building brick (commonly called cast stone). The latter type is similar to clay brick in function, size, and appearance, but is often less expensive and can be made stronger. Slump brick, or what is sometimes called slumpblock, has an irregular face shape, resulting from the sagging or slumping of the wet mixture before it is fired. Cast stone, commonly called cultured stone (Figure 13.22), is manufactured as a concrete product to simulate cut or natural stone. It is often used as facing or trim features, attached with glue/binders or metal ties to a supporting wall. It can be composed of crushed stone, gravels, colored cements, or sand, and cast into various naturalistic-looking shapes, colors, and textures. It can resemble real stone, but is thinner and lighter. It is very durable and often used to imitate slate, granite, travertine, and other stone.

FIGURE 13:22 Cast stone was used in this kitchen as vertical column elements to provide a textural quality to the space and complement the wood.

Courtesy of National Kitchen & Bath Association

Concrete Block

Concrete block is a lightweight masonry unit composed of portland cement and porous aggregates, such as cinders, volcanic ash, or pumice. These blocks are manufactured in a variety of sizes and shapes. They are excellent for structural uses and can be made with various facing finishes or as decorative screen block. Split-faced block and blocks with fluted and ribbed faces are popular in exterior and interior installations. Concrete block is made as a nominal 8 by 8 by 16 inches (203 × 203 × 406 mm), although half-sizes and many other shapes are also abundant.

Because they are larger, concrete blocks can be laid more quickly than brick; their hollow cores can accommodate steel reinforcing and utility routing. Concrete blocks are used for general utility construction but can be ceramic faced or can be finished with paint, stucco, decorative facing (bush-hammered), and in other ways if their natural state is not appropriate.

Concrete blocks are also specially made as pavers and concrete roofing tile, both of which are lighter and less expensive than clay tile. Concrete blocks can be cast in different colors and sometimes are difficult to distinguish from real clay products. Pavers are made in a variety of shapes, colors, and thicknesses, some as interlocking units.

Glass Block

Glass blocks were developed about 1900 and were widely used during the 1920s and 1930s, to allow for natural light in factories. We have seen a reemergence of use today. These units are made largely from limestone and sandstone, and consist of two hollow half-blocks of glass that have been pressed together, with the center partially evacuated of air or other gases added to the cavity. Some glass blocks are made as solid glass units for strength and are used in places where forced entry is to be prevented. Glass blocks come in many sizes, shapes, and surface finishes. Different light transmission through them can be created by varying the type of glass finish, such as frosted, rippled, textured, or clear. These variations can be made inside or on the surface of the block. Glass blocks are used on both the interior and the exterior of buildings, are nonstructural, and can be laid in curved sections.

CONCRETE

The invention of concrete is generally credited to the Romans, who first used it to construct roads, bridges, and buildings. Today, it is both a structural and an aesthetic building material that can be poured, molded like clay, or precast into almost any special shapes. It can be finished with a variety of textures, patterns, and colors. Concrete is strong in compression, and thus is appropriate for use in walls and columns, but is weak in tension unless reinforcing steel is integrally added to bolster its use for concrete beams (see Chapter 14).

Cement Manufacturing

Concrete is a mixture of portland cement, fine (sand) and coarse (gravel or crushed rocks) aggregates, and water. Portland cement is made up of a combination of pulverized silica and limestone, which are burned to fuse them together. That combination is then ground to a powder and fired in a kiln, and substances such as gypsum are added to make the final product. Other types of cements, aggregates, and admixtures can be added to alter concrete's strength, appearance, color, and workability.

The water-to-cement ratios affect the initial workability of the mixture and its ultimate strength after the concrete cures—in about 28 days. Generally, the less water used, the stronger the resulting concrete. Today, concrete is being made with recyclable materials such as fly-ash (byproduct of coal-fired generating plants) to reduce the amount of waste in landfill from the ash. Concrete is also recycled by putting it through a crushing machine, and used as gravel for new construction, such as a base in roadways.

Plaster, Stucco, and Synthetic Mixtures

Plaster has been used since Egyptian and Greek times for painting murals and as a finish for ceilings and walls. It is a thick, pasty mix of gypsum and water, although other additives, such as sand and lime, can be mixed

FIGURE 13.23 The ornate ceiling and pilasters in this restaurant are created with plaster work.
© Fisher Hart - age fotostock

in. Plaster (plaster of paris, for example) remains fairly soft after curing and can be shaped with metal tools for sculpture and other carvings. Plaster is troweled on in two or three layers over a lath subsurface. In earlier times, this subsurface was a series of spaced wooden strips. Now, most lath is metal; however, plaster can also be installed over masonry block or special gypsum board. Plaster (and stucco) can be molded into many intricate shapes or surface patterns before it dries (Figure 13.23). After curing, it becomes hard, retaining that initial shape. Plaster is also used as gypsum (plaster of paris), a thin coating material, and sprayed for various finishes.

Stucco is sometimes mistakenly referred to as plaster; however, stucco is made of portland cement, is used primarily on the exterior of buildings, and is more weather resistant than plaster. When stucco is used over wood or metal framing, a water-resistive subsurface and wire mesh are first installed to provide a bonding surface for the stucco. Like plaster, stucco is then applied in two or, preferably, three coats. In order of their application, these are a scratch coat, a brown coat, and a finish coat. The final coating can be varied, as it is in plaster techniques. Both plaster and stucco finishes are thin, brittle coverings subject to cracking or chipping. Both can be painted or have integral colors added to the mix, rather than being overpainted.

Synthetic mixtures that resemble plaster and stucco are now made with various additions of acrylic resins and polymers. Modern synthetic stucco can often be installed in two layers (base and finish) as a result of the additives, which increase the strength and flexibility. Synthetic stucco is referred to as exterior insulation and finishing system (EIFS) and is not a traditional portland product. The synthetics can even be applied to a variety of subsurfaces to which real stucco and plaster will not adhere. Some of these underlayments consist of a fiberglass mesh applied over a rigid polystyrene insulation board that has been cut and shaped into various forms (Figure 13.24). These synthetic coatings are integrally colored, are much stronger, resist cracking, and can be rolled, sprayed, or troweled on.

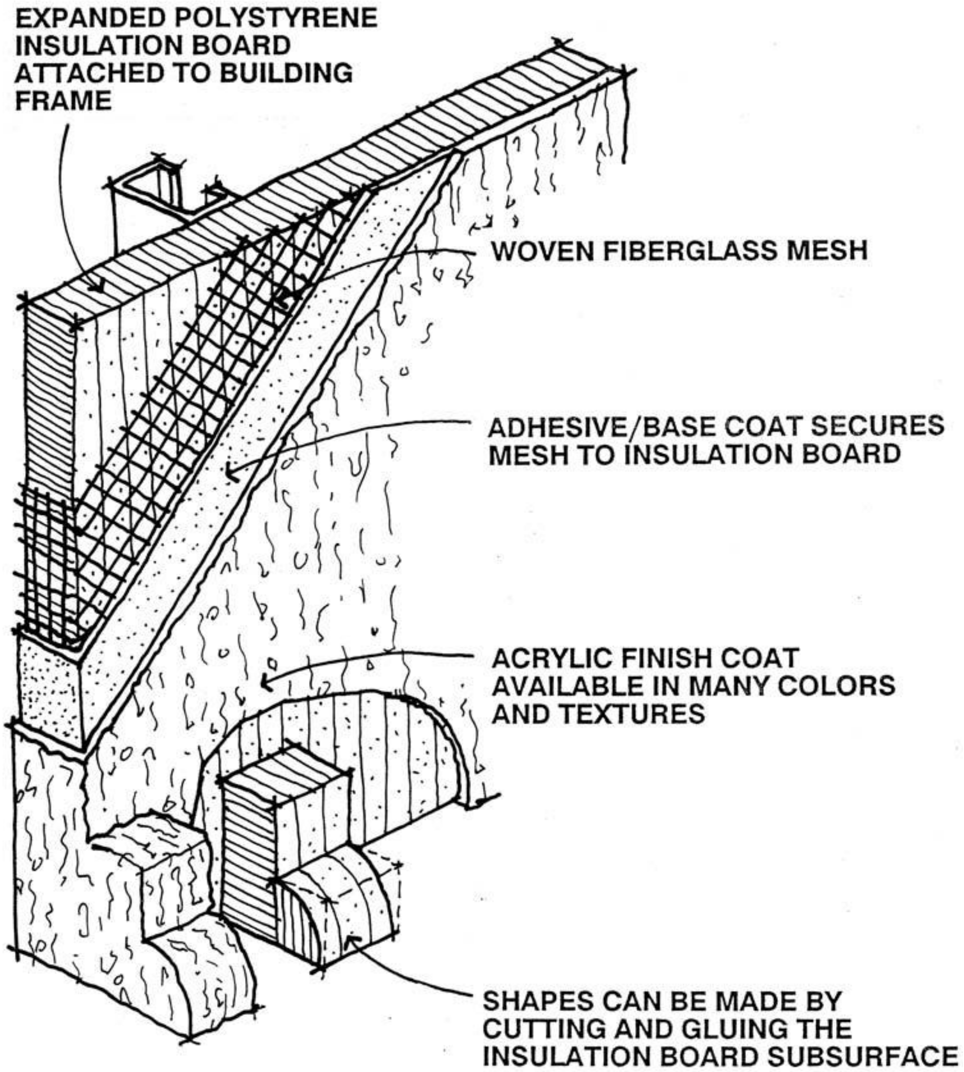

FIGURE 13.24 Several brands of synthetic stucco-like materials are made that are more flexible and resistant than cementitious mixtures such as true stucco.

CERAMICS

Ceramics have been made for centuries (c. 4700 BC) both for utilitarian needs and as expressive art forms. Tiles made from ceramics have been used throughout the world as floor, wall, and roofing materials. Today ceramics are also used to make bricks, drain lines, and chimney flues. (Ceramics are also used for artificial teeth and in space-age technology for rocket nozzles and heat shields.)

Ceramics are made of clay that is shaped and fused or vitrified by firing in kilns. Ceramics can be unfinished, carved, painted, or glazed. (In glazing, a glasslike coating is fused by heat to the surface.) Different clays, additives, and glazes are combined to produce many variations in color, finish, and strength in ceramics. Ceramics are classified into four general types based on their firing temperatures: earthenware, stoneware, porcelain, and china.

Earthenware and Stoneware

Earthenware is made of coarse-textured clay fired at relatively low temperatures (about 2,000°F or 1,093.3°C) and can be glazed if needed. Bisque ceramics are fired but not glazed. Earthenware is usually porous, fragile, and opaque in its finished state. Colors of earthenware, sometimes referred to as terra-cotta (meaning cooked earth), tend toward red or brown. Objects such as bricks, flower pots, tiles, and folk pottery are commonly made from earthenware. Raku ware is a stoneware example of traditional Japanese pottery.

Stoneware is made of finer clays than earthenware and is fired at medium temperatures (about 2,200°F or 1,204°C), making it waterproof, strong, less porous than stoneware, and durable. Colors are usually gray or light brown, and glazes can be given a matte finish, showing flecks in the glaze or clay. Stoneware is used for casual dinnerware, cookware, and sculpture.

Porcelain and China

Porcelain is the highest grade of ceramics and is made of feldspar (crystals) and white clay (kaolin). It is fired at high temperatures (about 2,400°F or 1,315.5°C), causing it to vitrify and become waterproof even if chipped. Porcelain is a very hard, white, translucent, and high-quality material that resists chipping. It is often used for fine dinnerware, artwork, and finishes on sinks and bathtubs.

China is the name originally given to fine porcelain from the Orient or to its European imitations. A hard, translucent porcelain (made from a high proportion of animal bone ash) is called bone china or English china. China is fired at a much lower temperature than porcelain, but it is more durable than earthenware or stoneware.

Ceramic Tiles

One of the most popular uses for ceramic as a building material is as tile for floors, walls, cabinetry, tubs, showers, and even ceilings. Tiles are made in numerous materials, sizes, shapes, thicknesses, and surface textures. In addition to ceramics, tiles can be made with glass, stone, and even metal additives (Figure 13.25). They are classified as having impervious, vitreous, semi-vitreous, and nonvitreous qualities. All floor tiles can be used on walls and other surfaces, but not all wall tiles can be used as floor applications, which require more durable and thicker tiles. Tiles are installed in portland cementitious setting beds (thickset) or with special epoxy adhesives (thinset). As in

FIGURE 13.25 Ceramic glass tile is used as a durable finish on the wall of this wet bar area. *Courtesy of Kohler Co.*

bricklaying, patterns and joints can vary a great deal. Grout, in many colors and finishes, is added between the tiles in various widths, depending on how the tile is used, for example as a floor or wall application.

Ceramic tiles are made from different clays and shale mixtures. They are fired at different temperatures to produce specific glazes, surface finishes, and hardness. Ceramic tile is produced in three basic types—glazed, mosaic, and quarry—as well as other miscellaneous types of tiles.

Glazed and Mosaic Tiles

Glazed ceramic tiles are used in many ways, both on building exteriors and in interiors. They are produced in modular sizes and often have matching trim pieces for corners, wall bases, and nosings. Floor tiles have a heavier coat of glazing than wall types, since floor units are subject to heavy traffic and must have very tough glazes as their finish coat.

Mosaics are an assembly made of small pieces of glass, stone, tiles, and other materials. Mosaic ceramic tile is made in small sizes for composing intricate patterns for use in murals on floors and walls. Mosaic tiles are made with clays, porcelain, or glass, and sometimes are produced in units with a back-mounted fiber mesh to facilitate their handling and installing. These are generally smoother, brighter, and more impervious than other glazed tiles.

Quarry and Other Tiles

Quarry tiles, made of graded shales and fine clays, are among the thickest and strongest of the tiles. Their color is usually a result of the type of clay used. Quarry tiles generally are left unglazed in their terra-cotta state. These tiles are available in reds and browns; in some cases the faces might be flashed, producing a center lighter than the edges. Traditional quarry tiles are long lasting and excellent for floors that receive a lot of abrasion. Quarry tiles are also produced in a variety of colors, tints, and finishes.

Other ceramic tiles have their own distinct characteristics. Mexican tile is produced by taking clay directly from the ground and hand-shaping it. This tile exhibits a rough, uneven shape and thickness and is usually glazed or hand-painted. Its appeal is in its handmade qualities and rustic imperfections. Mexican tile is more fragile than most other tiles, may be very porous, and may take special care to maintain.

Ceramic tile is also manufactured into durable roofing tiles, which can be flat pieces or rolled into interlocking sections that resemble Mediterranean roofing.

Historically, architectural terra-cotta tile was manufactured until the 1930s and used, either glazed or nonglazed, for exterior building facings and details. These pieces were cast in molds and can still be seen in many older buildings, such as those by Louis Sullivan and the Wrigley Building in Chicago.

Digital Tiles

Digital tiles are made as custom tile printing utilizing inkjet printers and ceramic inks with digital images of photography and art, to produce photographic images/patterns in restaurants, kitchens, showers, and many other locations.

GLASS

Glass is made from a number of abundant natural materials such as sand, soda ash, and limestone. It is inert and doesn't off-gas, which could otherwise affect indoor air quality. Glassmaking is an art form that has been practiced for more than 4,000 years. Most early glass was used for objects and beads, although evidence shows that the Romans used it for windows. Today, large windows or whole walls can be made of glass. However, glass does not have a high tensile strength and must be made in great thicknesses or by special techniques to prevent breaking. Glass is formed by high-temperature fusing of silicates, alkalis, lime, and other materials. The colors generally come from minerals that are added; the final product is finished in many ways.

Manufactured Glass

Glass can be manufactured in sheet form from 1/12 inch to 2 inches (2 to 50 mm) thick for windows, mirrors, tabletops, and doors (Figure 13.26). These glass planes are produced in three basic ways: sheet, plate, and float. Sheet glass is produced by drawing out molten glass and subjecting both sides to heat. It is not further treated, and the resulting faces are not truly parallel, which produces ripples and some distortions. Most sheet glass is now found in older buildings, since the technique has been replaced by better methods.

FIGURE 13.26 A custom designed and fabricated circular glass countertop is used for an eating surface open to the adjacent kitchen.
Courtesy of National Kitchen & Bath Association

Plate glass is ground and polished after being drawn from the molten state, producing more parallel surfaces without the imperfections commonly found in sheet glass. However, this method is costly.

Today, float glass (commonly known as window glass) has almost replaced both sheet and plate glass. Developed in the 1950s, it is made by floating molten glass over a molten metal such as tin, producing an even layer of glass that ends up polished on both faces. After forming, float glass goes through a controlled cooling process called "annealing," which relieves internal stresses that might have developed during the manufacturing process. This type of glass is relatively distortion free and can be made in varying thicknesses and strengths.

Glass is also melted and forced through small orifices to produce thin glass fibers. These are used in manufacturing building insulations and various fibers for textiles.

Most discarded glass can be crushed, ground, and reused in the process of making new glass, thus making it a very recyclable product. For example, glass bottles and jars are recycled (cullet), but much of the architectural glass products are not. Part of this dilemma is that the making of new glass is fairly cheap compared to the labor-intensive process needed to separate this type of glass from metal and wood frames. However, most of this glass can be used in making products of lesser quality and functions—such as reflective highway paints, concrete admixtures, and anti-slip flooring surfaces.

Architectural Glass

Glass used in buildings is generally thought of as a flat, transparent, and fragile medium for windows, doors, and skylights. But architectural glass is also made in different thicknesses, strengths, tints, colors, and finishes. It can be frosted, ribbed, pebbled, or curved to suit a variety of purposes. Several specialized types of architectural glass are described in the following sections.

Safety Glass

Safety glass (commonly called annealed) can be made in several ways to increase its resistance to breakage from impact and thermal stresses. Normally, when sheet glass breaks, it falls in jagged pieces and slivers that can cause severe cuts. Tempered, wire, laminated, or security glasses are available to help prevent injury. Although most of these are clear, they can be colored or tinted and can have special surface finishes (Figure 13.27). Tempered (or toughened) glass has about six times the strength of annealed glass and is used as the most common form of safety glass. Safety glass can also include fire-rated glass, which is used in fire-rated partitions to slow the spread of fire and smoke. These can be made as wired glass or a type of clear ceramic "glass."

Insulating Glass

Insulating glass (made as double or triple glass) is made to reduce heat loss and gain in buildings. It consists of two or three layers of glass that are separated and hermetically sealed, with an air space (or a gas) between layers. These spaces vary from ¼ inch (6 mm) to more than ½ inch (12 mm) and are secured in place by spaces and/or

COMMON ARCHITECTURAL GLAZING MATERIALS (GLASS)

TYPE	CHARACTERISTICS	SAFETY	SOUND* CONTROL	SECURITY	APPLICATIONS
ANNEALED GLASS	Common glass; often called clear window glass; variety of thicknesses and quality.	Easily fractured produces sharp long splinters	Poor	Weak unless thickened	General usage glass for variety of products—doors, windows, mirrors, glass shelves
LAMINATED GLASS	Made with layers of other glass types; varying inner plastic layer can control heat, glare, and sound transmission	May crack on impact, but holds together, adhering to interlayer	Best of all, depending on no. of layers, thickness	Excellent as layers can be laminated to 2 inches	Safety glass in buildings and motor vehicles; overhead glazing
TEMPERED GLASS	Most common safety glass; heat strengthened during manufacturing	Difficult to break; shatters into non-cutting pebble-sized pieces	Poor	Stronger than unheated, but must be thickened	Entry and shower doors; windows subject to impact
WIRED GLASS	Holds together when subjected to high temperatures, impact, and air pressures	Breaks similar to annealed, but wire holds it together; cut wires and sharp edges can occur at protruding hole	Poor	Better than annealed and tempered, but must be thick	Used as common safety and fire-resistive assembly in buildings; overhead glazing

*Based on typical thickness. Better control by thicker sections.

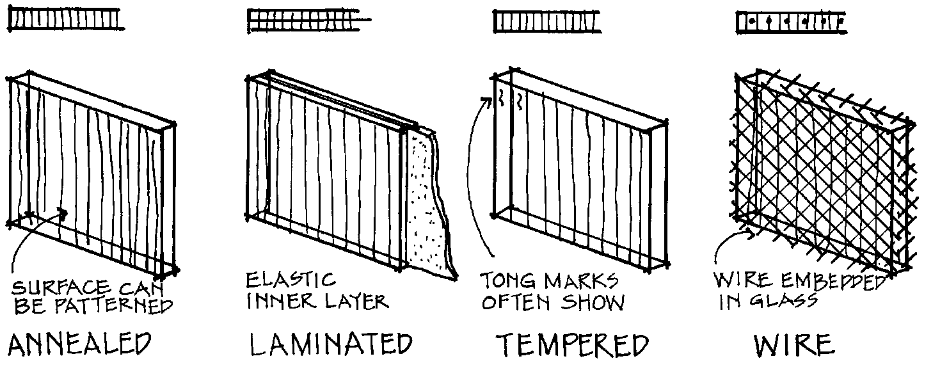

FIGURE 13.27 Common types of glass used in interiors. These can also be produced in tinted glass colors, or other films can be applied to their surfaces.

frames made of plastic or other thermal break materials. The air spaces provide a better thermal insulation value for the unit and lessen the amount of condensation that forms.

Insulated glass can be produced as uncoated glass or coated, whereby one layer can have a thin layer of metal oxide applied (often called "LoE") that decreases the transmission of heat through the glass.

Reflective and Heat-Absorbing Glass

Reflective glass and films reflect or absorb solar radiation. Reflective glass has a thin film of transparent metal or metal oxides bonded to the glass surface to reflect the sun's rays. It is produced by adding coloring agents during manufacturing. These agents are usually gray, green, or bronze tints that reduce glare, light, and heat transmission.

Some specialized glasses help maintain optimum thermal conditions in buildings. Metals are integrally cast into the glass and are charged electrically to become opaque or clear, depending on the need. These types of glasses are often called electrochromic glazing.

Decorative Glass

Decorative glass (often called art glass) is an expressive material that can be used in both utilitarian and decorative or aesthetic treatments. Several types of decorative glass, most using age-old processes, are described in the following sections.

Hand-Blown and Molded Glass

Hand-blown glass is one of the oldest and most popular art glass forms. It is made by dipping a hollow metal rod into molten glass material and blowing a bubble. Before the glass cools, the glassblower uses tools to roll, twist, or shape it, creating a distinct, handcrafted look. Glass can also be shaped as flame-worked glass, using torches and kilns to form more detailed works.

Molded glass is a mass production of the hand-blown process. Glass is blown or pressed into molds during the molten state. Many everyday glass items are made this way and can be intricate or simple in shape and texture, as seen in dishware and bottles.

Engraved and Etched Glass

Engraved glass is made with wheels and various abrasives to cut the surface, producing fine decorative and pictorial effects. To produce etched glass, either sandblasting or acid techniques are used to create art on the glass surface after the glass is blown or cast. The technique of etching produces a shallower design than engraving, and it is often used to imitate the more deeply incised engraved technique.

Beveled, Leaded, and Stained Glass

Beveled glass is made by grinding and polishing the edges of a piece of thick glass at an angle. Beveling is used for leaded glass windows, mirrors, and doors and in insets in wooden frames for decorative pieces.

The use of leaded and stained glass has been revived many times over the centuries. *Leaded glass* generally refers to transparent or colorless glass, such as in a window. Stained glass refers to glass that has been colored by glazing, pigmenting, or painting. It is set in lead or strips of copper foil for decorative uses and items such as lampshades and windows.

METALS

Metals are produced from ores. Hundreds of different types and alloys (mixtures) of metals are available. Metals are very versatile, as they can be shaped by melting and casting, rolling, extruding, machining, welding, drilling, bending, and so on. Metals are used for structural and decorative purposes, either alone or in combination with other materials. The strength of metals contributes to their utility in slender, durable shapes not possible with other materials, such as wood, masonry, or ceramics. Metals are inorganic materials that do not rot, decay, or support combustion. However, they can melt at high temperatures and some can rust if not protected from moisture and chemicals. Most metals are good conductors of electricity and heat. However, when two dissimilar metals come into contact in a moist climate, a galvanic action can occur and disintegrate one of the metals. This is the reason aluminum, rather than steel, nails are used with aluminum siding. Today, a large number of metals can be recycled; in principle, they can be used over and over for new materials and uses.

Metals can generally be classified into ferrous (iron-bearing) and nonferrous (ironless) types. Iron, a very abundant material in the earth, can be used alone or, preferably, alloyed with other metals. More than 60 different metal alloys and hundreds of combinations exist. Only those most important to interior design are discussed here and shown in Figure 13.28.

FIGURE 13.28 Common metals used in interiors.

METAL	PROPERTIES	CHARACTERISTICS	USES
ALUMINUM	Produced as alloys for specific properties; can be brushed or highly polished	Lightweight; easily worked; corrosion resistant; ductile; silvery luster to soft gray	Cooking utensils; building components; screens; hardware; furniture
BRASS	Alloy of copper and zinc; takes high polish, but tarnishes readily; re-polish or add protective coating	Easily shaped by casting, rolling, and stamping; yellow color	Lighting fixtures; hardware; bolts; screws; furniture; accessories
BRONZE	Originally copper alloyed with tin, but now alloyed with various elements of tin, silicone, aluminum	Fairly hard and durable; patinas with age; brownish-red	Sculpture; bells; hardware; plaques
CHROMIUM	Used mostly as alloying element; can be brushed or polished	Durable; doesn't readily tarnish; used in plating blue-white	Lighting fixtures; furniture; small appliances
COPPER	Resistant to corrosion; surface will tarnish unless polished or protected with coating	Ductile; malleable; good conductor of electricity and heat; reddish-orange color that oxidizes to dull greenish-blue/brown	Electrical wire; water piping; roof flashing, gutters; cookware; accessories
GOLD	Considered a precious metal; takes high polish	Easily worked; made in thin sheets for gold leading	Accessories; inlays; decorative elements
IRON	Pure iron oxidizes rapidly; galvanized or painted to resist rust; produced as cast or wrought iron	Strong; malleable; ductile; easily cast or worked; grayish	Building hardware; railings; furniture; cookware; grilles; fences
LEAD	Resistant to corrosion; alloyed with tin to make pewter	Soft; very dense; easily worked; vapors can be a health hazard; bluish-white	Waterproofing; radiation shields; stained-glass work
MAGNESIUM	Resembles aluminum; alloyed with other metals	Easily worked; resists corrosion	Furniture; hardware
NICKEL	Used primarily as an alloy with other materials; takes a bright polish	Makes other metals harder, corrosion resistant, ductile; grayish-white	Cooking utensils; sinks; hardware
PEWTER	Alloy of tin and other metals; takes high polish or rough finish	Resists tarnish; can be cast, hammered, machined; warm gray	Lighting fixtures; tableware; accessories
SILVER	Alloyed with other metals to increase hardness; alloyed with copper for sterling silver; takes high polish	Ductile; malleable; tarnishes easily; white metallic	Accessories; jewelry
STEEL	Iron alloyed with carbon; surface deteriorates unless coated or other alloys added	Very hard; alloyed to make stainless steel; resistant to rust and tarnishing	Structural forms; furniture; cookware; door and window frames
TIN	Soft metal often alloyed with others; nonrusting and tarnish resistant	Easily worked; produced mostly in sheet form; soft silvery metal	Light fixtures; accessories; tin foil
TITANIUM	Important alloy; titanium oxides used in materials to make them white, bright	Easily worked; used as alloy for structural material	Furniture
ZINC	Used mostly as alloy with other materials	Easily worked; bluish-white	Major uses are in galvanizing or plating for corrosion-resistant finishes

Ferrous (Iron-Bearing) Metals

Iron and Steel

Pure iron is a ductile (soft) material, generally too weak to shape. Adding carbon as an alloy increases its strength, as well as its resistance to warping and cracking. Iron is the main element used in making steel, but it can be manufactured alone as wrought or cast iron.

Wrought iron is an iron alloy that was developed about the fourteenth century with the introduction of blast furnaces that reached high temperatures (2,786°F or 1,530°C). These furnaces produced pig iron, which was then refined by remelting to become wrought iron, a high-purity, malleable material used for ornamental work, fences, pipes, railings, and furniture. A form of it was used to make the Eiffel Tower (1889) in Paris.

Cast iron is made with carbon additives, melted in furnaces, and cast into various shapes. It is hard, brittle, and fairly resistant to corrosion and has a high compressive strength. It was developed about 1700 and became a substitute for wrought iron, since it could be mass-produced as castings rather than having to be hammered and bent. In the past, it was used for a lot of plumbing drains and vents in buildings, but it is now seldom used for these purposes.

Steel, invented in the mid-1800s, is an alloy containing iron, other alloys such as manganese, and proportions of carbon. It is stronger, more ductile, and less brittle than iron. Steel can be cast, bent, welded, rolled, and drawn into many shapes for use as a building material. It is used for fasteners, structural framing, concrete reinforcing, and a host of other functional and decorative applications. With the addition of other alloys, steel can be made corrosion resistant; it also exhibits varying strengths or ductility. It can be coated to develop a protective oxide rust to prevent further deterioration.

STAINLESS STEEL Stainless steel, developed in 1912, has chromium added to make it corrosion resistant. It is used where greater protection is needed from moisture, such as in flashings, railings, hardware, fasteners, sinks, countertops, furniture, and cooking utensils. Stainless surface finishes are tough and can be polished to a mirror quality or brushed to a low luster. The St. Louis Gateway Arch is a 630-foot-high (192m) arch coated with prefabricated stainless steel sections. Stainless steel can be made in a variety of forms for walls or as columns, handrails, or custom installations (Figure13.29).

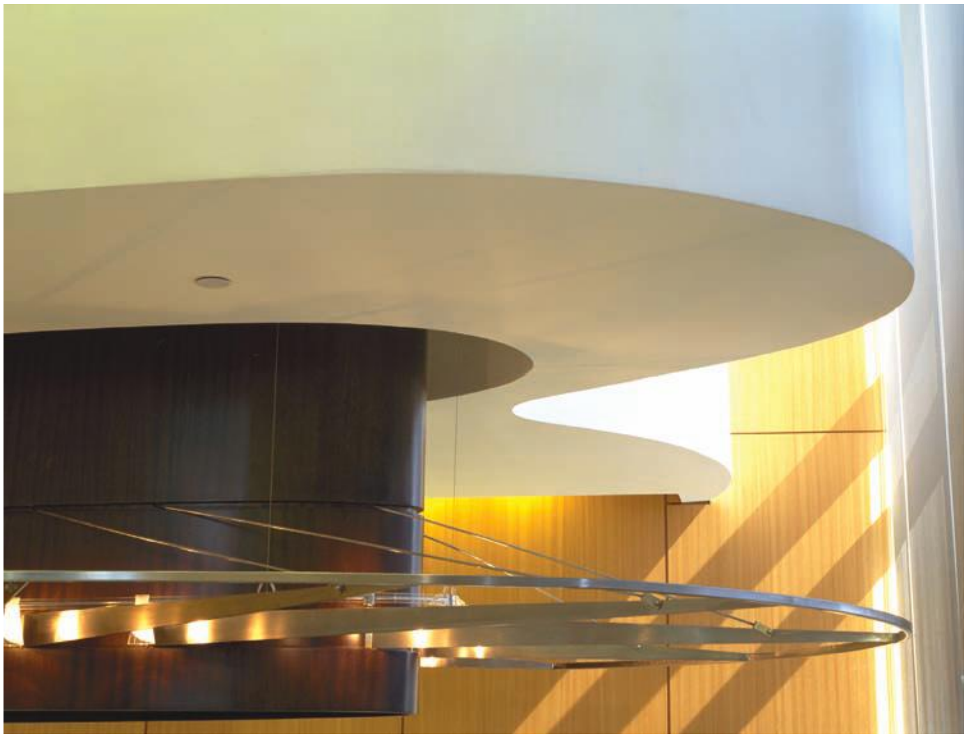

FIGURE 13.29 Stainless steel is used in custom-made curvilinear shapes in this hanging light fixture, complementing the shapes of the curved ceiling soffits.

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Nonferrous Metals

Most of the nonferrous metals are alloys, and most resist corrosion. They are used for a lot of structural applications that require higher strength and reduced weight.

Aluminum is available in a variety of fabricated forms and is used for structural framing, door frames, screens, hardware, flashing, railings, and furniture. It is lightweight, is easily worked, does not deteriorate, and is a good reflector of heat.

Aluminum is produced by casting, rolling, and extruding. In a procedure similar to that used with iron, casting is accomplished by pouring or injecting molten metal into molds; this procedure produces many utilitarian objects, such as grilles, handles, and electrical fittings. Aluminum is rolled using steel rollers; the resulting products include sheets, awnings, sidings, and other shaped planes. Extruding aluminum forces molten metal through a die shaped to the desired configuration, producing a long, continuous, and accurate section. This method is used for making door and window frames in a variety of shapes.

Aluminum finishes range from unfinished mill production to finishes that are polished, etched, and bonded over with plastic films. Anodized aluminum coatings are made by electrolysis, which increases the depth of surface oxide film. Surface oxides have hard finishes that can be integrally colored.

The other metals listed in Figure 13.28 are combined in many ways as alloys and other forms to produce a variety of special metals or to modify others. Brass and bronze are particularly useful in producing many building items and other items for daily usage.

Finishing and Coating Metals

The surface treatment of metals can be finished by different manufacturing processes and coatings. The finishes produced can be highly polished for mirror surfaces or be brushed for satin finishes. Textured or buffed finishes are created by scratching the surface with belt sanders, blasting with fine particles, or hand-rubbing with steel wool. Chemical etching and acid dippings of metal can produce frosted surfaces and galvanizing qualities. Electrolysis is another method employed to create bright metallic finishes of one metal over another, such as a chrome finish on steel.

Coatings are applied to metals to produce durability and aesthetic effects. Varying in color and luster, these coatings can be sprayed, painted, or baked on. Other coatings, such as anodized and vitreous layers, are applied through chemical and heat processes. Vitreous layers are used on cast iron, for plumbing fixtures of lavatories and tubs, for example; anodizing is used on aluminum window and door frames.

PLASTICS

Plastics are chemical substances derived from common materials, such as coal, air, water, wood, and oil. Plastics are produced synthetically and can be molded and hardened for a wide variety of uses. Their performance abilities are similar to those of every other known material from soft rubber to steel. Early plastics were considered to be cheap imitations of natural materials, such as wood, marble, and metal. Design explorations and technological advances, giving plastics a wide range of properties, reasonable cost, and inherent design characteristics, have caused plastic to be more appreciated. Plastics are generally resistant to corrosion and moisture and are lightweight, tough, and easily molded into complex shapes (Figure 13.30). Because of their durability, low cost, and low maintenance, plastics are made to replicate natural building materials, such as wood. Plastics are used for insulation, vapor barriers, window and door frames, exterior siding, plumbing pipes, countertops, tabletops, safety windows, floor coverings, furniture, and accessories.

Because the technology of plastics changes so rapidly, designing with plastics requires the interior designer to have a thorough knowledge of the properties and the methods by which they are fabricated into products. Some plastics are highly flammable, and some give off dangerous fumes or explosive gases when burned. It is very important for the designer to understand the performance factors of the plastic material being specified, because he or she could be liable for the protection of the public's health, safety, and welfare.

Recycling concerns have changed the perception of plastics from a throwaway material to a recyclable one. Plastics that can be ground down or melted down can be reclaimed and re-formed; however, not all plastics can be recycled this way. Researchers continue to work on ways to recycle plastics.

FIGURE 13.30 Plastics constitute many items in this showroom, including the light fixtures, furniture, cubicles, and computer equipment.

Photo Courtesy of Haworth, Inc.

To assist in recycling, many plastics are marked with a triangle of three directional arrows and coded with a number noting the plastic type.

Thermoplastics and Thermoset Plastic

Plastics fall into the two categories of thermoplastics and thermoset plastics (Figure 13.31). Thermoplastics soften when heated and harden when cooled. They can be reheated and molded over and over. Some examples of thermoplastics are polyethylene (plastic bags), acrylonitrile-butadiene-styrenes (ABSs), vinyls, and polyvinyl chlorides (PVCs). Thermoplastics are easier to mold into complex shapes and exhibit higher impact strength than thermosets. Many thermoplastics are flammable, which must be taken into consideration when using them in areas subject to fire. Thermoset plastics cannot be reshaped by heating because once formed in the manufacturing process, they become rigid. Some common thermoset plastics are melamines, epoxies, phenolics, and polyesters. A number of thermoset plastics are difficult to recycle; however, they can be ground up and used as a filler in other material processes.

Plastic Fabrication

Plastics are formed in a variety of ways, such as foamed, molded, laminated, vacuformed, sprayed, injected, calendered (rolled), or blown. They can be produced in just about any weight, and almost any malleability from rigid to spongy, to create various forms and applications. Mineral or fabric fillers, such as mica, cotton, paper, sisal, and glass, are added for strength, moisture, and thermal resistance. As plastics are strengthened by fillers, they become less transparent. The strength of plastics to support heavy loads generally decreases as their flexibility increases.

Plastics are produced in powder or liquid form and are then fabricated into sheets, rods, strips, cylinders, or any other conceivable form. Through the application of heat and/or pressure, the surface quality of plastics can be changed by processes that include buffing, dipping, sanding, tumbling, and vaporizing.

FIGURE 13.31 Common plastics and their uses

NAME	CHARACTERISTICS	USES
THERMOPLASTICS		
ABS	(Acrylonitrile-butadiene-styrene) hard, tough; resistant to chemicals and abrasion	Plumbing systems; furniture
ACRYLICS Lucite Plexiglas Corian	Lightweight; rigid; strong; good color and optical qualities; resistant to weather and temperature changes; scratches	Glazing; skylights; furniture; paints; accessories; countertops (Corian)
NYLON Alpha Chemstrand Nypel	Rigid; resistant to chemicals and temperature changes; scratches	Furniture; bearings; gears; dinnerware; nylon yarn
POLYSTYRENES	Rigid; hard; resistant to chemicals, but not abrasion; breakable when bent; expanded to make Styrofoam	Furniture; kitchenware; insulation; tile
PVC (polyvinyl chloride)	Rigid or made flexible with plasticizers; excellent resistance to wear and abrasion	Plastic plumbing fixtures and fittings
VINYLS Ethyl Exxon Genon	Variable properties according to fillers and plasticizers used; foam and cellular; chemical resistant; stiffens at low temperature	Vinyl floor coverings; upholstery; wall and ceiling coverings; coatings for materials
POLYETHYLENES Dow Monsanto	Made rigid or flexible; lightweight; resistant to chemicals and temperature extremes; used in thin films for water and vapor barriers	Furniture; bowls; dish pans; squeeze bottles
THERMOSETS		
MELAMINES	Tough; resistant to stains, scratching, heat; used in thin layers to make plastic laminates	Cabinetry; furniture; countertops
PHENOLICS Bakelite	Strong; durable; resistant to heat and electricity	Electrical assemblies; paints; finish hardware
POLYCARBONATES Lexan	Very durable; good optics; high resistance to impact	Plastic glazing for shatterproof assemblies
POLYESTERS	Often reinforced with fiberglass and made into thin sheets; flexible or rigid; resistant to weather, chemicals; translucent	Furniture; patio covers; skylights; ceiling panels; yarns
URETHANES	Cellular plastic available in many different properties; formed in place	Insulation; cushions; fabrics; furniture

Certain characteristics of plastics, such as the degree of flexibility or stiffness, tensile or impact strength, and sensitivity to environmental effects of moisture and sunlight, are controlled through the fabrication process. A high or low temperature range, colorability, and resistance to corrosion, cracking, staining, and scratching are also controlled in the fabrication stage.

Plastic Laminates

Plastic laminates are used extensively for interior surfacing, such as wall treatments, furniture, cabinets, countertops, and tabletops. These are very durable materials available in a wide variety of colors, textures, and patterns. Plastic laminates are impervious to many chemicals and are easy to maintain.

Thermosetting plastics are used in the fabrication process of high-pressure laminating. This process is different from other manufacturing processes because it involves high heat and pressure. Reinforcing materials, such as cloth, paper, wood, or fibers of glass that compose the body of the finished product are laminated between two sheets

FIGURE 13.32 This custom sink trough is made of Corian, a solid surface material that is extremely durable and can be refinished if scratches do occur on the surface.
Courtesy of National Kitchen & Bath Association

of plastic that hold them together. These added materials are impregnated with uncured resin or alternated with uncured plastic films, then pressed between two highly polished steel plates that are subjected to heat and high pressure. The plates squeeze the layers of material into a single sheet of the desired thickness. Textured or patterned steel pressing plates transfer these characteristics to the surface of the laminate.

Solid Surface Materials

Many cabinetry countertops are made of an acrylic resign composite, commonly referred to as *solid surface materials*. These are manufactured of plastic and other combined materials to look like granite, marble, quartz, and many other types. Some of the most well-known brands are Corian and Avonite. These materials are resistant to stains and generally nonporous. They can be cast into shapes for integral sinks, and lavatories (Figure 13.32). A major feature of solid surface counters is that they can be made to look seamless, because they are joined and bonded together with no gaps.

Carbon Fiber

Carbon fiber (carbon-fiber-reinforced plastic) is a strong fiber-reinforced polymer plastic that contains carbon fibers and is very lightweight. It is useful for high strength-to-weight ratios and used to manufacture items such as fishing rods and laptops, and in the automotive and aerospace industries. It is also being used by some furniture manufacturers for strong, lightweight furniture assemblies.

TEXTILES

Textiles are important materials that contribute to the overall design of an interior space. Textile fabrics humanize our interior environments, adding softness, comfort, flexibility, and dynamic movement to otherwise static spaces. Fabrics are used for both functional and aesthetic purposes in an interior environment, as illustrated in Figure 13.33.

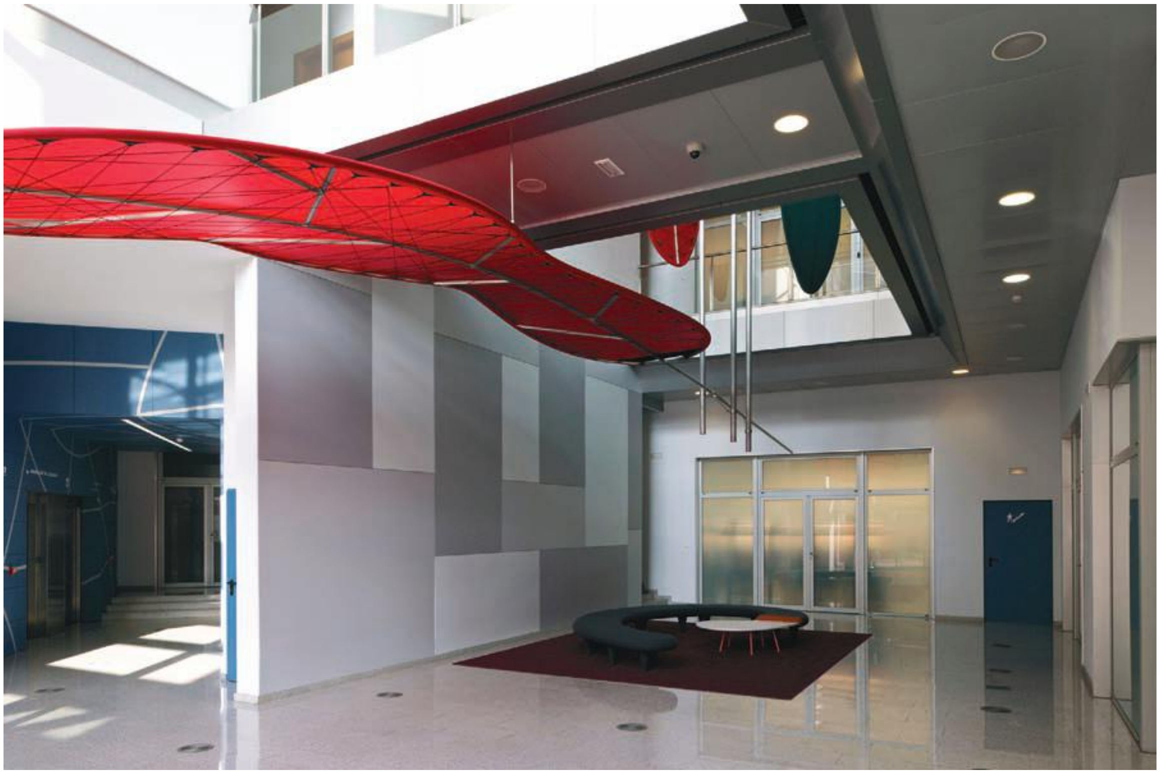

FIGURE 13.33 Fabrics of nylon help diffuse intense light and add color and interest to this lobby of the William MacDonough Partners Ecourban Building in Barcelona.
VIEW Pictures Ltd / Alamy

Functionally they are used to control natural light, provide privacy without solid walls, insulate from heat and cold, and absorb noise. They also provide comfort as upholstery for sofas and chairs.

Aesthetically, fabrics are pliable and can be manipulated to create any kind of mood or characteristic. They come in a limitless variety of colors, patterns, and textures and can be readily changed or replaced. Fabrics are excellent as a unifying element throughout an interior space and can be integrated with walls, windows, ceilings, and furniture.

Selection and Application of Fabrics

The selection of fabrics depends on their specific use within an interior space. The criteria governing the selection of textile end products depend on many variables. Some fabrics are selected for their aesthetic characteristics; others may focus on function-related performance, maintenance, and installation factors; and some may be determined by economic factors. Figure 13.34 shows the variable characteristics involved in the selection criteria of fabrics for interior environments.

Aesthetic Factors

Often a fabric is selected because of its aesthetic appeal; however, a designer must be sure that the fabric is also durable and appropriate for its intended use. Three attributes of a fabric that form the basis for aesthetic judgment are color, pattern, and texture. A fabric can also be judged on good design principles within itself and on how it will coordinate with other materials.

Color preference is sometimes the most important factor in the selection of fabric. Coordinate color schemes of fabrics with those of other materials in an interior space; the color schemes should support, enhance, and complement one another, not compete or cause visual irritation. The intensity and brightness of color within a fabric color scheme should be varied. If all colors are of a low value or dulled, the overall effect may be uninteresting or monotonous. If all the colors are intense, the effect may be unlivable.

FIGURE 13.34 Selection criteria for fabrics used in interiors

CRITERIA	CHARACTERISTICS/CONSIDERATIONS
AESTHETIC FACTORS	
Appearance	Color, pattern size and repeat, visual textures, style
Tactile	Touch: rough, smooth, soft; fabric weight and drapability
Visual Coordination	Coordination with other interior elements
FUNCTIONAL	
Durability	Abrasion and tear resistance; light fastness; color and texture retention; soil resistance; structural stability and flame resistance; reparability
Performance properties	Value for acoustical, static, insulative, and light control properties
Maintenance needs	Cleanability, stain removal, and touch-up requirements
ECONOMIC	
Material Costs	Material, delivery, and installation costs; maintenance, warranty, and replacement costs
Labor Costs	
Maintenance Costs	

Another consideration in selecting fabric color is the light within the space and how it will affect the color of the fabrics. The quality, type, and direction of light should help coordinate and enhance the fabric color scheme.

Pattern expresses the personality and character of a fabric. Pattern within fabrics should be well proportioned and exhibit good design composition. When coordinating two or more patterns, the designer should vary the scale of the fabrics, using a small pattern with a large one, for example. Support patterns and textures, such as stripes and geometrics, can be combined with a floral pattern, as well as with a plain, textured fabric. Pattern can also be used to relate a particular fabric to a period of time. Coordination of period styles and their patterns and motifs must be consistent to produce an authentic effect.

Fabrics possess both visual and tactile textural qualities. Textural characteristics range from a smooth and refined quality (satin, velvet, damask) to a coarse and sturdy quality (tweed, matelassé, frieze). Textural relief within a fabric refers to the three-dimensional quality of the surface, such as the peaks and valleys created. This third dimension gives depth and interest to a fabric and accounts for the highlights and shadows in its appearance.

The weight of a fabric is also important in the selection process. These weights are often related to how many ounces per square yard the material exhibits, such as 1 ounce to over 12 ounces. Fabrics can be classified into four basic weight categories: sheer and/or thin, lightweight, medium-weight, and heavyweight. Sheer and/or thin fabrics are typically used for window curtains or draperies, soft top window treatments, and canopy coverings. Lightweight fabrics can also be used for curtains, draperies, and top treatments, as well as for shades for windows, lampshades, and lined bedspreads. Medium-weight fabrics are used for bedspreads, slipcovers, upholstery, draperies, shades, rigid top treatments, and heavier curtains. They can also be used as wall and partition coverings. Heavyweight fabrics are applied as furniture upholstery, wall coverings or hangings, and heavy bedspreads.

Good textural coordination within an interior depends on textural harmony. Generally a designer sets a theme, ambience, period, or style to work from that unifies all the fabrics in a scheme. The texture of the fabrics must be appropriate for their intended use and the level of formality or informality within a space.

Functional Characteristics

Functional characteristics include serviceability expectations, as well as design and performance qualities. These often include durability, strength, stain resistance, water resistance, and sometimes flame resistance. Some fabrics will wear out faster than others because of the fiber, yarn, or construction method. Some fabrics may wear out aesthetically because of functional weakness, such as fuzzing or pilling, colors fading or crocking (color rubbing off), or being difficult or impossible to clean.

A designer must also be aware of performance requirements, such as flame resistance, static reduction, or structural stability. Fabrics installed in commercial applications must meet minimum requirements for durability, colorfastness, and fire safety.

Economic Factors

Economic factors include cost limitations involved with the installation of the material and maintenance requirements. A designer should be aware of a fabric's ability to hide soil and still look good. The cleanability of a fabric is based on the fiber content, construction method, and durability of finishes.

Like the other basic construction materials (stone, wood, brick, and plaster), fabrics come from a natural or raw state and go through an average of six finishes to become marketable or usable as finished products. Before specifying or selecting fabrics for an interior space, the interior designer must understand the qualities of the basic materials, the process that fibers undergo in order to be transformed into fabrics, and the finishes and applied ornamentation of the fabrics.

Fibers

Fibers are any substance that can be separated into threads or threadlike structures and used for spinning and weaving. In interior design, the term is used for textile fibers. Fabrics are often named for the fibers from which they are made. Fibers are classified according to their chemical composition, how they are produced, and whether they are natural or manufactured. Further classification may be made according to the general source of each fiber; for example, natural fibrous materials come from plants (cellulose) or animals (protein), and manufactured (man-made) fibers are produced from petroleum- or mineral-based compounds. "Man-made" has traditionally meant regenerated cellulosic fibers plus synthetics. The preferred term is *manufactured*. Fibers are further classified by their generic (based on chemical composition) names, such as acetate or acrylic. Basic fiber properties discussed in this chapter refer primarily to textiles. Carpet fibers, which are slightly different, are discussed separately, in Chapter 14.

Natural Fibers

Natural fibers come from two main sources: protein and cellulose. Protein fibers are derived from animals (wool from sheep) or insects (silk from silkworms). Cellulose fibers (cotton, linen, jute, ramie, sisal, and less common fibers) come from plants.

Manufactured Fibers

Manufactured fibers are produced from man-made substances; the usable fiber is a result of industrial processing. Manufactured fibers can be divided into two categories: cellulose based and noncellulosic, or synthetic. Rayon, acetate, and triacetate are produced from cellulose, a natural raw material, to which various chemicals are added. Noncellulosic, or synthetic, fibers—nylon, polyester, olefin, acrylic, saran, vinyl, and many others—are synthesized from chemical compounds, such as petroleum, natural gas, coal, air, and water.

Other Fibers and Blends

Another category of fibers is natural/mineral fibers, processed in ways similar to those used for manufactured fibers. Natural/mineral fibers, limited in their use, include rubber, glass, and metal. Asbestos, formerly popular for its fire-resistant properties, has been dropped from most use because it has been found to be a carcinogen.

Although a textile may consist of one type of generic fiber, frequently two or more are blended to increase the strength and aesthetic appearance, or to minimize the weakness, of a particular fiber. For example, natural and synthetic fibers can be blended to retain the appearance and texture of the natural fiber while gaining the soil resistance and durability of the synthetic fiber. Different fibers can be spun into one yarn, or different yarns can be blended into a single fabric. These combinations have produced some important changes in fabric characteristics. Combining polyester fibers with cotton in various proportions makes the resultant textile wrinkle free and almost completely soil resistant. Wool's strength is increased when it is blended with nylon. Fabric manufacturers can devise almost endless combinations to obtain the best attributes of various fibers. However, some fiber blends can have disadvantages. Manufacturers are required by federal law to label fabrics with fiber content and method of care, which can help offset these disadvantages. It is extremely important for a designer to keep abreast of the characteristics of fibers and their probable performance. See Figure 13.35 for a listing of the advantages, disadvantages, characteristics, and applications of some common fibers.

FIGURE 13.35 Features and characteristics of fibers commonly used for furniture and other interior applications

FIBER	TRADE NAME[1]	ADVANTAGES; CHARACTERISTICS	DISADVANTAGES	APPLICATION[2]
NATURAL				
ANIMAL (PROTEIN)				
Angora (rabbit) Camel's hair Cashmere (goat) Horsehair Mohair (goat) Wool (sheep)		Durable; resistant to stains, soiling; cleans well; variety of color and textures; high quality; dyes well; noted for appeal and warmth; special treatment processes increase properties and versatility; resists burning	Susceptible to insects; shrinks unless treated; sunlight deterioration	B, C, D, R, U, WC
Silk (silkworm cocoon)		Fair soil resistance; dimensionally stable. Lustrous; glossy; deep luster; burns slowly	Sunlight deterioration; damage by moisture and soiling	D, R, U, WC, L
PLANT (CELLULOSE)				
Cotton		Economical; excellent color range; stronger when wet; versatile; dimensionally stable; irons easily; absorbent; lightweight to heavy	Soils, stains, wrinkles easily unless treated; burns readily	B, D, R, L, U, WC
Jute (burlap, gunnysack)		Economical; takes color well; strong; used primarily as backing for carpets	Rots if left wet; fades, burns readily	D, WC
Flax (linen)		Dyes well; natural luster; strong fiber; washes and irons well	Soils, fades, and wrinkles easily unless treated	D, L, U, WC
MANUFACTURED				
CELLULOSIC				
Acetate	Celebrate® Chromspun® Estron® Kodel®	Resistant to moths, pilling, mildew, discoloration; dries quickly; economical; dry-clean or wash according to specifications; silk-like sheen	Poor resistance to sunlight; low abrasion resistance; flammable	D, L, U
Rayon	Cuprammonium® Fibro® Rayon® Tencel®	Resistant to moths, pilling; excellent color range; strong, durable (in heavyweight fabrics); resembles cotton; colorfast; drapes well; economical substitute for silk or cotton; versatile fiber	Very flammable unless treated; shrinks in hot water if not treated	B, C, D, L, R, U
Triacetate	Arnel®	Resistant to aging, chemicals, insects, mildew, sunlight, wrinkling; colorfast; excellent color range; holds shape well; dries quickly		B, D

[1] Partial listing of trade names.
[2] Application code: B = blankets, C = carpet, D = drapes, L = linens (table/bed/bath), R = rugs, U = upholstery, WC = wall coverings.

Yarns

Yarns are long, interlocked strands or threads made from fiber to prepare it for construction into fabric. Making yarn from natural fibers involves cleaning the fibers, pulling them out more or less evenly and parallel, and then twisting or spinning them into yarn. Manufactured fibers are made from a liquid or melted polymer, which is then forced through holes in a spinneret, which resembles a showerhead. The shape and size of the holes in the spinneret determine many fiber characteristics. The extruded filaments are then twisted into a yarn. Generic fibers can be combined in the liquid stage to make blended fibers for specific needs.

Yarns vary according to the type of fibers used (either alone or in combination); the type, direction, and tightness of the twist; the number of strands twisted together (called the ply); and the size of the finished product. Long fibers laid parallel and twisted tightly produce smoother and stronger yarns than short fibers placed randomly and twisted loosely. Silk is the only natural fiber that is one long, continuous fiber, although synthetic fibers can be made long and continuous. Any fiber, or combinations, can be cut into short pieces for different effects.

Besides having their component fibers tightly or loosely twisted, yarns can also be given a right- or left-hand twist to create special effects. Yarns differ according to the various methods of construction. The most common are described in the following sections.

Monofilament

In the monofilament process, a single filament or strand is treated as one yarn structure. For stability and strength, the filament is relatively large in diameter, stretched, and heat set. Monofilament yarns are generally used in the production of lightweight, transparent window coverings. They are also used in the construction of many interior textiles as a strong sewing thread. In the latter, the filaments may be clear or translucent to blend with the color of the textile.

Multifilaments

A single multifilament yarn is produced by twisting a multitude of individual filaments (often twisted) together. Multifilament yarn can be used alone or spun with other fibers.

Spun Yarns

Short-length fibers, such as wool and cotton, are converted into usable yarn strands by processing them through various spinning systems. Before the invention of the spinning machine during the Industrial Revolution, yarns were produced by hand-spinning. Natural fibers have been blended with synthetic fibers in an attempt to produce a yarn that combines the best qualities of both.

Twisted Yarns

Yarns can be twisted to increase their strength. Twisting is used for all spun yarns. A fabric's texture and appearance are influenced by the tightness and twist. Texture can be created by using yarns of different twist direction, or by varying twist direction within one yarn.

Plied Yarns

Plied yarns are formed by twisting or plying two or more single yarns together, which increases the thickness and strength of the yarns and produces varied textures in fabrics. The yarn strands are generally twisted together opposite in direction from the way they were spun as a yarn. Special visual effects can be created by plying yarn strands of two or more colors.

Complex and Novelty Yarns

SLUB YARNS Slub yarns are irregular in diameter and have coarse and fine segments along their length; these segments are produced by varying the level of twist used in spinning. Slub yarns give fabric a distinct texture. Slub yarns in a durable material such as upholstery can be a liability, but slub yarn used in window treatments or tablecloths can produce a desirable visual treat.

STRETCH YARNS Stretch yarns can be constructed with a stretchable, elastic core and covered with fibers wrapped around them, or synthetic fibers can be crimped by a new process into a springy, coiled form. These stretch yarns are used for apparel, as well as for some upholstery fabrics.

Textile Construction

Fibers are made into a textile or cloth by various construction methods. Each method creates distinctive aesthetic and structural features that affect the fabric's serviceability, installation, and maintenance requirements. In turn, these factors will influence the suitability of the fabric for end-use applications. The method of construction also has a direct effect on the cost of the end product, which is an important criterion in the selection of most residential and commercial interior textile products. The most common fabrication methods use yarn as the basic element; however, there are some methods that do not require fiber in a yarn form. The most common fabric construction methods are described in the following sections.

Weaving

Weaving is still the dominant form of fabric construction. Weaving is done on looms and is the interlacing of lengthwise yarns called warp and filling yarns called weft (an old English word) or woof; the latter run crosswise and usually at right angles. The filling yarns hold the warp together. The pattern of the interlacing and the number of yarns used determine the type of weave. Several basic categories of weaves—plain, leno, twill, satin, pile, and Jacquard—are produced on looms (Figure 13.36).

PLAIN WEAVES The plain weave simply interlaces one filling yarn over and under one warp yarn in a regular sequence. It generally can be identified by its appearance of a checkerboard pattern. Using different sizes of yarns or adding extra yarns in one direction creates variety. For example, a rib weave creates a lengthwise or crosswise rib effect by interweaving heavy yarns with thinner ones, and a basket weave creates a distinct pattern by using two or more warp yarns interlacing two or more filling yarns.

LENO WEAVES Leno weaves, a variation of the plain weave, are produced when the warp yarns form an hourglass twist. They interweave the filling strands to create an open, lacy effect that resists distortion better than a corresponding plain weave does. Leno is the most common lace weave and is often used for casement fabrics, because it produces an open mesh appearance.

TWILL WEAVES Twill weaves produce a definite diagonal line or wale on the surface of a fabric; this wale is created by having the warp yarns "float" across a number of filling yarns in a regular pattern. Textiles woven in twill weaves generally have high strength and resist soil and wrinkling better than textiles of plain weaves of similar quality. Twills are often used on furniture upholstery for their soil- and stain-hiding capabilities. Typical twill-woven textiles include serge, hound's-tooth, denim, and gabardine.

SATIN WEAVES One warp yarn is floated over four or more filling yarns in the satin weave. The floats in the satin weave are longer than in the twill weaves and minimize the over-under texture. Satin-woven fabrics are characterized by high luster and sheen produced by fine, lustrous yarns and the reflection of large amounts of light from the smooth, uninterrupted surface areas of the floats. The level of luster will be reduced if abrasion ruptures the floating yarns during use. Textile examples of this weave category include satin, sateen, and chino.

PILE WEAVES The pile weave adds a third set of yarns (pile yarns) to the basic warp and weft sets of yarns during the weaving process. In the finished textile, the pile yarns protrude from the background, introducing

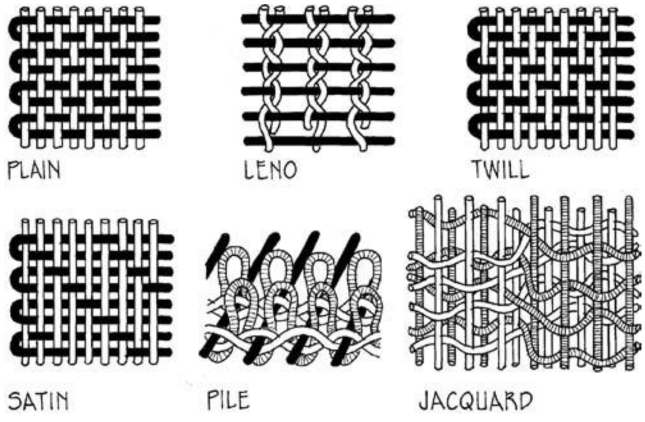

FIGURE 13.36 Common textile weaves

a dimension of height to otherwise two-dimensional fabrics. This extra set of yarns produces loops that can be left uncut, as in terry cloth, or cut to produce velvet, corduroy, or plush textiles. Patterns can be created by cutting some loops and leaving the remainder uncut or by having some portions of the pile higher than others.

JACQUARD WEAVES Jacquard-woven fabrics often have extremely complex patterns combining two or more simple weaves, multiple sets of yarns, and strategically placed colors. These weaves are produced on a highly complex machine that operates like a computer. The Jacquard loom was invented in the eighteenth century by a Frenchman, Joseph Marie Jacquard. It resembles an early computer, in that hole-punched cards are utilized to control the interlacing of yarns. The holes in the card allow some threads to rise while others stay in their original position. The result is that large, complex patterns can be woven at a fraction of the cost of hand-woven fabrics. Today, this loom takes a long time to thread and set up, but once it is ready to operate, large runs of textiles can be produced at relatively little expense and in a reasonably short time. Damask, brocade, matelasse, brocatelle, and figured velvets are examples of Jacquard weaves.

Knitting

Knitting is another method that can be used to combine yarns into textile fabrics suitable for interior applications. Knitting is a process whereby needles are used to weave a single strand of yarn into a series of interlocking loops. Patterns are created by a combination of stitches, such as plain, rib, purl, jersey, and interlock. Knitted fabrics are popular because of their wrinkle recovery, stretch recovery, and form-fitting characteristics.

Other Fabrication Methods

Bypassing the yarn stage is now possible because of modern ways to produce fabric structures. Spun-bonding and spun-lacing—techniques similar to the age-old technique of felting—and the efficient method of needle punching are new methods being used to combine fibers directly into fabrics.

FELTING Felting means matting together wool fibers to form a web. These fibers are layered and exposed to controlled heat, moisture, and pressure, which causes the fibers to intermesh and entangle, compacting and shrinking the fibers into felt. Felt is a dense cloth that is firm and slightly fuzzy and has comparatively low tensile strength. It is generally used as a backing fabric to prevent scratching, or as an insulation material.

NEEDLE-PUNCHED FELTS Needle-punched felts are constructed by pushing barbed needles through a mat of fibers to entangle them without the use of heat or pressure. This technique is used in the production of some carpets, wall coverings, and blankets.

BONDED-WEB FABRICS Bonded-web fabrics are also nonwoven and consist of layers of fibers bonded through the use of a binding agent, such as an adhesive spray. The adhesive is first sprayed over the fibers to cause the nonthermoplastic fibers to adhere to one another; then heat is added to fuse the fibers together. Bonded-web fabrics are used as interfacing in upholstery to add body and weight. They are also used to interface the heading in curtains and draperies to support pleats and scallops.

SPUN-BONDING Spun-bonding converts thermoplastic fibers directly into fabric. After the fibers are arranged in a thin web, heat or chemical binders are added to stabilize them. Compounds can be sprayed over them for additional strength, stability, and weight, or for reduced transparency. Spun-bonded fabrics are used as tablecloths, bedding products, and backings for wall coverings and carpets.

SPUN-LACING Textile fabrics produced by mechanically entangling fibers are referred to as spun-laced fabrics. These fabrics are stabilized or held together solely by fiber-to-fiber friction, rather than by an adhesive or other type of bonding agent. Spun-laced fabrics are used as backings for textile wall coverings, simulated leather upholstery fabrics, mattress pads, and comforters.

FILMS Synthetic polymer solutions, such as polyester plastics, can be converted directly into film sheeting fabrics. This technique involves extruding the liquid solution through a spinneret that has a narrow slit rather than holes. As the polymer ribbon emerges, it is stretched into a thin sheet or film. The thickness of the material is controlled by varying the extrusion pressure and the amount of stretching. Film sheetings are used for interior products such as shower curtains, simulated leather upholstery, drapery linings, and plastic-coated wall coverings.

Textile Colorants

Color can be added at several stages of the textile-construction process. Although most natural fibers contain some color-producing substances, which may or may not be retained, very few fibers or other textile structures have intrinsic color today. Most textiles have color-producing substances added. In the textile industry, the term "greige goods" refers to undyed and/or unfinished fabrics. The importance of color-related variables to the selection of interior textiles is reflected in the methods used for applying color—dyeing, printing, and dyeing and printing combinations. In the selection of interior textiles, it is important to know what methods are used to add color, because the method used will affect durability.

Dyeing

Dye can be added to fibers, yarn, or woven textiles. Most dyeing operations require the textile substance to be immersed in the dye solution. For some synthetics and plastics, dye can be mixed with the liquid form from which the fiber or film is made.

Solution dyeing and fiber or stock dyeing are the two methods of dyeing fibers. Solution dyeing is used only with manufactured fibers, but fiber dyeing can be used with both manufactured and natural fibers.

SOLUTION DYEING In solution dyeing—the more permanent form of coloring synthetic fibers—dyes or pigments are added to the polymer solution before extrusion from the spinneret. This method locks the color inside the fiber. Manufacturers use the terms *color-sealed* or *produced-color* to identify solution-dyed fibers. Because the color is incorporated as an integral part of the fiber, the process produces uniform color. Solution-dyed fibers have comparatively high color retention and stability but can be expensive.

FIBER OR STOCK DYEING Fiber or stock dyeing involves immersing manufactured or natural fibers in a dye solution before they are spun into yarn. This method produces excellent results, since loose masses of fibers can absorb the dye more readily and thoroughly than fibers in the yarn or fabric state can.

YARN DYEING Yarn dyeing involves adding colorants to the yarn before it is made into fabrics. Most yarn-dyeing methods, such as package dyeing, beam dyeing, and skein dyeing, produce single-colored yarns. However, space-dyeing techniques can be used to produce multicolored yarns also.

PIECE DYEING In piece dyeing, yarn that has been fabricated into a fabric piece is immersed in a dye liquid. This process produces single-colored fabrics and is economical; however, the dye generally does not penetrate the fibers and yarns as well as in other dyeing methods.

CROSS-DYEING Cross-dyeing is a color application process in which two or more fibers that are chemically different are dyed in the same bath, accepting the dye or dyes in different ways and producing a multicolored fabric.

Printing

Several printing methods can be used for adding colors and patterns to fabrics. The most common are described in the following sections.

BLOCK PRINTING One of the oldest methods of printing, block printing involves carved wooden blocks inked with a dye paste and stamped onto a fabric. This method was popular in England and France before machine-printing operations were developed. Some patterns required as many as 100 different blocks. This method is not much used in commercial production, but it can produce very artistic results that are unique to each piece.

ROLLER PRINTING At one time, one of the most common printing processes was roller printing. This involves large metal rollers that are engraved or etched with a design. Separate rollers (a different one for each color) continually ink the large etched cylinder as the fabric moves around it. This process produces very fine-line prints and is fairly inexpensive. However, it has been almost entirely replaced by rotary-screen printing, which is much faster.

SCREEN PRINTING Screen printing (often called silk screen) is the most common technique based on the principle of a stencil, with a fabric screen stretched over a frame. Some areas of the fabric are blocked by the screen to prevent the dye from reaching them. The two methods of screen printing are flat-bed screen printing and rotary-screen printing.

In flat-bed screen printing, large rectangular frames are covered with a fine, strong fabric. Today, nylon and polyester fabrics are used instead of silk because of the higher cost of the natural fiber. A rubber squeegee then presses the dye paste through the screen. A different screen is used for each color. Flat-bed screen printing is generally used for upholstery and drapery fabrics that are designed with large-scale motifs and pattern repeats.

Rotary-screen printing is also a stencil technique, but it is fully automated. The rotary screens are wrapped around circular drums that rotate the ink onto fabric that moves beneath the screens. Some rotary-screen printing machines can accept up to 20 screens, enabling them to print up to 20 different colors. Rotary-screen printing is more economical and faster than other screen printing techniques. This method produces a more uniform level of color when large quantities of fabric are being run.

TRANSFER PRINTING Transfer printing is a heat-transfer process similar to that used for applying decals. A pattern is printed with dye onto a waxed paper, then transferred by applied heat and pressure onto the fabric. The fabric absorbs the dyes from the pattern. Transfer printing was developed in the 1970s mainly for use with polyester knits because the inherent elasticity of these fibers caused them to shrink after the release of the tension used in the roller and screen-printing operations. Transfer printing requires minimal fabric tension, which eliminates the problems.

ACID PRINTING Acid printing, also referred to as burnt-out or etched-out printing, prints a design by using a chemical that dissolves one of the two or more fibers in a fabric. For example, in the printing process of a fabric blended of nylon and rayon, a weak sulfuric acid is printed on selected areas of the fabric, which destroys or "burns away" the rayon fibers. This process creates a higher level of transparency in the treated areas of the fabric. Another typical acid-printed fabric is a cotton-polyester semisheer in which the cotton is burned out.

DIGITAL PRINTING Digital printing uses modified inkjet technology to print directly on fabrics. This method can produce basic patterns or highly refined artistic images that can appear quite realistic.

Dyeing-Printing Combinations

Combinations of dyeing and printing techniques involve immersing fabric in dye solutions in combination with printing procedures, to produce interior textiles with colored backgrounds and noncolored designs.

DISCHARGE PRINTING In discharge printing, areas of color (usually the patterned motif areas) are bleached out or replaced by another color. The fabric is first piece-dyed, then printed with a reducing agent, such as bleach, wherever the design motifs are planned. This agent removes, or "discharges," the dye.

RESIST PRINTING Resist printing is a technique in which parts of the fabric are protected from being absorbed by the dye. Artisans use several hand-resist methods to create distinctive interior fabrics. The two most common methods of resist printing are batiking and tie-dyeing.

Batiking is a hand-printing process in which parts of a fabric are covered with a hot wax to prevent the dye from penetrating. The wax is removed after the waxed cloth has been immersed in a dye solution. This process can be repeated a number of times with different dye colors to create interesting patterns.

In tie-dyeing, another popular hand-resist method, the fabric is tied with thread or knotted to prevent parts of it from coming into contact with the dye. This process can be repeated to create abstract patterns.

Fabric Finishes

Finishing is the process of converting textiles from their raw state to usable interior textile products. Until cloth is converted into a finished fabric, it may lack aesthetic characteristics, as well as structural stability and service-related performance features. The appropriate selection and proper application of finishes expand the variety of fabrics available to the interior designer and the consumer.

Finishes can be divided into three categories: prefinishes, functional finishes, and decorative or surface treatment finishes. Figure 13.37 lists the characteristics of some of these common finishes.

Prefinishes

Prefinishes prepare textiles for coloring or other finishes. Prefinishes are applied to both natural and manufactured fibers in their raw, untreated state.

FIGURE 13.37 Common fabric finishes

PREFINISHES	
BLEACHING	Chemical process that removes unwanted color and whitens greige or gray goods.
BOILING-OFF OR SCOURING	Removes various compounds such as grease, sizing, or other unwanted components.
BRUSHING	Mechanical process that aligns pile yarns and pulls out unwanted short fibers.
CRABBING	Process used to wet wool fabrics.
MERCERIZATION	Chemical process used on cotton or linen to increase the fiber's ability to absorb dye, increase strength and luster.
PRESHRINKING	Process that subjects fabric to moisture and dry heat that lessens the tendency of the fibers to contract when exposed to moisture.
SANFORIZING	A trade name process of preshrinking to limit shrinkage to less than 1 or 2 percent.
SHEARING AND SINGEING	Remove short fibers, lint, and fuzz to prevent pilling. Singeing is used primarily on cotton, cotton/polyester blends, linen, and rayon.
STABILIZING AND HEAT-SETTING	Processes that produce dimensional stability and aid in crease or pleat retention.
FUNCTIONAL FINISHES	
ANTIBACTERIAL, ANTISEPTIC, OR BACTERIOSTAT	Chemical treatment to inhibit growth of mildew, mold, other fungi, and rot.
ANTISTATIC	Chemical treatment to prevent buildup of static electricity.
BURNT-OUT	An acid process (also called etched) that burns out one fiber in a fabric to produce a transparent or shear pattern.
CREASE/WRINKLE RESISTANCE	Chemical treatment to resist creases and wrinkles.
FIREPROOFING	Chemical or fiber treatment to inhibit flammability.
FIRE-RETARDANT	Chemical treatment to resist ignition and retard flame spread.
INSULATING	A coating of foam or other materials layered to the back of a fabric to increase insulative values.
MOTH-REPELLENT	Chemical treatment to resist damage by moths and other insects.
SCOTCHGARD	A trade name chemical process that conditions textures to be stain resistant.
SOIL-RESISTANT OR SOIL-REPELLENT	Chemical process that coats or impregnates fibers to make them less absorbent and make soil removal easier.
SOIL RELEASE	Chemical process that increases a fabric's ability to release soil through wet cleaning.
WATER-REPELLENT	Chemical process that coats or impregnates fibers with materials such as metal, resin, or wax to prevent soil and moisture from being absorbed.
DECORATIVE OR SURFACE TREATMENT FINISHES	
BEETLING	Mechanical process that gives luster, absorbency, and smoothness to linen fabrics.
CALENDERING	Mechanical process that flattens and gives luster to a fabric by pressing with hot, heavy rollers.
CRABBING	Chemical process that tightens and sets the weave in wool.
CRUSHING	Mechanical process used mostly with velvet fabrics that flattens and orients pile yarns in various directions. Produces several levels of luster due to reflection of light in different directions.
DELUSTERING	Chemical process applied to fibers before spinning. It produces a dull surface finish that diffuses light.
EMBOSSING	Mechanical process using engraved rollers that press a three-dimensional pattern into a fabric.
FLOCKING	Mechanical process that embeds extremely short fibers (called flocks) in an adhesive or resin compound and applies them to the surface of a fabric. These are applied in a pattern or as a continuous layer.
FULLING	Mechanical or wet process that improves the appearance of wool fabrics and softens them.

FIGURE 13.37 *Continued*

GLAZING	Mechanical process that impregnates the surface of a fabric with compounds and passes the fabric through high-speed calender rollers. This produces a smooth and lustered surface. This process is frequently used on chintz fabrics.
MOIREING	Mechanical process of calendering used on filling-rib woven fabrics that produces a wood-grain or water-marked appearance.
NAPPING	Mechanical process using hooks that pull fiber ends from low-twist, spun yarns. Produces a low, soft, fuzzy pile.
SCHREINERING	Mechanical process of calendering that creates small hills and valleys on the fabric surface. Not a permanent finish unless resin or heat treatments are included.
SOFTENING	Chemical process that produces a softer feel to a fabric.
STIFFENING	Chemical process of applying resins and starch to the fabric surface to add crispness.
TEXTURIZING	Mechanical heat treatment or chemical process that produces a surface texture such as a wrinkle or pucker.

Functional Finishes

Functional finishes are applied to fabrics to improve their performance and their resistance to environmental factors. These finishes also improve the quality and potential serviceability of the structural features. Functional finishes may be durable (finishes that will withstand repeated cleaning) or nondurable (finishes that can be removed with cleaning and need to be reapplied).

Decorative or Surface Treatment Finishes

Decorative or surface treatment finishes are either durable or nondurable and are used to control the level of surface luster or embellishment on the fabric face for aesthetic and textural qualities.

Textiles for Interiors

Textiles in interiors are used as draperies (and curtains), upholstery, carpet, wall coverings, table linens, bedding, and towels, among others. The most common textiles, their characteristics, and their applications are shown in Figure 13.38.

FIGURE 13.38 Some typical fabrics and terms used in textiles for interiors. See symbol key at end of chart.

FABRIC OR TERMINOLOGY	FIBER	CONSTRUCTION	DESCRIPTION	APPLICATION
Sheer Weight				
BATISTE	C, SYN	Plain weave or dobby loom weave	Delicate fabric often printed with designs.	D, V
CHEESECLOTH	C	Plain weave	Cotton woven with low thread count; inexpensive; used as utility fabric.	V
CHIFFON	S, SYN	Plain weave	Delicate, sheer fabric; usually soft. Term is also used to note a soft finish given to a fabric, such as "chiffon velvet."	D
DIMITY	C	Plain, rib, weave	Warp spaced ribs give fabric a striped appearance; printed or plain.	D
MARQUISETTE	C, S, SYN	Open leno weave	Sheer fabric for curtains or draperies.	D
NET	SYN, V	Plain weave	General term for open work mesh fabric made fine or coarse and open like a fish net.	D, V
NINON	V	Plain or novelty weaves	Sheer curtain or drapery fabric; sometimes referred to as "triple voile."	D

Continued

FIGURE 13.38 *Continued*

FABRIC OR TERMINOLOGY	FIBER	CONSTRUCTION	DESCRIPTION	APPLICATION
ORGANDY	C, SYN	Plain weave	Fabric used primarily for curtains and drapes; given a stiff, crisp finish.	D, V
SCRIM	C, I	Plain weave	Loose constructed weave used for curtains and bottom of upholstered goods as dust cover.	D, U
SWISS	C, S, SYN	Plain weave	Thin sheer fabric with crisp finish and dotted pattern. Also known as "dotted swiss."	D
VOILE	V	Plain weave	Sheer drapery fabric with tightly twisted yarns; variety of patterns and color.	D, V
Light Weight				
ANTIQUE SATIN	S, SYN	Satin weave	A reversible fabric that imitates silk shantung, a basic type of weave.	D, U
BIRD'S EYE	C, L, SYN	Plain or dobby weave	Overall pattern of small diamond shapes that have a small dot that suggests a bird's eye.	V
BROADCLOTH	C, S, SYN, W	Plain, rib, or twill weaves	Tightly woven with fine cross ribs. Wool weaves have finely napped texture in a single direction.	V
CALICO	C, SYN	Plain weave	Similar to broadcloth; usually printed with all- over patterns.	D, V

KEY TO SYMBOLS

FIBER		APPLICATION
C = Cotton	S = Silk	D = Draperies and/or curtains
H = Hemp	SYN = Synthetic	U = Upholstery
J = Jute	V = Various	V = Various
L = Linen	W = Wool	WC = Wallcovering

The interior designer is often called upon to estimate the quantity and costs of fabrics used for curtains, draperies, upholstery, and wallcoverings.

MISCELLANEOUS MATERIALS

Rubber, Cork, and Leather

Rubber was developed in the 1940s and used for interior applications. Today, it is primarily a combination of synthetic materials, although it can also be obtained from rubber trees. Rubber is used in flooring in varying thicknesses, types, and color. It can be made as solid sheets with raised circular or ribbed patterns or as interlocking tiles. Rubber flooring is used in locker rooms, air terminals, malls, elevators, and offices. Rubber can be combined with various nylon fibers and used for stair nosings, wall bases, and roofing membranes. Rubber flooring can be installed in seamless applications, making it ideal for surfaces that require frequent cleaning, because the joints are minuscule in width. Rubber flooring has good color uniformity and wearability because its color permeates throughout the entire thickness, not just a surface layer.

Cork is produced from the bark of a tree grown in the Mediterranean region. It is generally viewed as an environmentally friendly material because cork trees are not cut down; the bark is harvested, and a new layer regenerates on the tree for future harvesting. It is made in sheet or tile form and is used both as flooring and as wall surfaces. It is insulative, elastic, and fairly soft. Cork can be combined with vinyl or urethane for resistance to water and stains, for use in kitchen or bath areas. It can also be used as an underlayment for wood and marble floors.

Leather comes from tanning hides of animals (primarily cattle and swine) and is cut into varying sizes and thicknesses. Leather is categorized in several forms, from the full and top-grain to the lower corrected-grain and split varieties. Leather can be dyed, embossed, and treated for many surface finishes, from soft Napa leather to highly polished patent leather. It is pliable, durable, and versatile, used for clothing, furniture, and other decorative elements.

Paint and Related Coatings

The interior designer uses paint and other coatings as design mediums, not just protective finishes. The color and the light-reflecting or absorption capabilities of these finishes make definite design statements. These can be bold, aggressive geometric relationships or quiet, subtle organic creations. Paints are made from a wide variety of synthetic and natural materials. The designer needs an understanding of their types and characteristics to properly select the best paint for a situation (Figure 13.14). Paints can be applied to a variety of surfaces, such as walls, floors, ceilings, furniture, and cabinetry.

Paint properties can vary for particular paints, but they generally are composed of a pigment, solvent, binder, and additives (Figure 13.39).

Pigments provide the color of the finished product and can also provide toughness. Pigments are generally a form of granular solids, but some are manufactured as dyes.

Solvents are the carriers of the pigment and are volatile, evaporating during the paint drying process. Water is one of the main solvents used in water-borne paints, whereas other chemical liquids are used in oil- or resin-based paints.

Binders (also referred to as the vehicle) are generally resin and form the bulk of the paint film. Binders give paint its adhesive properties and provide flexibility, gloss characteristics, toughness, and weatherability.

Additives in small amounts are added to paint to achieve special effects such as improved colorfastness or improved flow properties. Paints with higher solid contents (primarily the pigment and binder) will provide a better and thicker dry paint film over a given area of coverage than paint with lower solid contents. For this reason, paint with more pigment and binder will generally cost more.

"Green" paints are generally associated with low levels of volatile organic compounds (VOC) and are low in odor or out-gassing. These paints contribute to better indoor air quality in buildings. Latex (water-based) paints are easily recyclable, but oil-based paints are considered hazardous waste material and must be disposed of or recycled with more effort. The metal and plastic containers can often also be properly recycled.

Paint finishes range from flat or matte sheens to high-gloss, shiny surfaces. In between are satin or eggshell and semigloss finishes, which give a softer luster than high-gloss paints, yet are more reflective than flat paints. Paints are also made as texturizers and produce various rough textures.

Paint primers are made to serve as an undercoat application for paint finishes, where the subsurface is not suitable for a final paint coating. However, some finish coats are self-priming. Primers and other sealers are used to provide a gripping base for paints and prevent the waste of expensive final coats being absorbed into a porous substrate.

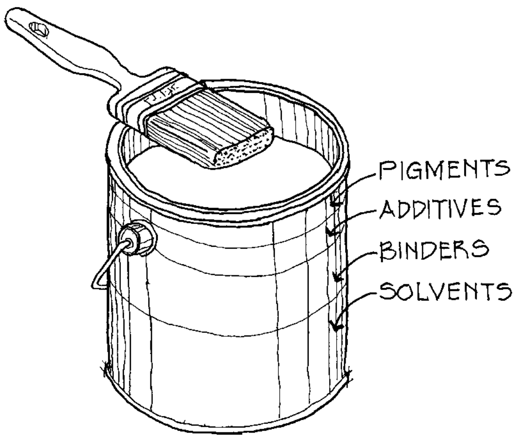

FIGURE 13.39 Paint is composed of a pigment, solvent, binder, and other additives.

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Architectural Systems and Interior Finishes 14

SUSTAINABLE ARCHITECTURE AND ENGINEERING

As discussed in earlier chapters, material selections and the design of sustainable structure seek to work in harmony with the environment, preserve nature, and encourage conservation. The methods and materials used in the construction of buildings and their interiors have an impact on the larger environment and world. The selection of the building's materials and assemblies is directly related to the energies required to produce and ship the materials, and to their eventual reuse or disposal. In turn, the design of the building and its performance will determine how much energy is used throughout its life.

A building's envelope can be designed to be sensitive and responsive to the environment's changing patterns, such as the seasons. The building shell can be made dynamic to respond to the environmental changes of temperature, breezes, humidity, sunlight, and other variable factors.

This chapter is organized the way buildings and interiors are constructed—from the ground up. However, buildings are actually designed structurally to hold weights of materials, equipment, and people from the roof down, cumulatively adding these loads until they reach the ground. Buildings must not only support these types of loads but also counteract forces from wind, snow, and even earthquakes.

A building consists of various architectural systems that serve as floors, walls, and ceilings. These systems form spaces, hold up the building as shelter, and provide finish materials that enrich our physical and emotional needs. In some situations, such as the TWA terminal building at Kennedy Airport (Eero Saarinen, see Figure 3.28), the walls, roof, and ceiling structure form an integral, fluid design statement. Although any one of these can be viewed as a separate design element, together they are an integral part of the interior and of the building itself. They are not just a background element but an active generator of space, form, and surface quality that enhance our spaces.

Materials are chosen for structural integrity but can also contribute to the interior expression of space, form, finishes, and character. Materials have been shaped into basic structural forms over the centuries. A material's characteristics, such as strength and form, influence both the exteriors and the interiors of buildings.

This chapter will discuss the basic architectural systems of a building: floor, wall, and ceiling systems. The foundation system is not included, because it varies according to the type of building and soils, and is designed by architects and engineers. It is not an integral part of interior spaces—unless, of course, there is a basement level.

Last, the many finishes available within each of the architectural systems will be presented. Criteria for selecting these materials and their finishes will be highlighted. Although components such as doors and windows (Chapter 15) are an integral part of the systems, they generally do not constitute a major structural element and so are not discussed here.

BUILDING SHELL AND STRUCTURAL SYSTEMS

Although it is the architects and the engineers who are primarily involved in designing or remodeling a building's shell (envelope) and structural system, the interior designer must be aware of fundamental principles and forms of structures while designing stairs, cutting openings in walls (both bearing and nonbearing), and designing ceiling systems. Because the interior designer often works as a team member with architects, engineers, and builders, he or she must be capable of conversing with these other professionals about the interface of structures and materials within the interior environment.

Structural Design

Historically, building construction was based on trial-and-error knowledge of how far a material and a structural shape could be loaded and stressed before they failed. Later, with the integration of mathematics and better testing methods, new materials and analytical design methods were developed. Structural analysis of the anticipated performance of materials used within a system led to the field of structural design and theory. These improved methods allowed engineers and architects to predict performance of a system by using calculations rather than by building and testing. Today's building designs can be modeled with a computer, allowing variations in proportions, materials, and structural performance to be explored quickly.

The structural system of a building enables it to withstand static and dynamic loads caused by gravity, wind, earthquakes, and other impacts, such as vibrations (Figure 14.1). The building structure is designed to counteract these forces and maintain a state of equilibrium, or static balance. If these forces overpower the system's ability to resist them, failure can occur—a high wind could blow the building over, or an earthquake might shake the building to the ground.

In addition to static and dynamic loads, the building shell and structural system are designed to accommodate expansion/contraction movements due to variations in temperatures. The building must also control moisture migration (rain and humidity), heat gain/loss, sound transmission (external/internal), resistance to fire, and egress during emergencies.

Structural Characteristics of Materials

Materials used as structural elements (columns, beams, and walls) are selected to resist various loads and stresses. If the material is overstressed, it may go into deformation, or change in shape.

This change might be permanent (e.g., a piece of steel rod that will not return to its original shape when bent) or temporary (e.g., a wood stick that springs back to its original position when bent). These deformations could be major, leading to failure of the system, or minor, within the limits for the material to function. For example, in the latter case, a wood beam or bookshelf might sag from a heavy load but not fail.

Materials can be selected for their structural ability to withstand two basic stresses: compression and tension. Compressive stresses are those placed on a material from a load that tends to crush it; an example is a heavy weight supported by a column, which places the column in compression.

Tension is the force that pulls a material apart; the tensile strength of a material resists this force. The vertical steel cable holding a heavy chandelier from a ceiling is under a tensile load.

A material can also be subjected to a combination of these and other complicated forces. When a beam is supported at each end by columns, the beam's material is placed in both tension and compression (Figure 14.2). In this example, a steel beam will perform better than a stone beam, since stone has less tensile strength than steel does. It is because of this factor that earlier civilizations could not span great distances with simple structures of stone or other natural materials.

Basic Structural Elements

Most buildings are composed of one of three basic structural elements: frame (skeleton), bearing wall (planar), or envelope (skin or shell) (Figure 14.3). However, some are constructed either of a combination of these types or of specialized components, as in the case of an air-inflated structure assisted by steel cables. A building's shape and architectural design often reflect the basic structural form. In turn, the interiors might also have spaces and characteristics related to the exterior form and structural components, often exposing these as part of the interior finishes.

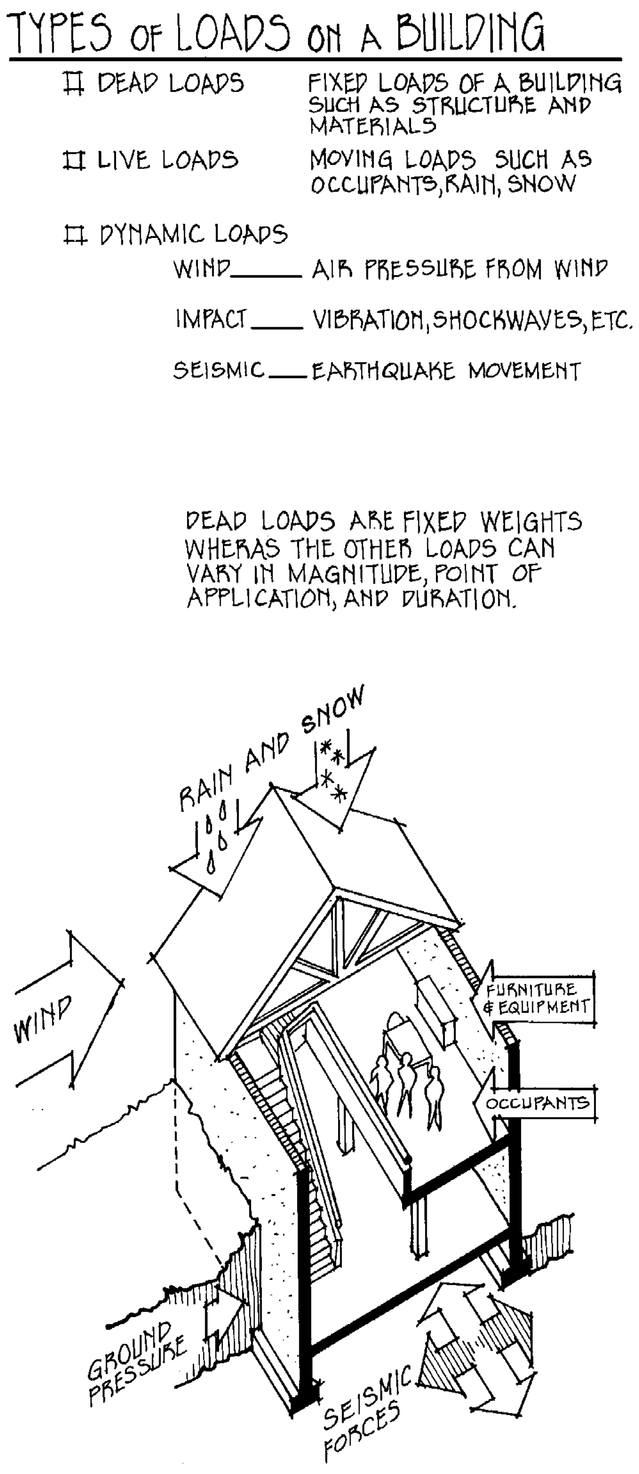

FIGURE 14.1 The structural elements of a building must withstand dead loads, live loads, and dynamic loads.

The basic elements used in a building have developed over the centuries from post and lintel to arches, vaults, domes, and shells to suspension and tensile structures. Each has particular structural advantages and can impart a unique form and expressive character to a building and its interiors.

Post and Lintel

One of the first structural systems was the post-and-lintel arrangement, today referred to as column and beam. In this system (Figure 14.4), stone lintels (beams) were placed between columns to span the posts (columns) that in turn supported the roofs of these buildings. However, the stone lintel spans were very short, creating a forest of

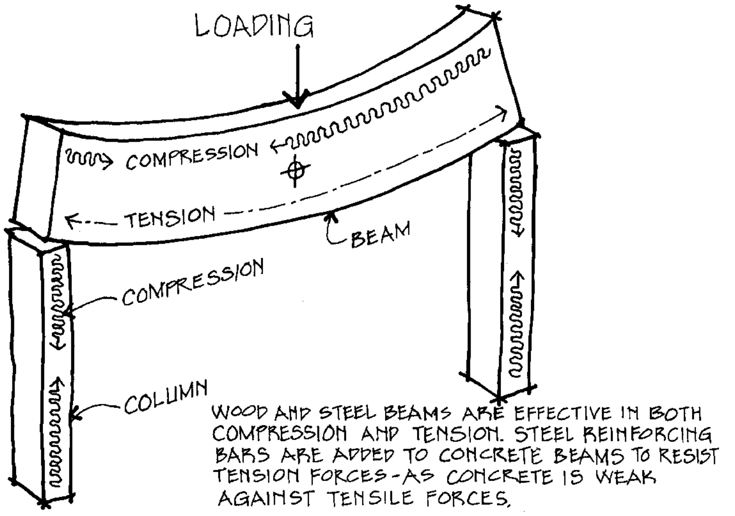

FIGURE 14.2 A material used in a structural system can be subjected to several different forces, depending on the direction, magnitude, and point of loading.

columns in Egyptian and Greek buildings. The post-and-lintel principle was expanded to use large, wide slabs of stone rather than narrow lintels. No doubt timber was also used for beams, but unlike those of stone, timber beams have not survived over the centuries to give evidence of their widespread early use.

Arches and Vaults

In early times, stone and bricks were used to construct simple cantilevered sections called corbeled arches, which could span approximately 6 feet (1,828 mm) (Figure 14.5) The Romans introduced the true arch, which could span

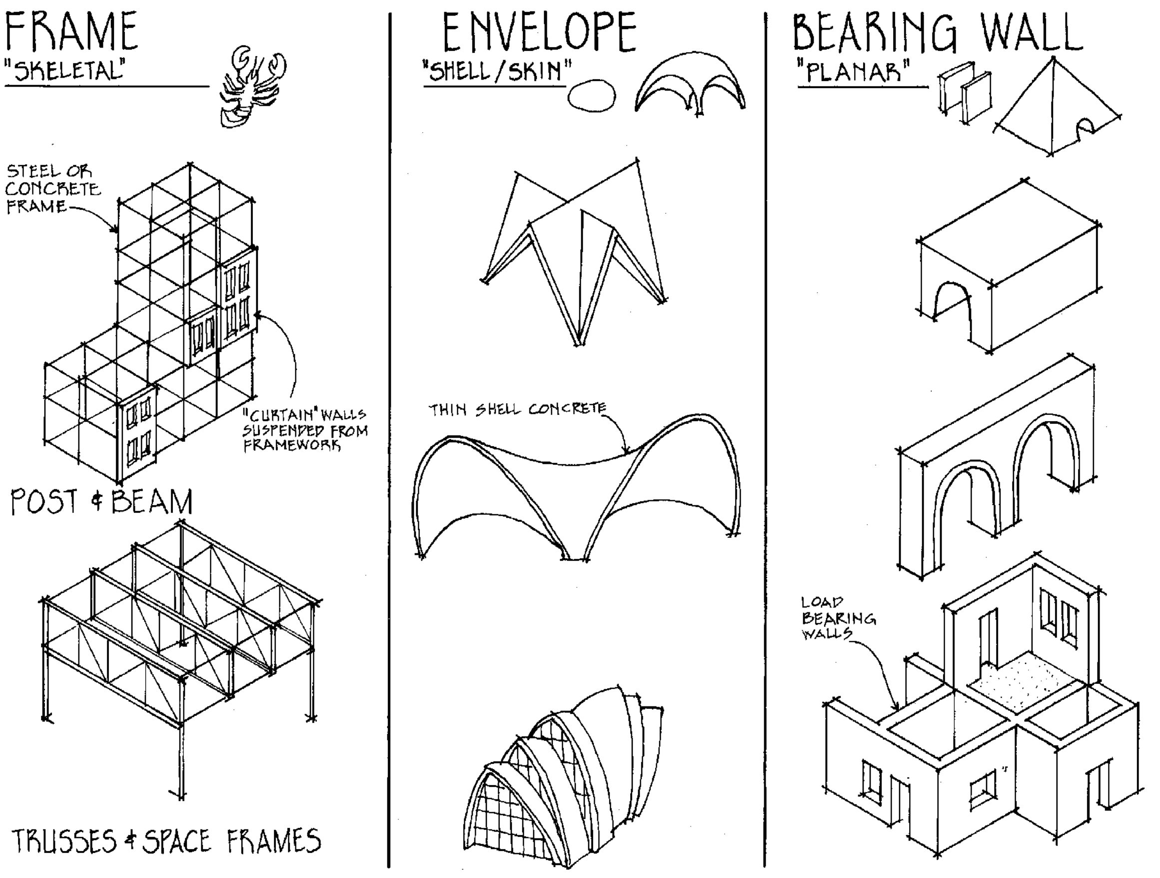

FIGURE 14.3 Three basic methods of construction are used to create building forms.

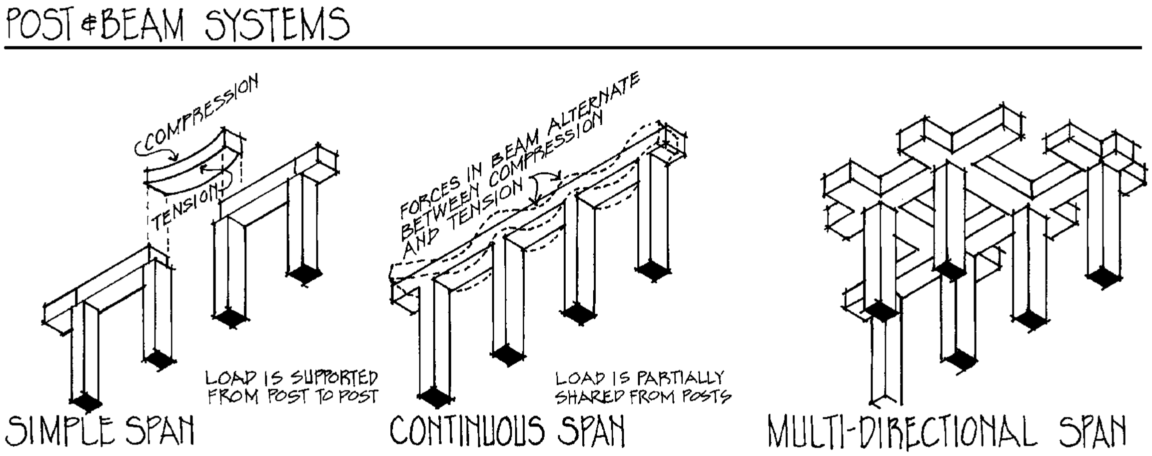

FIGURE 14.4 Post-and-beam systems can be constructed as simple spans or be integrally made into composite sections, thus increasing their structural characteristics.

about 80 feet (24.3 m). Later, the brick was replaced by concrete, allowing the arches to span greater distances and building sizes. Arches were further modified into Islamic and Gothic pointed styles, which reached great heights.

Although arches are generally associated with stone, brick, and concrete, other materials, such as wood, iron, and steel, have been used to construct them, often imitating the true arch. The steel arch for the Gateway to the East in St. Louis is an arch form, but it has a steel inner skeletal structure and steel skin that help transfer the loads of weight and wind to the ground (Figure 14.6).

Arches extended in one direction produce the simple vault structure. These vaults provide more structural support than an arch in a lateral direction, help span greater distances, and provide more interior space. A groin arch is produced by the right-angle intersection of two vaults and permits the formation of a bay, often made open on all sides for passage or windows. These vaulting techniques were developed in the Gothic pointed and ribbed construction in cathedrals (Figure 2.21); the vaults so formed were topped with domes in the Renaissance. As the arches and vaults grew higher and thinner, flying buttresses were used to brace them and help transfer loads to the ground.

Domes and Shells

Domes are an important structural element developed by the Romans in the first century. The Pantheon (Figure 2.18) is an impressive dome structure of unprecedented size for its time (c. AD 120–124). Domes became popular during the Renaissance to span large spaces, reach great heights, and cap building forms, such as the Villa Rotonda (Figure 2.24).

Shell structures were developed early in the twentieth century, as cylinders, domes, and flat plates. They were further engineered into the hyperbolic paraboloid (Figure14.7) in both concrete and timber.

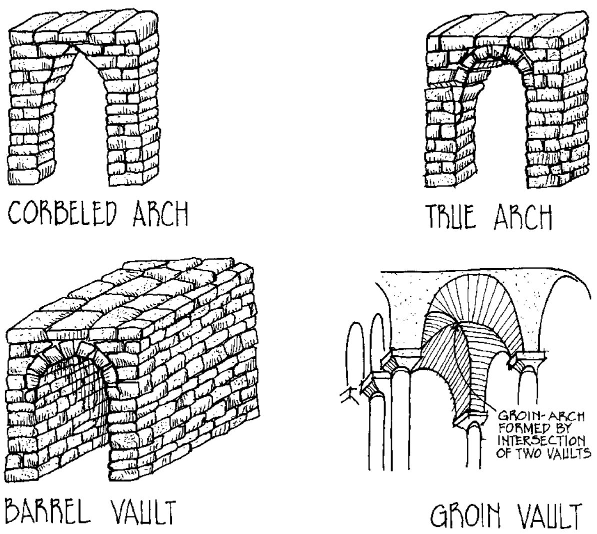

FIGURE 14.5 Arches and vaults transfer loads from above to the ground plane.

FIGURE 14.6 The St. Louis arch is a symbolic image of a gateway between the East and West. Structurally, it is a true arch that transfers loads to the ground.
Library of Congress

Shells are vault-like in form but much thinner and generally of reinforced concrete construction. They might be curved or folded in one direction like a vault, or in two or more directions like the TWA terminal at Kennedy Airport (Figure 3.28).

Trusses and Space Frames

Simple, truss-like structures made of timber were developed during Roman times, but it was not until the nineteenth century that true large-span timber trusses and their complex forces were employed. Large-span trusses were made of timber or iron and used for bridges as well as large buildings where great spans were needed. Today, many shapes and spans of trusses are available in wood, steel, and combinations of these.

In the twentieth century, these trusses were triangulated in three dimensions to produce what is commonly called space frames (Figure 14.8). The trusses can be used flat and supported on columns to span large roofed areas,

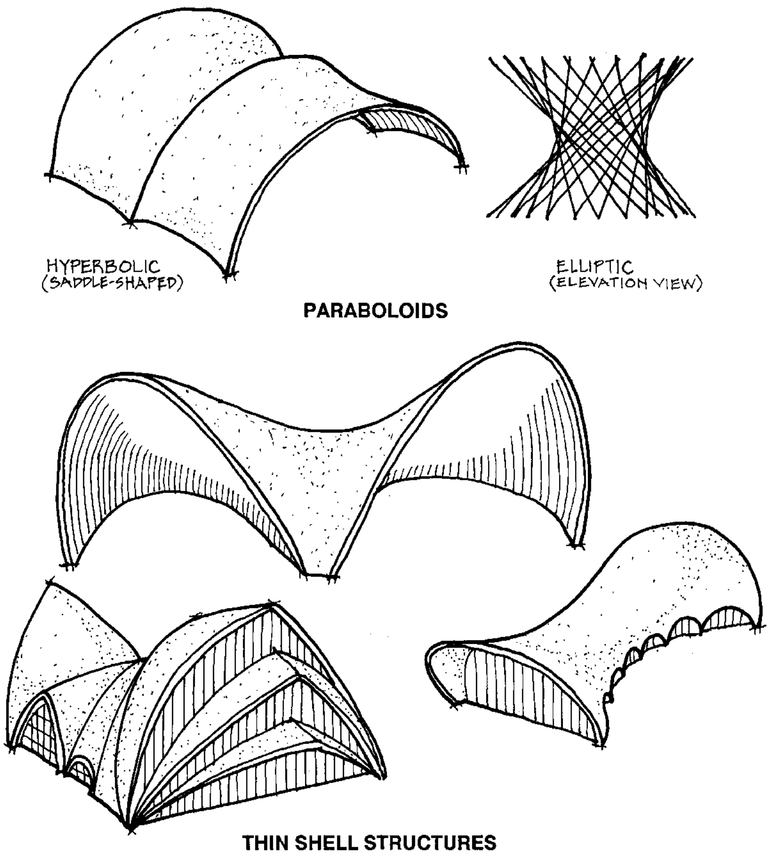

FIGURE 14.7 Concrete shell structure built as a hyperbolic paraboloid

FIGURE 14.8 Space frames, such as this one in France, can span large areas with a minimum of supporting columns.
Courtesy of Jacques Mossot (www.structurae.de)

generated as dome shapes such as Buckminster Fuller's geodesic domes, or used vertically for wind reinforcing of glazing and support columns.

Tensile, Suspension, Membrane, and Pneumatic Structures

Tensile structures support and encompass space based on a material's tensile properties. Many such structures are made in tent-like shapes, such as the roofs of buildings (Figure 14.9). Later, tensile structures were developed into large air-inflated structures that span great distances and are used primarily in sports arenas (Figure 14.10).

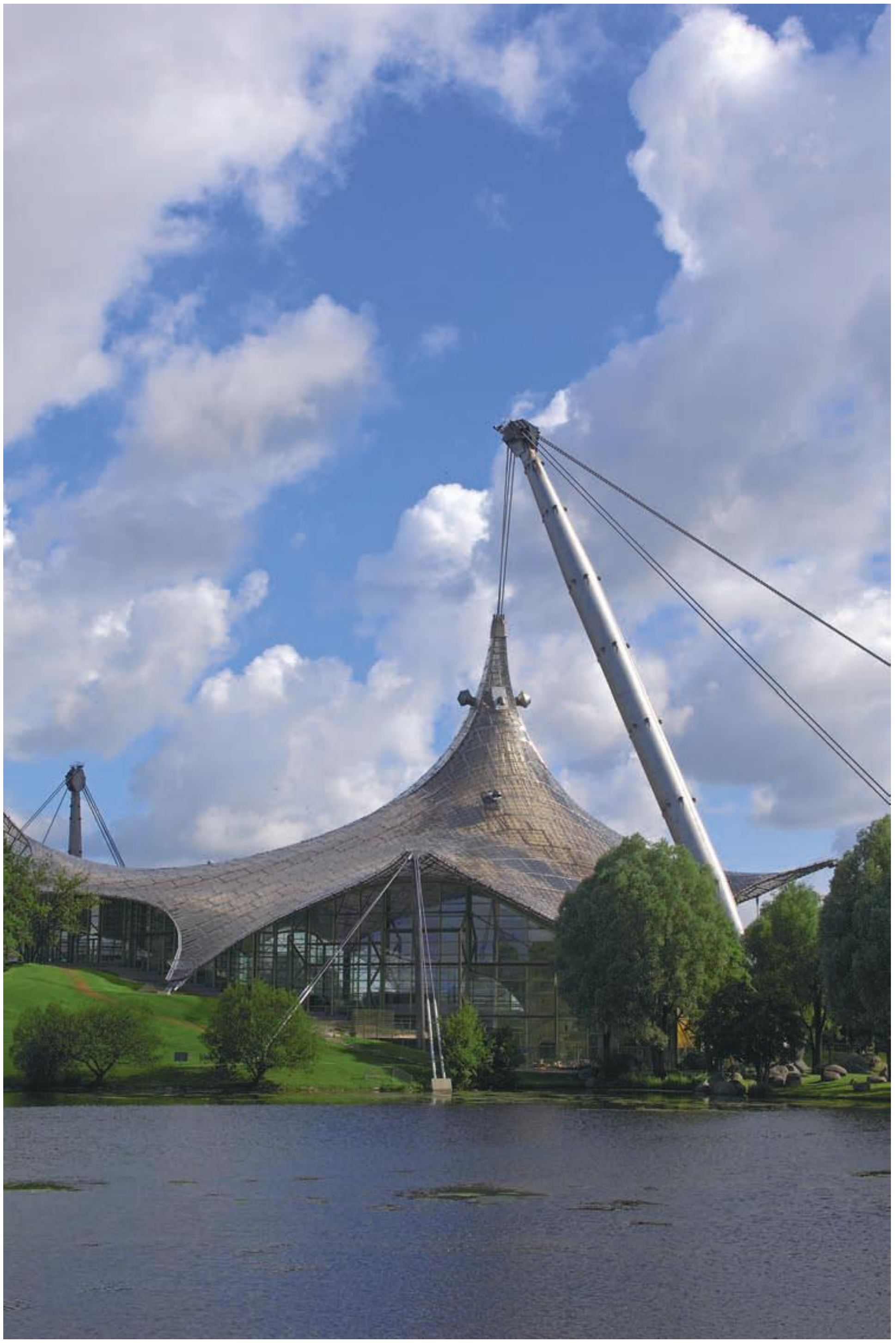

FIGURE 14.9 Many tensile structures are forms consisting of roof membranes supported on steel cables.

© José Antonio Moreno / age fotostock.

FIGURE 14.10 The Hubert H. Humphrey Metrodome is a tensile structure constructed of fabric reinforced with steel cables and inflated with air.

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Suspension structures are a variation of tensile structures. The Golden Gate Bridge in San Francisco is a suspension structure made possible by the development of iron and steel. Although used mostly for bridges, suspension structures are also used for some building construction.

Structural Systems

Most buildings are composed of structural systems, such as the foundation, floor system(s), bearing walls (or beams and columns), and roof/ceiling structure (Figure 14.11). These systems are interdependent and react to the various loads imposed on them, transferring these forces from the roof to the foundation below. In some instances, such as a geodesic dome or A-frame structure, the roof and wall are one element.

These systems might contain other elements, such as doors, windows, balconies, stairs, or separate ceilings suspended between floors or beneath a roof. Finish materials can also be an integral part of, or be applied to, the basic structure.

FLOOR SYSTEMS

Floors not only support the building's contents and occupants but also can become strong architectural elements that influence the character of a space, imparting a sense of stability and flow. Varying floor levels by a step or two can define different activities within an open space. Also, different floor finishes can suggest separate areas and traffic patterns.

The type of materials used for the structural design of flooring depends on several factors, such as the live loads (people, furnishings, and other movable items), the dead loads (weight of floor materials), and economics. In

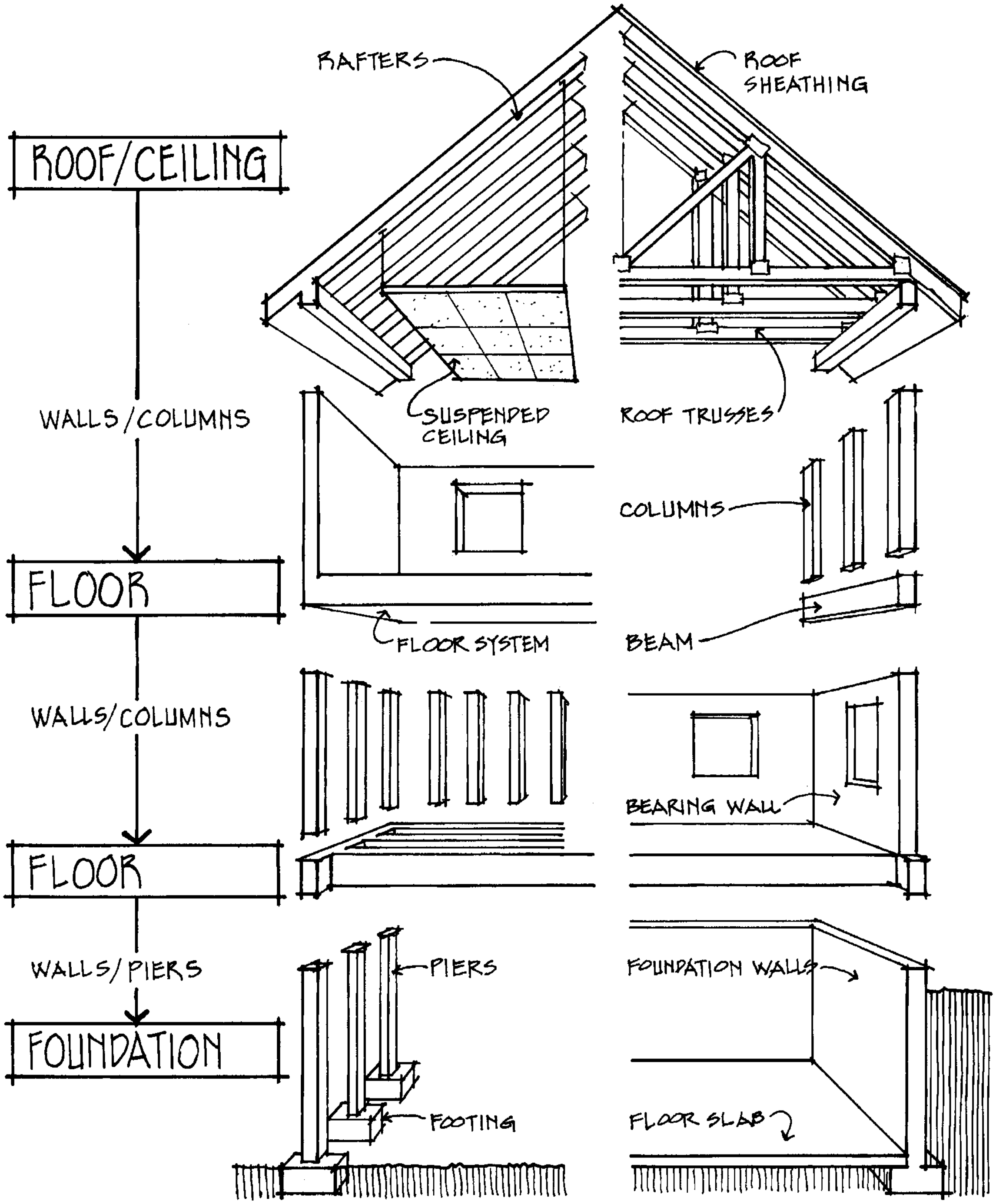

FIGURE 14.11 Most buildings have a structural system of a foundation, floor, walls (or columns), and ceiling/roof assemblies.

multistory buildings, the floor also provides acoustical control and is part of the fireproofing assembly to keep potential fires from spreading from floor to floor.

In some cases, the primary structural floor also serves as the finished flooring material. Floors that do not serve as the finished flooring material are often referred to as the subfloor. For example, a concrete or plywood floor system may not be appropriate for the desired finish and therefore serves only as a structural subsurface for an applied finish material.

Three primary types of flooring systems, used alone or in combination, are wood, steel, and concrete (Figure 14.12).

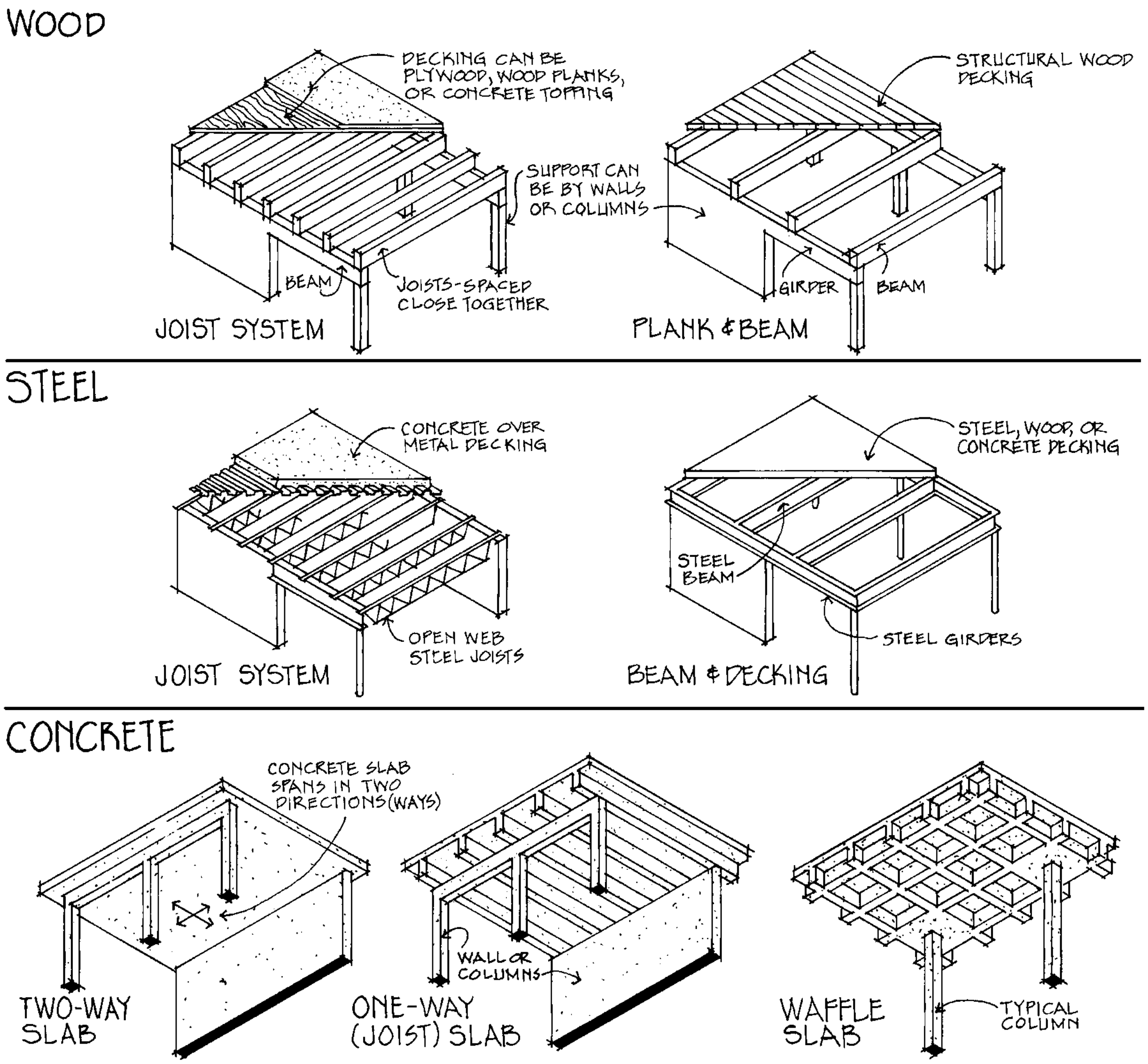

FIGURE 14.12 Three primary types of materials used in floor systems

Wood Floor Systems

Wood floor systems are used primarily in residential and small commercial buildings because of their low cost, availability of materials, and ease of cutting and nailing for construction. However, concrete floors are also used in many multifloor buildings for garages, for basements, and as the first level when placed on the ground. Most building codes restrict the heights and floor area of wood-framed structures, mainly because of the possibility of fire in large wooden assemblies. The codes further set minimum standards for the sizes, materials, fireproofing, and construction details of these wood structures.

Wood floor systems are typically constructed by the joists and decking system or the plank and beam system. In the former, floor joists are closely spaced on centers (often not to exceed 24 inches, or 609 mm) and overlaid with sheets of plywood, oriented strand board (OSB), wood planks, or even thin concrete toppings. These joists can be solid lumber, composite sections, or wood-floor trusses. The other common method of wood framing, the plank and beam system, utilizes joists (that are now referred to as large beams) that are spread farther apart and spanned by thick wood planks. Sometimes the underside is left exposed as a ceiling for the floor below.

Steel Floor Systems

Steel floor systems are used primarily in nonresidential buildings as an integral part of a steel skeletal frame. Steel has great tensile and compression strengths. It can span longer distances than wood systems and be constructed higher for tall skyscrapers. However, steel can melt when subjected to high temperatures and must therefore be protected by fireproofing methods or encased in concrete.

Steel members are manufactured in standardized sizes and are used in a manner similar to wood joists, beams, and decking. However, spans can be greater and sections can be thinner than with wood members. Steel assemblies are welded, riveted, or bolted together. Most steel joist systems are covered with a ribbed metal decking over which 2 to 4 inches (51 to 102 mm) of concrete is poured to serve as the floor surface.

Concrete Floor Systems

Concrete floor systems can be a slab on grade or can serve as the floor systems in multilevel buildings. These floors can be poured as slabs and integral beams or made as precast units and delivered to the job site for erection. Concrete floors are reinforced with steel rods and designed as one- and two-way slabs, waffle slabs, flat slabs, and other configurations. These types generally refer to the way the concrete floor slab is poured and supported by the integral beams from one or multiple sides or by coffered shapes, as shown in Figure 14.12.

In addition to these poured concrete systems, concrete shapes for floors are made as precast with integral high-strength steel cable placed in the casting forms before the concrete is poured in. These concrete systems are usually made in single- and double-tee systems, as seen exposed in large parking garages. Precast hollow-core slabs are also available and often found in multistory motels, serving as the floor (and ceiling for the unit below).

In concrete systems, the entire structure of floors and columns is of reinforced concrete rather than all steel. Concrete construction is fireproof, since concrete will not burn. However, care must be taken to protect the inner steel reinforcing within concrete because high temperatures can cause the steel to weaken.

Specialized Floor Systems

Specialized floor systems are designed for specific functions within buildings. For example, access flooring is a modular raised flooring system placed over a floor structure to provide easy access to wiring, air ducts, and plumbing needs. This type of flooring is primarily used in offices and computer rooms, where access is needed for maintenance, repairs, or changes to equipment connections.

FLOOR FINISHES AND SPECIFICATION CRITERIA

Floor materials can be the finished floor or can be overlaid with a floor covering. However, when discussing the wearing surface of a floor, we generally refer to it simply as the floor finish. Floor materials and their finishes are classified as hard, resilient, and soft. Hard (or nonresilient) flooring includes concrete, stone, brick, tile, and wood. Resilient floorings are vinyl, rubber, cork, and compositional tile. Soft floorings are carpeting and rugs.

Floor finishes are selected for their sustainability, aesthetic, structural, durability, and maintenance qualities. These finishes are chosen for their functional and harmonious relationship to the interior space, the contents, and the users. Each type of finish can impart a certain feeling or attribute to our activities, expressions, quality of life, and heritage. Stone floors, such as granite, are long-lasting and low maintenance, and can portray a sense of formality, prestige, or grandeur. Brick can be reminiscent of handcrafted works and impart informality and warmth. Ceramic tile offers a variety of visual excitement, permanence, and some of the grandeur of stone. Wood flooring can exhibit many different characteristics, depending on the species, how the flooring is installed, and its finish. Carpeting provides a visual and tactile quality that can lead the eye through space or can accent with pattern, color, and focal points.

Several considerations must be taken into account when selecting flooring materials for interiors (Figure 14.13). Functionally, the flooring must withstand traffic over a specific period of time and resist wear. For economic considerations, a designer must look at the initial cost plus installation and maintenance costs for the material, weighing these against the number of years it will last. An analysis of cost per year (gained by dividing the total installed cost by life expectancy in years) may show that in the long run a more expensive, more durable material will be more economical than a less costly type.

FIGURE 14.13 Checklist for specifying flooring systems and finishes

CRITERIA	SPECIFICS
AESTHETICS	Visual and tactile qualities. Color, texture, pattern. Appropriateness to overall design concepts. Light reflectance or absorption.
ECONOMICS	Initial material and labor costs for installation. Possible costs for subsurface preparation. Warranty costs. Life-cycle costs and sustainability.
MAINTENANCE CODE REQUIREMENTS	Cleanability and frequency required. Costs of maintenance service. Flame resistance, wear resistance. Weight. Compliance for handicapped or special population use.
FUNCTIONAL CRITERIA	Acoustic and wear-resistance properties. Soil repellency, hiding, and removal. Possible solar and energy benefits or drawbacks.

Flooring materials are generally priced by the square foot (hard materials) or square yard (resilient materials and carpets). To find the square yardage, divide the square footage of the area by nine. Actual square footage or square yardage will generally give a fair estimate of the flooring amounts needed; however, material waste and special conditions during installation must also be calculated into the estimate.

Hard Flooring

Hard flooring materials are used for their high resistance to abrasion and durability. In general, they do not absorb liquids and are more impervious than other types to soiling. However, they are heavier and often more expensive. Some hard materials can also be damaged by heavy objects; for example, a vase dropped on a ceramic tile floor can cause breakage of the vase and the flooring. Hard materials also tend to reflect sound, creating acoustical problems in spaces with floors and walls of hard surfaces.

Hard flooring materials, such as concrete, stone, and brick, can be used in sunspaces and greenhouses as thermal mass (Chapter 11) for solar applications. Ceramic tile is also used for heat storage when applied over a thick concrete subfloor to increase its compositional mass.

In colder climates, most hard flooring (except wood) tends to be cold to the touch unless it is heated by the sun or insulated from the cold. Area rugs are often used over hard flooring to offset this condition.

Concrete

Concrete flooring is used mostly for structural support and is usually surfaced by other materials. However, garages, warehouses, manufacturing plants, and some unique or stylized interiors use concrete as the finished material. Concrete is porous and can absorb water, so it is often treated with a finish sealer coat.

Concrete floors can have a rough, textured, patterned, or smooth trowel finish. They can also be colored by adding pigments of recycled materials such as glass powders, or can have a finish of exposed stone aggregates. Concrete used as the final finish material can be painted or left in its natural color; it is usually sealed with various substances, such as water-based and low-VOC coatings to help make the surface easier to clean and maintain.

Stone

Stone floor finishes are usually more expensive than others, but are very durable and beautiful (Figure 14.14). They are generally installed over a concrete subsurface and laid in various patterns, either random or coursed. They are set in a cement bed (thickset) or with special adhesives (thinset) and grouted at the joints. Today, many grouts and sealants are water-based or low-VOC products. Most stone floors require only a damp mopping to clean, but some are waxed and polished to a high sheen.

All the stone materials listed in Chapter 13 are used as flooring. These include granite, travertine, marble, and slate. Terrazzo is popularly used for a floor finish where a high degree of durability and low maintenance are needed. Chips of colored marble, crushed stone, tiles, or glass are mixed with concrete or resins and poured into floor areas divided by metal strips (to reduce cracking), then ground smooth and polished. In other installations, terrazzo is precast in panels and delivered to the job site to be placed in a setting bed.

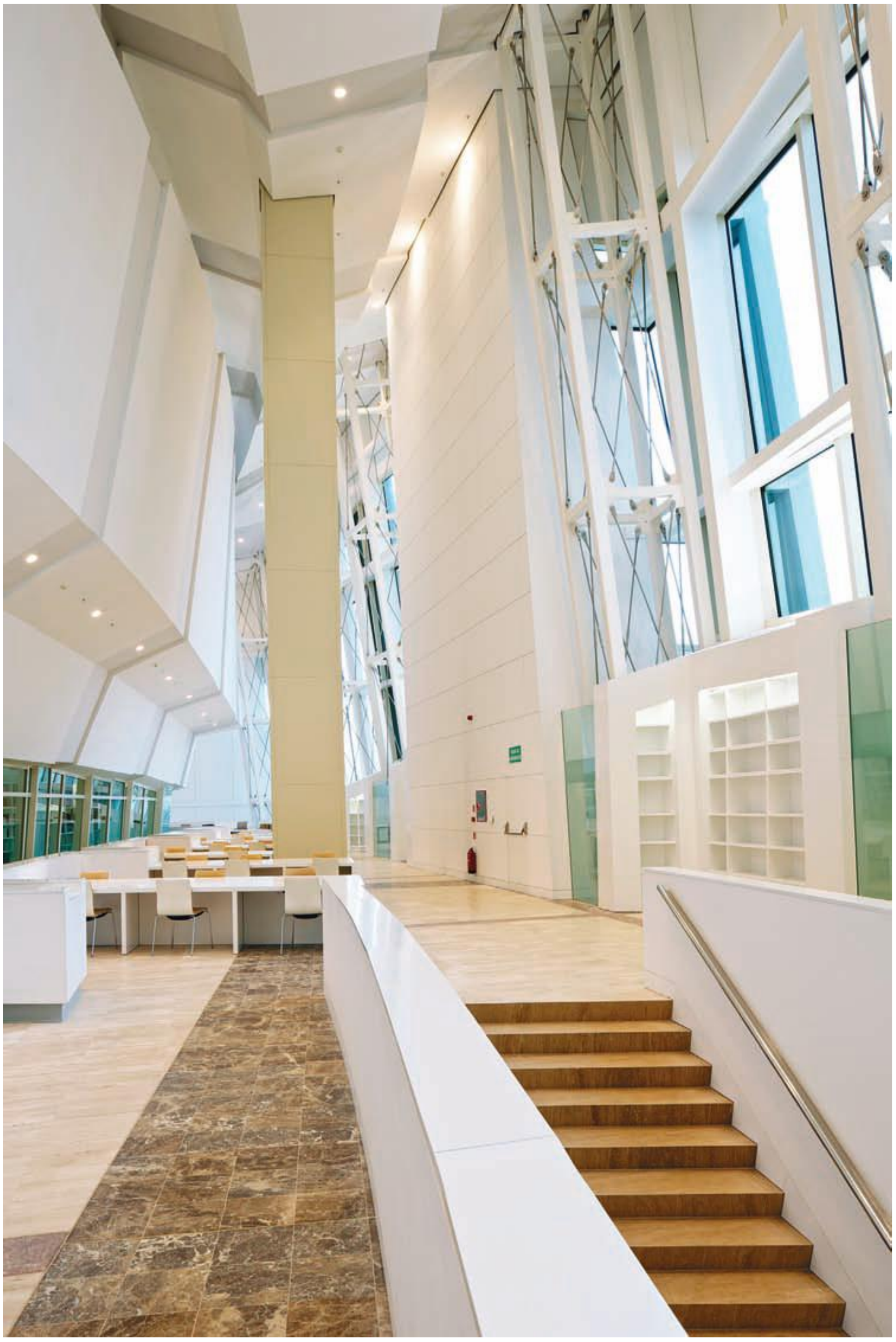

FIGURE 14.14 The marble floor in this building features strong visual patterns within the material. *Photographer: View Pictures*

Brick

Although most bricks are made of clay, some are made of concrete. Many colors, textures, finishes, and patterns of brick are available for interior and exterior use. Most bricks used for flooring, called pavers, are specially made and come in all shapes and thicknesses. Most interior applications utilize thin pavers in order not to raise the floor several inches or add the extra weight of full-depth units.

In most cases, brick flooring is sealed much like concrete to prevent it from absorbing spills. Brick is laid on a concrete or sand base (the latter popular in the Southwest) and can have the joints grouted like a wall or can be closely set together with sand or dry cement, which is then brushed into the joints.

Tile

Tile may be used for either interior or exterior floor surfaces. The ceramic, quarry, and mosaic tiles described in Chapter 13 have commercial and residential flooring applications. Tile comes in a seemingly endless variety of shapes, textures, sizes, thicknesses, finishes, and colors (Figure 14.15). Most tiles have matching trim pieces for wall bases, stair nosings, and room corners. Tile is produced in varying densities and glazes that allow some to be used in wet locations (showers) or waterproofed installations (swimming pools).

Tiles are installed over concrete surfaces and wood using both thickset and thinset methods. Grouts for the joints are often colored and lock the flooring together in a hard, durable surface. Some grouts are integrally siliconized and resist soiling, and others can be top sealed with special plastic coatings.

Special care must be taken when specifying tiles for flooring because some are slippery when wet. Most floor tiles are textured to some degree, have a matte face, or are installed in small pieces to prevent slipping. Floor tiles are generally stronger, and have more durable finishes, than wall tiles.

FIGURE 14.15 Ceramic tiles can be used for durable and scrubbable floor surfaces, as seen in this cafeteria.

Image Courtesy of Herman Miller, Inc.

Wood

Wood flooring is used as a subfloor or applied as a finish material over a concrete or plywood subfloor. Hardwoods are most common for flooring, although some softwoods can be, and often were, used in older buildings. The most popular hardwood species for flooring are oak, maple, and birch (Figure 14.16).

Various organizations set standards to grade the quality of manufactured hardwood and softwood flooring. Gradings are based on length, number of imperfections (such as knots), and appearance. Higher grades have more even visual characteristics and are more expensive.

In addition to conventional wood flooring, engineered wood flooring is produced in either prefinished or unfinished products. These are made in multiple, thin plies of wood glued together (wood ply), fiberboard core, and finished face, or finger core whereby small pieces of lumber are glued perpendicular to the face layer.

Wood flooring is installed over concrete by using special nailing strips, called sleepers, embedded in, or attached to, the concrete surface. When installed over wood subsurfaces, the flooring is screwed, nailed (toe or blind), or glued down. The nailing or screwing methods often use a specialized layer of building paper between finish and subfloor to prevent any future "squeaking" of the two wood faces if the attachments become loose. In some wood flooring installations, the flooring is not nailed down but locked together, and floats over a foam substrate layer.

Wood flooring is manufactured in three general types: strip, plank, and parquet (Figure 14.17). These can be made as a tongue-and-groove system, a "click system" (the tongue and groove are made to interlock), or a direct glue down method. Wood flooring is available with prefinished and unfinished faces; the prefinished is impregnated with stain colors and acrylic coatings for durability and appealing character. Finishes also

FIGURE 14.16 The hardwood in this office is used as a strong linear and directional design element on the floor and walls. *Courtesy of Knoll, Inc.*

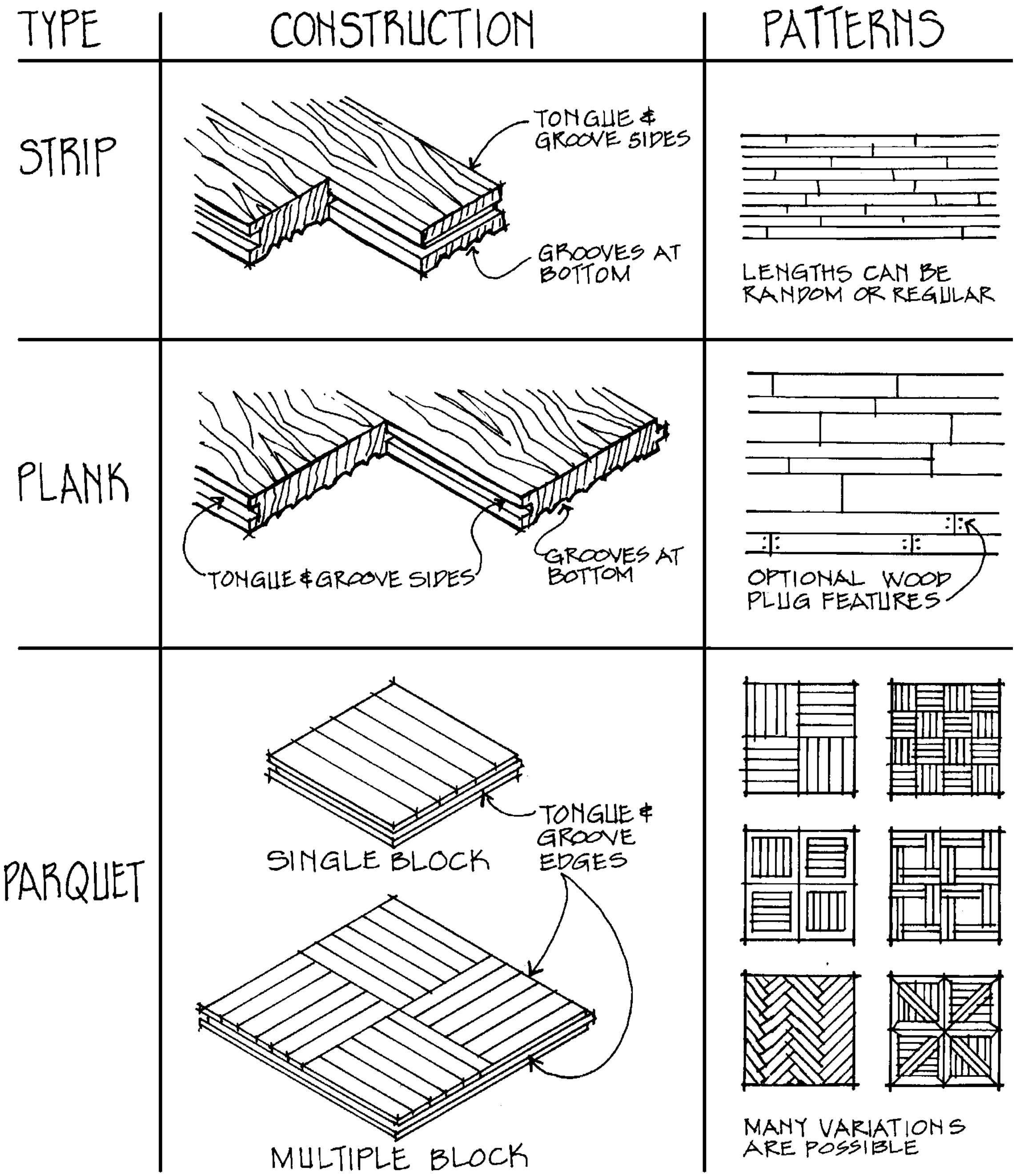

FIGURE 14.17 Three types of wood flooring and their patterns

include natural oils and polyurethane coatings. Some wood flooring can also be treated with fire-retardant materials.

STRIP FLOORING Strip flooring is made of tongue-and-groove boards (or "click" systems) and ranges in width from 1½ inches to 2¼ inches (38 to 57 mm). It is available in varied wood species, lengths, and thicknesses. The tongue-and-groove edges provide interlocking, and grooves cut on the backside facilitate laying over uneven subsurfaces.

PLANK FLOORING Plank flooring is produced in widths from 3 to 8 inches (76 to 203 mm), and three different widths are usually used on a project. The planks are tongue-and-groove or "click" system and are available in varied lengths to produce random patterns when installed. Plank faces have beveled or square edges that produce a v-joint or flush-face flooring when laid together.

Originally, plank flooring was installed using wooden plugs inserted into holes bored near the end of each board. These plugs were cut off and sanded smooth. Later installation techniques used screws countersunk into the ends, with wooden plugs added, sanded, and finished to show contrasting patterns. Today, nailing, screwing, and gluing are still used, with some planks premade with false wooden plugs.

PARQUET FLOORING Parquet flooring is made of hardwood and varies in thickness from ⅜ to ¾ inches (90 to 190 mm). These small pieces can be joined with tongue-and-groove connections into a variety of patterns. Although parquet was originally installed as individual pieces of wood blocks (and still is, in custom jobs), it is now produced in factory-made squares held together with mesh or metal spines. Some of these squares are laminated sections of several wood layers.

BAMBOO FLOORING Bamboo flooring is considered a hard flooring and often associated with wood flooring, although it is technically a grass plant, not a tree. Bamboo grows to harvesting size in approximately five years and is renewable because the root system is left intact when bamboo is harvested. Most bamboo is shipped from China, but some is grown in the United States. The flooring material is produced as laminated planks or strips and available in unfinished or prefinished products. Many thicknesses and colors are available.

Resilient Flooring

Flexibility, or give, is one of the main advantages of resilient flooring materials. Their resilience helps to resist permanent indentation, while providing comfort and quietness underfoot. Resilient flooring is relatively economical compared to other hard flooring materials. It is durable and, depending on the finish, can be relatively low maintenance.

Resilient materials include cork, rubber, and most vinyls. Resilient flooring is available in both tile and sheet form.

Cork

Cork tiles are made from chips of cork mixed with resin binders and baked, rolled into sheets, and cut into tiles. Cork used for flooring is compressed to make it harder (unlike soft cork used on bulletin boards). Cork tiles are usually treated with a vinyl coating or impregnated with plastics to make them more durable, but either process may decrease their resiliency. Cork tiles can be used in residential or nonresidential applications with low or limited traffic. Cork is a very insulative material and should not be used over floors where radiant heating systems are used or where solar gain is desired.

Rubber

Rubber flooring material, now primarily synthetic, is made of butadiene styrene rubber and other synthetic materials. Recycled rubber flooring is made with discarded automobile and truck tires. Rubber is very resilient and durable, has good dent resistance, and is available in two forms: a flat surface with a marbleized pattern or a solid color with a variety of raised surfaces. The raised surface was designed to knock dirt and mud off shoes and to provide water drainage from the face to prevent slippage. Rubber tiles are excellent for entrances where dirt and mud can be tolerated and where traction is needed on wet floors.

Linoleum

Linoleum is used for flooring because it is resilient, low maintenance, and durable. It is made from renewable natural substances such as linseed oil, cork, pine resin, and sometimes limestone chips. Color is produced with natural pigments, and the material is produced with a jute backing. It is available in sheet and tile forms.

Vinyl

Vinyl flooring is a thermoplastic material composed primarily of polyvinyl chloride (PVC), a plastic solution that hardens to a solid film. The three basic types of vinyl flooring are vinyl composition tile (VCT), vinyl tile, and sheet vinyl.

VINYL COMPOSITION Vinyl composition (or reinforced vinyl) is a blend of vinyls, resins, plasticizers, fillers, and coloring agents formed into sheets under heat and pressure. The sheets are then cut into tiles. VCT is more brittle than vinyl tile because it has more fillers and pigments, and less PVC. Asbestos fibers were originally added to these vinyl compositions but have been eliminated as a result of past adverse health effects.

Vinyl composition tiles are used in high-traffic areas because they are durable, inexpensive, easy to install, and easy to maintain. Compared to solid vinyls and solid rubber, however, they exhibit low impact resistance, poor noise absorption, and semiporous qualities. They are produced mostly in 12 inch × 12 inch tiles, with other varying plank widths and lengths available.

VINYL TILES Vinyl tiles are made mostly of pure PVC and small amounts of other additives. Vinyl tiles are referred to as solid vinyl, since the color is not just on the surface, but throughout the depth. They are available as solid colors, in veined marble and travertine designs, and in brick, slate, and stone patterns. Vinyl tiles are tough and flexible, which makes them effective for floor and wall base trims. They are moderate in cost, durable, dent resistant, and easy to maintain. They can be produced in any degree of transparency. Some companies manufacture a floor covering with a real wood veneer sealed between layers of solid vinyl. The top layer is composed of a transparent pure vinyl that permits the natural wood color, grain, and texture to be visible, yet protected. They are available from 12 inch × 12 inch to 36 inch × 36 inch.

SHEET VINYL Sheet vinyl is easy to maintain, having fewer seams to collect dirt than tiles have. Sheet vinyl is made in widths of 6, 9, or 12 feet (1,828; 2,743; or 3,657 mm). The two methods of producing patterns in the manufacturing of sheet vinyl are inlaid (or homogenous) and backed. Inlaid vinyls are made of thousands of tiny vinyl granules that are built up in layers and fused by pressure and heat. The color and pattern penetrate the vinyl layers and will not wear off. Inlaid vinyls are generally soft, thick, and very durable, making them a good choice for nonresidential applications or heavy-traffic areas.

Backed sheet vinyls have a thin surface-wear layer bonded to a backer sheet. A thicker surface-wear layer and higher binder content will produce better durability and abrasion resistance.

Rotogravure vinyls, also referred to as rotovinyls, are made through a combination of photography and printing. An image is photographed, printed on the sheet vinyl, and protected by a wear layer coating of vinyl resin or urethane. The vinyl resin coating produces a satin-gloss surface; the urethane coating creates a high-sheen appearance. The wear layer of vinyl resin is usually thicker than that of urethane.

Most sheet vinyls have an inner core of foam or a foam backing to cushion them and make them more resilient. Most sheet vinyls have a no-wax finish, which helps them to maintain a shiny surface appearance. However, this finish may wear off when subjected to heavy traffic. Vinyl sheet flooring is seamed with either a chemical or heat welding technique, the latter being more expensive. Since sheet vinyl is very flexible, it can in some cases be coved up on the wall to form its own base (called *flashcove*). Sheet vinyl is also made with nonconductive properties to reduce static electricity charges in areas—such as operating rooms—where sparks might ignite flammable gases.

Soft Floor Coverings

Soft floor treatments include both carpets and rugs. Carpet is one of the most popular floor coverings used today because of its variety of colors, patterns, textures, touch, costs, installation techniques, and cleanability. Carpet is made from natural or synthetic materials and can provide flooring that is both visual and tactile. It can reduce noise impact and of all the flooring materials can have a direct impact on indoor air quality.

Carpet is generally cut from a large roll that ranges in width from 27 inches (68 cm) to more than 18 feet (548 cm), with 12 feet (365 cm) being the most common size produced. "Broadloom" is a term frequently used to identify roll goods more than 54 inches (137 cm) wide. Carpet tiles or modules are a popular alternative to roll carpeting, especially in commercial applications (Figure 14.18). These tiles are generally 18 inches (46 cm) or 24 inches (61 cm) square and can be glued directly to the floor with a permanent or releasable adhesive, or laid freely with gravity holding them in place. Although initial material costs are high, the tiles can be easily installed, replaced, or rotated if damaged or soiled. They can also be lifted for underfloor accessibility. Environmentally, carpet tiles present the opportunity to replace damaged tiles instead of the entire floor covering, as with broadloom carpet.

Rugs are standard sizes of carpet material bound and finished at the edges and usually not fastened to the floor. Rugs can also be custom designed and woven, such as Oriental and Persian styles. Area rugs are available in a large range of sizes and shapes and can be used to define a furniture grouping or as accents, calling attention to a specific area of a space—for example in an entry or an elevator lobby. They can also be hung on walls as decorative elements or for acoustical control.

FIGURE 14.18 Carpet tiles provide an excellent removable floor finish, because worn or damaged tiles can be replaced individually.
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Scatter or throw rugs are small rugs, generally 2 × 3 feet (609 × 914 mm) or less. They are used for decorative effect and where soiling or traffic is concentrated. These rugs can be relatively inexpensive but can also be a hazard because they can trip people, and they slide on smooth flooring surfaces.

To select or specify carpet, a designer should understand its basic terminology and characteristics. One important question is: How long will the carpet last and continue to look good? The strength, soil resistance, abrasion resistance, moisture absorbency, resilience, density, heat resistance, static control, color retention, and flame resistance of basic carpet fibers should all be taken into account. Sound absorption and energy considerations of carpet installations should also be investigated. Still other considerations include texture, color, and pattern. Cost factors include the initial material costs, installation charges, and long-term maintenance expenses. Today, several carpet manufacturers offer reclamation and recycling programs to keep discarded carpet from landfills. Installation methods and padding are also important factors that contribute to the performance of a carpet.

Basic Fiber Properties

Fibers generally are classified as either natural or synthetic. Virtually every fiber has been used in carpets, but today wool, nylon, acrylic, polyester, and polypropylene predominate. Over 90 percent of carpet made today uses some form of synthetic fiber. Fibers are also produced in several shapes to provide effective soil-hiding characteristics in carpets.

WOOL Wool is traditionally the luxury fiber and has long been regarded as the finest carpet fiber, possessing all the most desirable characteristics. Great resilience accounts for wool's vital quality of retaining its appearance. However, it can wear down with heavy traffic loads. Wool has warmth, a dull matte look, durability, and soil resistance. It takes colors beautifully, cleans well, and, when cared for, retains its new appearance for years. However, wool carpet is very expensive and therefore is used mostly in high-quality spaces and residences.

NYLON Nylon is the most popular carpet fiber used and is highly resistant to abrasion. Nylon is soil resistant and has excellent cleanability, particularly in spot cleaning for stains. It is nonallergenic and is resistant to mold, mildew, and moths. It is prone to static buildup and often treated to resist this feature.

ACRYLIC Acrylic (including modacrylic) is similar to wool in appearance. Its outstanding characteristic is solution dyeability, and it is very resistant to abrasion, soiling, and fading caused by sunlight. It cleans exceptionally well and has good crush resistance but some pillage. Acrylics rank second to nylons in quantity production.

POLYESTER Polyester has great bulk characteristics and combines the look and feel of wool with a durability approaching that of nylon. Stain and soil resistance are good, and polyester is easily cleaned, although there is some criticism about its crushing characteristics. Polyester fibers are also known for color clarity and retention of color properties.

POLYPROPYLENE Polypropylene is the best-known specific type of olefin. It is predominant in needle-punched carpets and popular for kitchen and indoor-outdoor carpets. Ease of care and its nonabsorbent nature are polypropylene's outstanding characteristics. Most stains lie on the surface, making it the easiest fiber to clean. Its wearing qualities are comparable to nylon's, and polypropylene is completely colorfast. However, it has poor resiliency, which can lead to crushing.

SISAL Sisal is made from the agave plant and has strong woody fibers, often used to make twine and rope. It is also used to make floor coverings and does not build up static or trap dust. However, it can expand or contract with humidity levels.

Fiber Performance Characteristics

Fiber properties can affect the performance of a soft floor covering. Fibers have both inherent and engineered qualities; however, almost every inherent quality can be altered during the manufacturing process for better performance. The designer must balance appearance and performance qualities against any additional costs when selecting carpets.

STRENGTH The ability of a fiber to withstand abrasion and wear is referred to as strength. All manufactured fibers are strong, and nylon is the strongest. The strength of a carpet determines how long it will last—but not how long it will look good. A client might tire of looking at a nylon carpet long before the carpet will wear out. Polyesters and olefins are nearly as strong as nylon, making them both, like nylon, well suited for heavy-traffic areas.

SOIL RESISTANCE Carpet appearance is destroyed by soiling more often than by any other single factor. Certain fibers have a greater tendency to attract soil than others. Nylon is the most soil prone, which produces an overall dull appearance early in the carpet's life. However, nylons such as Antron® have special soil-hiding characteristics and fiber shapes.

Pilling and static conductivity (the ability of a fiber to conduct electric charges) are also major soiling factors. Nylon pills easily and holds onto these pills because of its unusual strength. The pills themselves pick up dirt, giving a soiled appearance to the carpet. Improvements in fiber forms have produced continuous-filament fifth- and sixth-generation nylons that seem to have minimized this problem. Acrylic pills because of the soft nature of the fiber, but pills can be easily vacuumed away before soil has time to set.

MOISTURE RESISTANCE All manufactured fibers resist moisture, some a great deal more than others. This factor determines the fiber's capacity to accept dyes, its stain resistance, and its maintenance characteristics.

Nylon, with the greatest tendency to absorb moisture, takes the widest range of colors and can be dyed using the largest variety of processes. Polyesters and acrylics both dye well, using various techniques. Olefin, the least absorbent fiber, has the most limited dyeing capabilities.

An absorbent fiber that dyes easily could also stain rapidly. Polypropylenes are very difficult to stain, while nylons stain more rapidly than any other manufactured fibers. Few substances can permanently stain manufactured fibers if mishaps are treated quickly. Like dyes, stains must set over a long period of time.

Whether the material is moisture resistant or absorbent also influences carpet cleanability. Since olefin is very nonabsorbent, it can easily be maintained by using everyday methods of care, such as vacuuming. However, nylon, polyester, and acrylic carpets need periodic specialized cleaning, such as wet or dry shampoo or steaming, to retain their original look.

RESILIENCE Matting and crushing are governed by fiber resilience, the ability of a fiber to spring back to its original pile height and shape. If a resilience problem exists, a visible traffic pattern can be seen long before a carpet actually becomes worn. Carpet textures do much to determine resiliency.

Acrylic is the most resilient fiber, which accounts for its popularity in high-pile styles. Nylons and densely constructed polyesters also spring back well. Olefin regains its shape very slowly, so mills limit its use to low-height carpet construction.

Fibers have different densities, or abilities to cover square footage. Olefin, a high-bulk yarn, offers the greatest coverage, with acrylics and nylons following closely. Polyester trails in this area, and its reputation has suffered greatly because of that disadvantage. Actually, a polyester carpet tufted with a sufficient amount of yarn is every bit as full and dense as its counterparts.

HEAT RESISTANCE Manufactured fibers do not actually burn but tend to melt or stick at different temperatures. Modacrylics, the most heat resistant of all, will not support combustion but will shrink at high temperatures. Polyester is claimed to be self-extinguishing, and polypropylene is the least heat resistant of any of the manufactured fibers.

STATIC ELECTRICITY The level of static electricity generated by a carpet is determined by the electrical properties and absorbency of its fibers. Static electricity can be controlled during the manufacturing stage by adding compounds to the polymer solution before extrusion or by weaving metallic fibers into the floor covering to drain the charge continuously. Fibers can also be encased with special coatings of a conductive material. Static electricity could be a serious problem with carpeting in spaces where computers and other types of electronic equipment are housed. Carpet specifications will indicate whether it has been treated for static electricity.

Construction Methods of Carpets and Rugs

Carpets can be tufted, woven, needle-punched, flocked, knitted, and handmade. These methods and their characteristics are more fully explained in Figure 14.19. It is unusual for one method to be better than another, since each can produce several grades, depending on the yarn, density, backing, and method of finishing. However, tufted carpet is less expensive and faster to manufacture than woven carpet. It is used to produce the greatest amount of carpet in the United States.

Surface Textures

Most carpets have a third dimension, that of depth, which is known as the texture or pile (visible surface fibers). Variations in the surface appearance and texture depend on the style or type, height, thickness, sweep, and density of the pile.

PILE STYLE Carpet styles fall into the categories of cut pile, uncut (loop) pile, and a combination of cut and uncut. The appearance of a carpet is further influenced by the level of twist used in cut pile yarns. Tightly twisted yarns create well-defined ends, and loosely twisted yarns have flared tips. Figure 14.20 shows the wide variety of textures available in floor coverings through variations on cut and uncut yarn piles.

PILE HEIGHT, SWEEP, AND DENSITY *Pile height* is the length of the pile yarns above the backing, which generally ranges from 0.187 to 1.250 inches (4.75 to 31.7 mm). The overall height is averaged when a carpet has a multilevel construction.

Pile sweep, also called the nap or directional pile lay, is the angle at which the pile yarns are oriented. The greater the angle, the more prominent the nap or shading created; this factor is important because the quantity of light reflected from a floor covering is determined by its pile sweep. When carpet is installed, it is important for the nap all to go in the same direction.

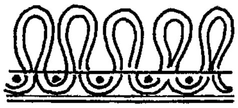
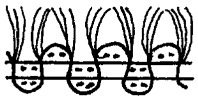
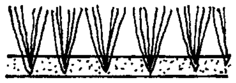
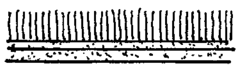
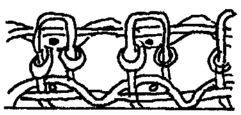
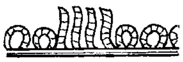
TYPE	CHARACTERISTICS
TUFTED 	Yarn-threaded needles punch back and forth through a preconstructed backing material and form loops, which can be cut or uncut. Tufts are secured with a latex backing, and a secondary backing of jute or other fibers is often applied. Tufting is the most used type of carpet construction.
WOVEN	
WILTON 	Produced with pre-punched cards on a jacquard loom that allows complex patterns and colors. Surface patterns vary from level cut pile to multilevel loop. Fibers are mostly wool and carpets are very expensive.
AXMINSTER 	Woven on jacquard loom utilizing long spools of various colored yarn for a variety of color and pattern. Axminster carpets are seldom made today due to the cost and type of loom required.
VELVET 	Produces a wide variety of color and textures, similar to axminster. Patterned design not possible, but tweed effects are made.
NEEDLEPUNCHED 	Dense mass of short fibers rather than yarns that are punched into a backing. Often called indoor-outdoor carpet, as polypropolene fibers resist moisture well.
FLOCKED 	Produced by blowing electrostatically short fibers on an adhesive backing to produce velvet-like texture. Not produced a lot as wearing qualities are low.
KNITTED 	Mutliple needles loop pile yarn, stitching yarn, and backing together for uncut loop texture. Latex backing generally applied. Process not used a lot for carpet construction.
HANDMADE 	Handwoven carpets are made by tied (knotted), untied, hooked, and braided techniques. Yarns can be looped, straight, or have ends cut. The braided technique can also be imitated on commercial machines.

FIGURE 14.19 Some of the most commonly used methods of carpet construction

Density is important in judging the quality of carpet construction, because it affects the surface appearance, wear-life, and texture retention. Density refers to how close the pile tufts are, and is measured in stitches per square inch. Stitches or tufts per square inch means the number of tufts within one square inch of carpet. The more stitches per square inch, the denser the carpet. *Gauge* refers to the distance between rows of tufts across the width of a tufted carpet.

Pitch is similar to gauge but refers to the method used in woven carpets to determine the density factor. Pitch refers to the distance between rows of tufts but is counted only on a 27-inch (685-mm) width of carpet. The higher the density, the better the carpet. In low-density constructions, the backing material becomes visible when a section is folded or rolled.

FIGURE 14.20 Common carpet textures and their characteristics

TYPE	CHARACTERISTICS
CUT PILE (one level)	
PLUSH OR VELVET 	Uniform cut level in height. Loose twist of yarn ends to produce luxurious feel and appearance. Good wear resistance.
VELOUR 	Similar to plush cut, but very short, fine, and dense. Good wear resistance.
SAXONY 	Tight yarn twist that is heat set to reduce flaring at tips. Similar in height and density as plush. Medium wear resistance.
FRIEZE 	Textures are rough, grainy appearance. Tightly twisted yarns of high stability and wearlife.
SHAG 	Pile heights over one inch. Low pile density, informal appearance. Used mostly in residential applications, as wear resistance is low.
SPLUSH 	Pile density and height between plush and shag carpets. Yarns tend to lay down in moderate and high traffic areas.
UNCUT PILE	
LEVEL LOOP 	Short, uncut loops. Dense, durable, wear-resistant. Good variations in color and texture. Used for residential and commercial areas for excellent wear resistance.
MULTI-LOOP 	Different heights of looped pile. Random or specified for distinct pattern. High density increases durability.
TWEED 	Similar to level loop, but larger loops and lower density. Cross-dyed with different colors for tweed pattern. Medium wear resistance.
CUT AND UNCUT (loop) PILE	
SCULPTURED 	Cut and uncut piles of different heights. Generally tall loops cut and short uncut to produce three-dimensional effect. Sometimes called high-low.
TIP SHEAR 	Similar to plush. Selective shearing (cutting) specific loops for subtle pattern of texture and color. Medium wear resistance.

Color

Color ranks second to cost as a determinant in the selection of carpet (wearability, carpet construction, and fiber are also among the five most important factors). A neutral or subdued wall-to wall carpet color can allow for changing color schemes or serve as a backdrop for other distinctive furnishings. Unusual colors, patterns, or bold graphic designs are not as versatile as neutral colors, thus limiting later choices; however, they are exciting and create strong visual impact.

Multilevel and multicolor carpets show less soiling than plain, smooth, one-color carpets. Colors that show less soil than others have high soil-concealment qualities. Blues and greens show the least soil, while white and all very light colors show soil and soon lose their original appearance. Dark colors show lint and dust if the carpet is darker than the soil.

Carpets are colored or dyed using the same methods as with other textiles. (Refer to Chapter 13 under "Textile Colorants" for methods commonly used to dye carpets.) When selecting the dye method for a particular carpet, an interior designer will be concerned with the soil-hiding properties, fade resistance, economy, and aesthetics. Because some dyeing methods are not effective on all fibers, it is advisable to consult with a textile or carpet expert about this factor.

Colorfastness of carpet refers to its resistance to fading from exposure to light (particularly direct sunlight) and color rubbing off.

Pattern

The size of the room, the style of furnishings, and the amount of pattern in walls and window treatments should influence the choice of a plain or patterned rug or carpet. If a strong pattern—either woven or printed—is used on the floor, then walls, window treatments, and upholstered items should be relatively subdued. Large, strong patterns tend to make a small room appear smaller, and little or no pattern gives the appearance of more space.

Codes and Regulations

Before purchasing or specifying carpet, the designer should be aware of certain codes and regulations relating to the manufacturing process and to the performance of the carpet. Various federal, state, and local regulatory agencies have established mandates affecting the design and performance of textile floor coverings for certain installations.

The Textile Fiber Products Identification Act (1960) requires a label on all rugs and carpet samples. Since no labels are required on orders of carpet cut for installation, the necessary information should be on a sample or the invoice. Each label or invoice should contain

- The manufacturer's or distributor's name and Federal Trade Commission registration number
- The country of origin of an imported carpet
- The common names of fibers in the pile and the percentage of each by weight

Flammability requirements, controlled by federal regulations, are concerned with flame spread, surface flammability, radiant heat flux (whereby intense heat is radiated to the floor), ignition, and smoke generation. Manufacturers' specifications indicate the flammability rating by a letter code or by ratings developed by the American Society for Testing Materials (ASTM). Since all building code requirements are not the same across the United States or internationally, it is necessary for the interior designer to consult the building code in the area that has jurisdiction over a particular project.

Installation Methods

The interior designer must be familiar with carpet installation terminology and methods, as well as with the materials, since the designer prepares the specification documents that contain installation instructions. There are two basic methods of installation: (1) the stretching method, in which a tackless strip is used at the perimeter to stretch the carpet over a pad, and (2) the glue-down method.

The most widely used tackless method involves 1½-inch-wide (38-mm-wide) plywood strips with pointed rows of protruding metal pins. The plywood strips are nailed to the subfloor at the perimeter of a room and other locations. The carpet is then tightly stretched over this strip, which holds the carpet in place. The tackless method is the most commonly used technique for residential construction. An advantage of this method is that it allows for easy removal and replacement of carpet.

The glue-down over cushion method uses adhesives to secure both a carpet and a cushion to the subsurface. The direct-glue-down method uses no cushion, securing the carpet directly to the subsurface. The latex-based adhesives used can be permanent (nonreleasable) or releasable. The releasable glue is used when periodic access is needed for running flatwire cable systems or for gaining access to the underfloor. Either releasable glue or double-stick tapes can be used to secure carpet modules in place.

Carpet is laid and seamed to provide a continuous covering. Piles should be uniform in their directional lay and seamed generally parallel with the pile rather than crosswise. Seams should not be placed perpendicular to a doorway (Figure 14.21) or linearly in the center of a hallway if heavy traffic is anticipated. Where possible, carpet seams should run perpendicular to windows for minimizing daylight patterns that might visually emphasize the seam.

Carpet is also manufactured in tiles for direct lay without glues, called *freelay.* The weight and butting of tiles together hold the pieces in place without the need for adhesives. However, some tiles are also made with pressure-sensitive base faces that have an adhesive coating for securing them in place.

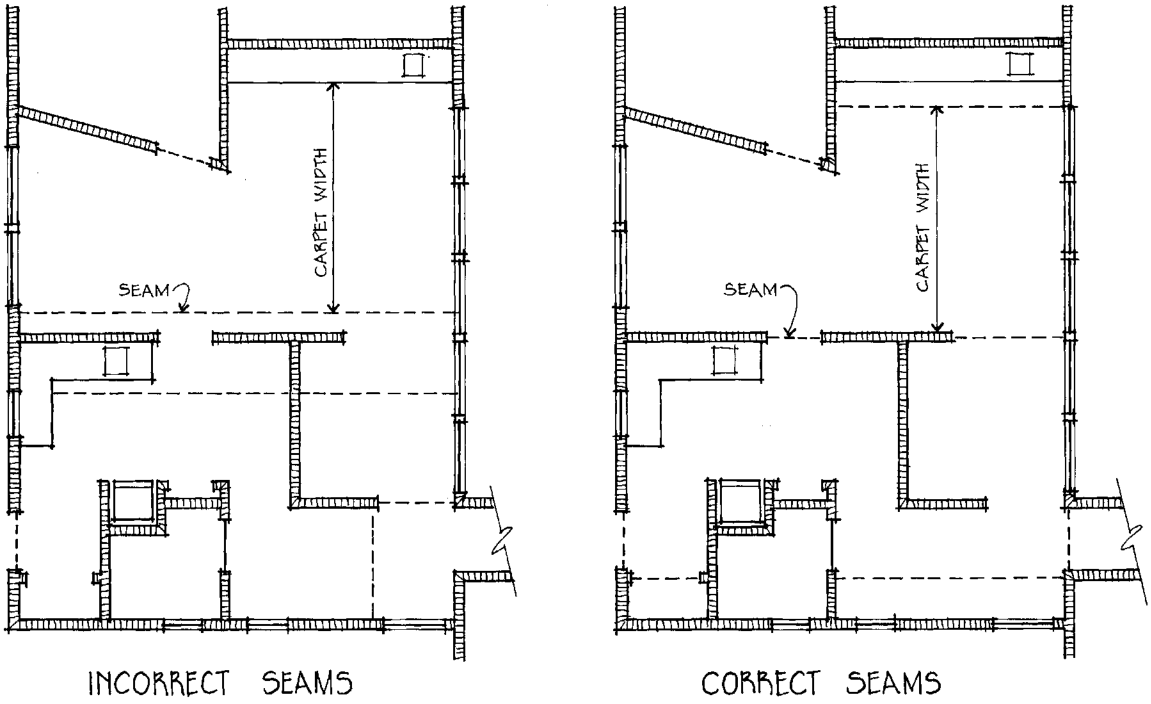


FIGURE 14.21 Carpet seaming is carefully planned to avoid piecing in high-traffic areas.

Carpet Padding or Cushioning

Carpet padding, or cushioning, is used under carpeting primarily to extend the life of a carpet and provide comfort for the user. Figure 14.22 lists the specific benefits of padding.

The types of padding used are fiber cushions, hair, felt, sponge rubber cushions, and polyurethane foam. Padding should be specified according to the needs of the user and the quality desired. Among the factors to be considered

FIGURE 14.22 Benefits of using carpet padding or cushioning

BENEFITS OF USING CARPET PADDING OR CUSHIONING

ADVANTAGES

Increases durability of carpets and rugs.

Prolongs the life of carpet pile.

Improves carpet appearance; abrasion is lessened.

Retains carpet texture, as pile is less likely to be flattened.

Increases carpet's resilience (ability to spring back after being crushed).

Increases sound absorption, making the carpeted area quieter.

Increases the absorption of static shock.

Helps in insulating and controlling temperature against cold floors.

Adds to the slippage safety of a carpet/rug with proper non-slip pad.

Provides for better cleaning.

Prevents subsurface cracks and roughness from "telegraphing" to surface of carpet.

DISADVANTAGES

Thick, bouncy pads could make a carpet difficult to walk on for elderly or handicapped persons.

Increases costs of installation and material.

Special problems: Dense foam or sponge is preferable in humid or flood-prone areas because it will not mold or mildew. For radiant heat conduction, sponge or foam is better than jute, although jute can be used. In either type, heavy, thick padding should be avoided.

are the amount of traffic, noise absorption, impact noise reduction, resistance to fire, thermal conductivity, frictional resistance, mildew resistance, tear resistance, and budget.

Other considerations include the following:

- Firmness vs. buoyancy. A fiber pad gives firmness and some resilience. Sponge and rubber give resilience with buoyancy rather than firmness, unless the pad is very high density foam. The firmest is reinforced foam rubber on hair or fiber, which combines the advantages of both.
- Sponge or foam. Waffle sponge is softest, but foam gives more uniform support.
- Special problems. Dense foam or sponge is preferable in humid or flood-prone areas because it will not mold or mildew. For radiant heat conduction, sponge or foam is better than jute or natural fibers hair, although these can be used. In either type, heavy, thick padding should be avoided.
- Polyurethane foam cushions can be manufactured as a continuous sheet or made with bonded polyurethane scraps of foam fused together.

WALL SYSTEMS

Wall systems comprise both exterior and interior vertical planes in a building. They help set the limits, character, size, and shape of an interior. Walls are a major element in shaping and enclosing interior space. The interior designer can use them to keep in or push out various positive or negative influences, whether visual, physical, or psychological. Walls can be active generators of strong statements that dictate the use and character of a space. Walls can also be passive, subtle enclosures of our human activities and can be unintimidating—almost implied. In some spaces, it is difficult to tell where the wall's limits are because they might flow into the floor or ceiling. Walls are more than a background element; they are an integral part of the architectural enclosure, along with floors and ceilings.

Walls might be one continuous material, such as concrete block, or a composite of materials. They can be solid planes or pierced with doors, windows, and other openings. They can extend all the way from floor to ceiling or just partway. Walls also are used for supporting built-in elements of storage, furniture, and other equipment. Walls can be for support, or they can be space dividers or transparent dividers (perhaps glass); they can have integral pilasters or even be movable. Wall finishes can be the same as the building's construction material (e.g., concrete), or applied (e.g., wallpaper). Walls might also be composed of a combination of columns and beams.

Walls are generally classified as load-bearing or non-load-bearing (sometimes referred to as partition walls). Bearing walls support floor or roof systems above them; nonbearing walls support no weight from the structural system. However, some nonbearing walls do support minor elements, such as cabinets that are hung or placed on top.

Generally speaking, before cutting openings in or moving a bearing wall, the designer should consult an architect or engineer in order to ensure that the structural integrity of the building is maintained. Most interior non-load-bearing walls can be modified easily; however, in some cases they do serve some loading purpose that must be considered.

Figure 14.23 lists a number of considerations to be used when selecting wall systems and finishes.

Wall Construction

Walls, both load-bearing and non-load-bearing, can be constructed as one solid material or as a composite of columns and beams. The choice depends on the structural integrity of the building, economic factors, construction details, openings, and the desired finish of the wall. Typical wall construction types include concrete, masonry, and wood or metal frame. Exterior walls are constructed like most interior walls but have added insulation and special finishes protecting them from environmental conditions.

Concrete and Masonry Walls

Concrete and masonry walls are used primarily as load-bearing elements and for fire resistance, although they are also used in specialized cases such as bank vaults or subsurfaces for other finishes. They generally are covered when used in occupied spaces, except in utilitarian areas or for visual effects in interiors. However, in large warehouses and factories, precast concrete wall panels are made as *sandwich panels* that have insulation placed within the panel during casting. This allows both the exterior and interior faces of the wall to be exposed as a wall finish, if desired.

FIGURE 14.23 Consideration for selecting wall systems and finishes

CRITERIA	CONSIDERATIONS
AESTHETICS	Relationship and appropriateness to the overall design in terms of concept, shape, color, texture, finish, etc.
DEGREE OF ENCLOSURE	Solid or partial; transparent or opaque; functional needs
TYPE	Hung or attached versus part of the building's structural assembly; whether elements will be hung or supported by the ceiling
HEIGHT	Heights above floor; fixed and variable
DURABILITY	Related to wear, damage, repair, and maintenance
COMPATIBILITY	Interfacing and details required to be compatible with light fixtures, HVAC equipment, and fire suppression sprinklers
THERMAL	Possible needs for energy conservation
LIGHT QUALITIES	Lighting considerations of absorption and reflection
ACOUSTICAL	Properties for absorbing, blocking, or reflecting sound waves
ECONOMICS & SUSTAINABILITY	Availability of materials, recycled content, initial costs, life-cycle costs including maintenance, and replacement or repair costs
FIRE RESISTIVE	Requirements needed to protect the occupants and the structural assembly from failure

Masonry walls can be constructed solely of stone, brick, concrete block, or clay tile. However, most of these walls are constructed as veneer walls over frame walls (made of wood or steel) or concrete block. These veneers do not provide structural support but serve as a covering; they are connected with metal ties to the subwall.

If an interior concrete or masonry wall is to be finished with another material, such as gypsum board, then generally wood or metal furring strips are secured to it at intervals and the finish material is attached to these supports.

Wood and Metal Frame Walls

Frame walls can be used as interior or exterior walls and be bearing or nonbearing. Wood or metal studs are placed vertically at intervals (usually 16 or 24 inches, or 406 or 609 mm, on center) and attached to a top plate and a bottom sole or runner.

With the advent of mass-produced lumber and nails, these framing techniques were developed using wood in the 1800s. Frame walls were formerly surfaced with wood lath strips, and wet plaster was applied in several coats for wall and ceiling finishes. Today, metal lath and plaster are still applied for finishes, but the use of premade gypsum wallboard panels, called drywall, is more economical.

Wood-stud walls usually have 2 × 4 inch (50 × 100 mm) nominal (1½ inch × 3½ inches, or 38 x 88 mm, actual) studs that provide support for sheets of finish materials to be applied. Such walls can structurally hold up floor loads from above and provide space for concealing wiring, plumbing, and ducts. Other stud sizes, such as 2 × 6 inches (50 × 152 mm), are used to accommodate more wall insulation (exterior) or contain larger drainpipes.

Wood-stud walls are usually framed in 8-foot (2,438-mm) heights (mostly residential) and covered with gypsum wallboard. This product is a gypsum, chalklike material sandwiched between sheets of special paper or other materials. Gypsum wallboard comes in 4 × 8 foot (1,219 × 2,438 mm) sheets, although lengths of up to 14 feet (4,267 mm) are also available. Thicknesses range from ¼ inch to 1 inch (6 to 25 mm), with ½ inch and ⅝ inch (12 and 15 mm) being the most commonly used. These wallboard sheets can be quickly cut, glued, nailed, or screwed to the studs. They are finished out with tapes and different-shaped metal or plastic casings and joint compounds (plasterlike material) to provide smooth wall surfaces for paint or a variety of other surface finishes (Figure 14.24). Gypsum boards can be added in layers to a wall to increase both the fire-resistive capabilities of the assembly and its ability to cut down on sound transmission.

Fire-rated gypsum board is commonly called *Type X* and is made with a specialized core mineral composition to increase its fire resistance over common gypsum panel board. Gypsum board is also made as water-resistant wallboard and used in moist areas—for example, as a backing surface for adhesive-applied ceramic tile (showers). However, most of these tile installations use a cementitious backer panel that is stronger and more moisture resistive than gypsum board.

FIGURE 14.24 Gypsum board has been screwed to the wood framing in this new kitchen addition and finished out with taped joints. After some surface sanding, it is ready for paint.

Metal-stud walls are similar to wood-stud walls in widths, spacing, and finish coverings. However, the metal studs are lightweight shapes of steel that must be screwed or welded together, rather than nailed. They have cutouts in their webs to facilitate piping and wiring runs. Being steel, they will not burn and are often required in high-occupancy buildings.

Specialized Walls

Interior wall systems are manufactured as movable or demountable partitions that can be assembled and disassembled for new locations or configurations, giving them a flexibility that other wall systems cannot provide. Most interior wall systems include doors, glazing, trims, and accommodations for wiring. They are frequently used in office installations where flexibility is needed.

Folding and sliding partitions are specialized units that provide flexible wall arrangements. Sliding panels of material in accordion-like folds are set in ceiling and floor tracks to create a wall or stack it out of the way, another arrangement that provides wall flexibility.

Wall systems can also be manufactured as prefabricated units for both bearing and partition use. In the factory several composites of materials are sandwiched together and shipped to a project for erection. This prefabricated system usually cuts down on job-site construction time and features better quality control techniques, as well as cost control.

Wall Finishes and Specification Criteria

Many wall finishes are available, some of them the same as or similar to the floor finishes previously discussed. All construction materials listed in Chapter 13 and all exterior wall finishes can be used on the interior. Some finishes are an integral part of the wall's structure, and others are applied as layers (ceramic tile) or coatings (paint).

Plaster and Stucco

For use as wall (and ceiling) finishes, plaster and stucco are applied over wood and metal studs by using metal lathing, or are applied directly over concrete block. Plaster and stucco can be applied in a variety of textures and patterns and can be integrally colored with additives. As wall finishes, they are subject to easy soiling from scratches, fingerprints, and other markings. These materials are long lasting but more expensive than drywall.

Paint

Paint is one of the most often used finish materials for walls and ceilings because it is inexpensive, easy to apply, and available in an infinite color range (Figure 14.25). It can be applied over numerous wall surfaces and can easily be changed later by overpainting. A list of the most common paints and their uses was discussed in Chapter 13 (Figure 13.14). Painted wall finishes are generally referred to as flat (matte), semigloss, satin, eggshell, or high-gloss, depending on the visual characteristics, amount of light reflected from the surface, and maintenance factors of the paint when dry.

Semigloss and gloss paints are specified for their shiny appearance and washability. Satin and eggshell finishes retain some washability characteristics, but are not as shiny as the glosses. Generally, the higher the gloss factor, the more the tendency of the painted surface to show surface imperfections. A flat finish doesn't show the defects as much as gloss, but suffers more from cleaning or washing the surface.

Water-based paints are used in both residential and commercial areas, primarily when wear factors are not a problem. Oil- and plastic-based paints are more applicable to commercial areas, as well as residential kitchens and bathrooms, if a scrubbable finish is needed. In addition to being spread by brush or roller, paint can be stippled, spattered, sprayed, or sponged, alone or with other colors, to create a variety of patterns and textures.

FIGURE 14.25 The painted red wall is used as an economical and strong visual design element in this residence.
Courtesy of Knoll, Inc.

Paints can be computer matched in color as a complement to or contrast with almost any other material. Often a designer has paint matched for coordination with fabrics.

Interior designers should be aware of environmental considerations of paint and the use of volatile organic compounds (VOCs). When used in paint formulations, these solvents can be released into the air. Hence, specifying low-VOC paints (which are mostly water-based products) can be environmentally friendly and not add to poor indoor air quality (IAQ).

Wood

Wood can be used as a wall finish in the form of boards, shingles, or veneered panels. Patterns, finishes, and joints can also be varied. Wood is used as trim for wall bases, ceiling molding, doors, windows, and paneling.

Wood finishes vary from none to heavy overpainting, although most finishes are selected to accent the natural beauty of the wood and its grain, pattern, or color. Wood to be used in high-occupancy areas can be chemically treated to make it fire resistive.

Wood paneling can be made as simple, flush designs or can be made more elaborate by adding moldings, such as those used for traditional panels and rails (Figure 14.26). Paneling can be made of hardwoods or softwoods and in plywood veneers or solid lumber sections. Manufactured paneling is generally produced in 4 × 8 foot (1,219 × 2,438 mm) sections with thin, unfinished wood veneers over plywood; these panels can be finished on the job site. Panels can also be produced with prefinished surfaces, photo reproductions, or plastic faces for a variety of installations. Medium-density overlay (MDO) is made in various panel sizes and thicknesses for use where a smooth surface is to receive a finish of paint, as opposed to staining.

Solid wood can be installed on walls (and ceilings) by various methods using tongue-and-groove connections or other assemblies. The wood can be applied in very simple vertical strips, in a design produced by a board and

FIGURE 14.26 Wood can be shaped into many forms and painted for wall and cabinet surfaces, as seen throughout this kitchen.

Courtesy of National Kitchen & Bath Association

FIGURE 14.27 A suspended wood ceiling provides a strong design element in this waiting area of a medical center.
Courtesy of Knoll, Inc.

batten technique, or in other patterns. Often the solid planks are cut and shaped into moldings and other trim for flat wall surfaces or for door and window trims.

Wood boards are manufactured for wall applications as tongue-and-groove, beveled, shiplapped, channel, and suspended installations (Figure 14.27).

Stone and Masonry

Stone and masonry wall materials project an image of strength, solidarity, rich texture, and high quality.

Stone and masonry can be installed in heavy, rusticated, random, and textured surfaces, or in smooth, coursed, and reflective faces. These installations can be heavy, thick wall sections or made of thin veneers and reinforced by

FIGURE 14.28 The rough stonework in the ceiling of this restaurant provides a rusticated heavy texture, reminiscent of ancient Roman vaults.
© ROB TILLEY / age fotostock.

a supporting wall. The stone is secured with metal ties or large-diameter wire. The installations can be either classic and traditional or stark and modern for a contemporary look (Figure 14.28). Stone and masonry can, however, cause acoustical problems because they reflect sound within a space. The thickness and maximum size of cut stone is dependent upon the quarry and type of stone selected. Generally, granite is the largest available, and slate tends to be the smallest.

They can also be effectively used in installations where mass is needed for solar heat storage in residential and small commercial buildings. Stone and masonry are excellent for fire resistance.

Some stone veneers are actually composed of concrete or stone and synthetic compounds, such as cast glass-fiber reinforced materials, that imitate stone (Figure 14.29). Often lighter, more stable, and less expensive than the real substance, these cast imitations may be visually almost indistinguishable from the genuine stone.

Ceramic and Other Tiles

Ceramic tiles are used as a wall finish for both interior and exterior applications. These tiles are excellent for durability, ease of maintenance, and attractiveness (Figure 14.30). They are available to coordinate in color, style, texture, and thickness with floor tiles. Tile is especially suited for humid, wet locations where water or steam is present, as in swimming pools or commercial kitchens. Because their hard surfaces can be readily cleaned and are resistant to staining, tiles have widespread application in bathrooms and kitchens.

Ceramic tile is attached to walls with a thinset method (residential and light commercial applications) or a full mortar bed method. The latter is the most durable but is often more expensive with material and labor costs. In wet areas (showers), the thinset is often done over special cement backer boards instead of the water-resistant gypsum board.

Plastics

Plastics for wall finishes appear in many forms, including rigid sheets of solid plastic, plastic laminated veneers over hardboard panels, or thin and flexible wall vinyls. Plastics are durable and easy to clean, although some can be

FIGURE 14.29 The stone veneer in this waiting room is a cast concrete product that resembles hand-cut stone.
Courtesy of EnviroMed Design Group

damaged by abrasive cleaning agents. Most plastic finishes are difficult to restore to their original finish if damaged. Plastics are available in a wide range of colors and surface finishes, many imitating other materials, such as wood, grasscloth, and even ceramic tile. Plastic is used in sheets, such as Plexiglas or acrylics, and placed in wall areas subject to breakage (windows) or as accent panels, for graphic signage, and for dividers within spaces.

Metals

Metals are primarily used in both residential and commercial buildings as exterior wall surfaces in forms such as siding, tiles, or panels. These products are generally aluminum and steel, although copper also is used for roofing and gutters. Stainless steel panels and strips are installed in interiors on walls, ceilings, and columns for both durability and aesthetic considerations.

Finish techniques for metals include hammering, brushing, polishing, and etching.

Glass and Mirrors

Glass is used in doors and windows or as whole or partial walls, either set in panels within wood and metal frames or made of glass blocks. Glass is used primarily for its light transmission, however, and other visual properties can be achieved, since it can be colored and textured. Glass walls can be straight or curved.

Mirrors are glass with a back coating of silver or bronze alloys. Mirrors are often used to expand a space visually and can cover entire walls, columns, and even ceilings in large, single expanses or in tiny mosaic patterns. Mirrors can be antiqued, grayed, veined, or etched with designs and can have beveled edges. Mirrors are installed by gluing or by setting within frames or clips.

Fabrics

Fabrics have been used through the ages to cover walls and even to serve as walls (as in tent structures). Fabrics are primarily used as a finish to add softness, texture, color, and visual interest to a wall surface. If used as a wall hanging, fabric can become a focal point. Silks, linens, wool, canvas, carpets—almost every kind of textile—can

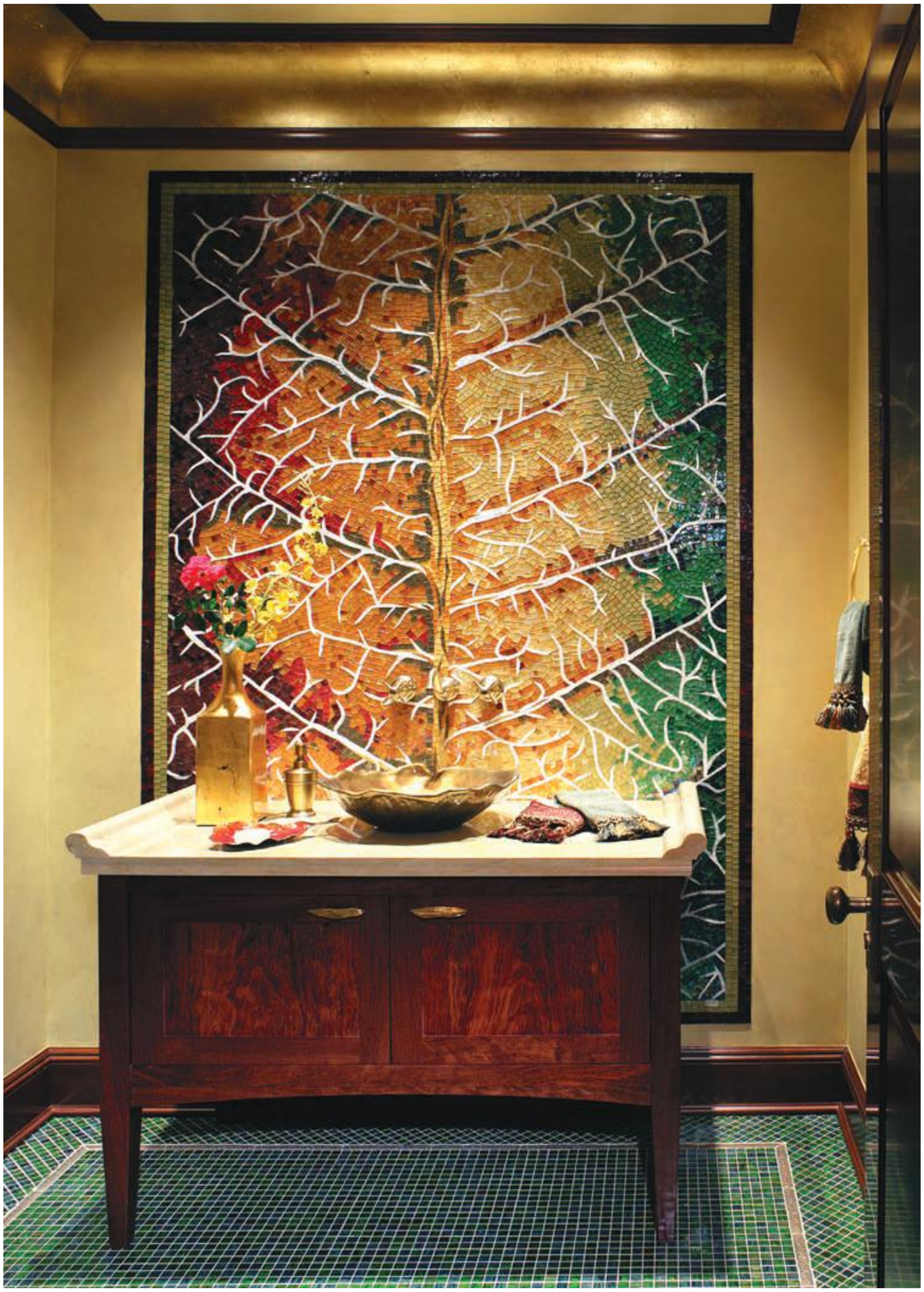


FIGURE 14.30 Small squares of tile can be used to create complex, colorful images such as this wall in a bathroom.

Courtesy of National Kitchen & Bath Association

be used as a wall covering. Fabrics on walls are subject to soiling; care should be taken as to where they are placed, avoiding heavy-traffic areas where people might handle them.

Heavy fabrics can sometimes be glued directly to wall surfaces. In other methods, fabrics are tacked, or stretched over frames and attached with mechanical fasteners to the walls. They can be applied as flat layers or folded, padded, or stitched into surface treatments. Thick fabrics and carpets can be used as sound-absorption surfaces, or fabrics can be stretched over frames with a sound-absorbing core (such as fiberglass or polyester insulation). Many also can be specially coated with soil repellent or fireproofing material for commercial applications.

Wallpapers and Vinyls

Wallpapers are produced for residential and commercial uses in a seemingly endless variety of colors, textures, patterns, and pictorial images. Wallpapers can imitate many other materials, be coordinated with fabrics, or reflect historical periods, as seen in some classical reproductions. However, they should be selected to be compatible with the character of the building interior and furnishings.

Many wallpapers have self-adhesive or prepasted backings for ease of installation. Wallpapers are produced as sheets of paper that can be flocked, metallicized, and vinyl coated for durability. Materials such as cork can be applied as a thin surfacing to the basic paper. Various fabrics or textiles are also laminated to wallpapers and produced in rolls. Wallpaper is sold in single 27-inch-wide (685-mm) rolls of 36 square feet (3.34 m^2). It is also made as a double roll and a triple roll. The rolls are generally manufactured with a pattern repeat, requiring alignment of the rolls as they are applied.

Although vinyl wall coverings are a plastic, they are similar in style and application to wallpapers. However, they are stronger and are often produced in wider widths. Vinyls are more durable than most wallpapers and can be scrubbed. Some are heavily backed for installation over rough subsurfaces or even over cracks in walls. Vinyls are produced in three grades, ranging from Type I (light duty), Type II (medium duty), and Type III (heavy duty).

CEILING SYSTEMS

Like floors, ceilings may be the largest unobstructed area within an interior environment. Ceilings play an important role in shaping the visual, acoustical, and lighting characteristics in a space. Ceilings define the upper limits of a space as well as provide for physical and psychological protection. Other uses are for thermal and fire-resistant barriers, as shown in Figure 14.31, which lists considerations for selecting ceiling systems and finishes.

Ceilings should be designed as an integral part of interiors and not just be considered a flat surface over our heads. The height, shape, and finish of a ceiling have a major impact on the occupants, furnishings, and other objects within the space. Vertical dimensions of an interior space should be in proportion to the horizontal dimensions, to achieve a feeling of balance. High ceilings can create an open, airy, lofty feeling; low ones can create cozy and intimate spaces. Typical ceiling heights are 8 feet (2,438 mm) in residential and usually a minimum of 9 feet (2,743 mm) in commercial spaces. Some building codes restrict ceiling heights to a minimum of 7 feet 6 inches (2,286 mm) in usable spaces.

Ceiling Construction

The construction of ceilings generally consists of a joist and rafter frame system similar to floor systems. However, these wood or steel members tend to be lighter and smaller, since the loads of a roof are usually not as great as those of a floor. In buildings of two or more stories, a floor system can also serve as the exposed ceiling system for spaces below. The structural frame might act as the finish material, such as wood, concrete, or metal. However,

FIGURE 14.31 Consideration for selecting ceiling systems and finishes

CRITERIA	CONSIDERATION
AESTHETICS	Relationships and appropriateness to the overall design in terms of concept, color, texture, finish, etc.
DEGREE OF ENCLOSURE	Solid or punched with openings; opaque silhouetted, or transparent; partial; full height of space or low
STRUCTURAL	Load bearing or nonbearing; continuous or designated point loads
DURABILITY	Related to wear, damage, repair, and maintenance
FUNCTION	Intended use interior or interior/exterior assembly; permanent, freestanding, or movable
LIGHT QUALITIES	Lighting considerations of absorption and reflection
ACOUSTICAL	Properties for absorbing, blocking, or reflecting sound waves
THERMAL	Characteristics needed for solar or energy conservation
ECONOMICS & SUSTAINABILITY	Availability of materials, initial costs, life-cycle costs including maintenance, and replacement or repair costs
FIRE RESISTIVE	Required fire-resistive characteristics to protect the occupants and the structural system from failure

FIGURE 14.32 This unique ceiling is designed in the form of abstract tree structures and evokes a park-like setting.
© EDMUND SUMNER / age fotostock.

false ceilings can also be installed beneath these floors to provide for lighting, aesthetics, fire resistance, mechanical systems, and acoustical barriers between floors.

Ceiling joists, rafters, and trusses are typically spaced at 12, 16, and 24 inches (304, 406, and 609 mm) on center. Other spacing modules can be used for lighter or heavier loading and framing details. Trusses can take the place of ceiling joists and rafters to allow a ceiling to take different forms and heights. They also allow for greater open spans because of their excellent strength characteristics.

Other ceiling shapes, such as the cathedral ceiling, use exposed beams, with the surface finish added directly to the rafters. With this type of construction system, interior ceilings can take on many forms and shapes created by the roof structure (Figure 14.32). Examples include shed or slanted, gable, cathedral, and domed ceilings. The coffered ceiling shape contains recessed paneled sections (structural or decorative) that can be rectangular, hexagonal, or other shapes.

Attached and Hung Ceilings

Ceiling surfaces are either attached or hung (suspended) from supporting systems. The attached type is the simplest, usually consisting of gypsum board, wood, or ceiling tile attached directly to the framing members. For example, gypsum-board finishes are usually secured directly to the frames.

Hung ceilings are common in commercial construction, and suspended from the building structure by various methods (Figure 14.33). The systems benefit from fast installation, low cost, and flexibility. These configurations consist of main and secondary runners of lightweight steel suspended from wire hangers attached to the structure above. Metal or acoustical panels of various materials and sizes are installed, as are light fixtures and mechanical equipment, such as air registers. Hung ceilings can be placed close to the structure above or lowered to provide space for mechanical, plumbing, and electrical equipment.

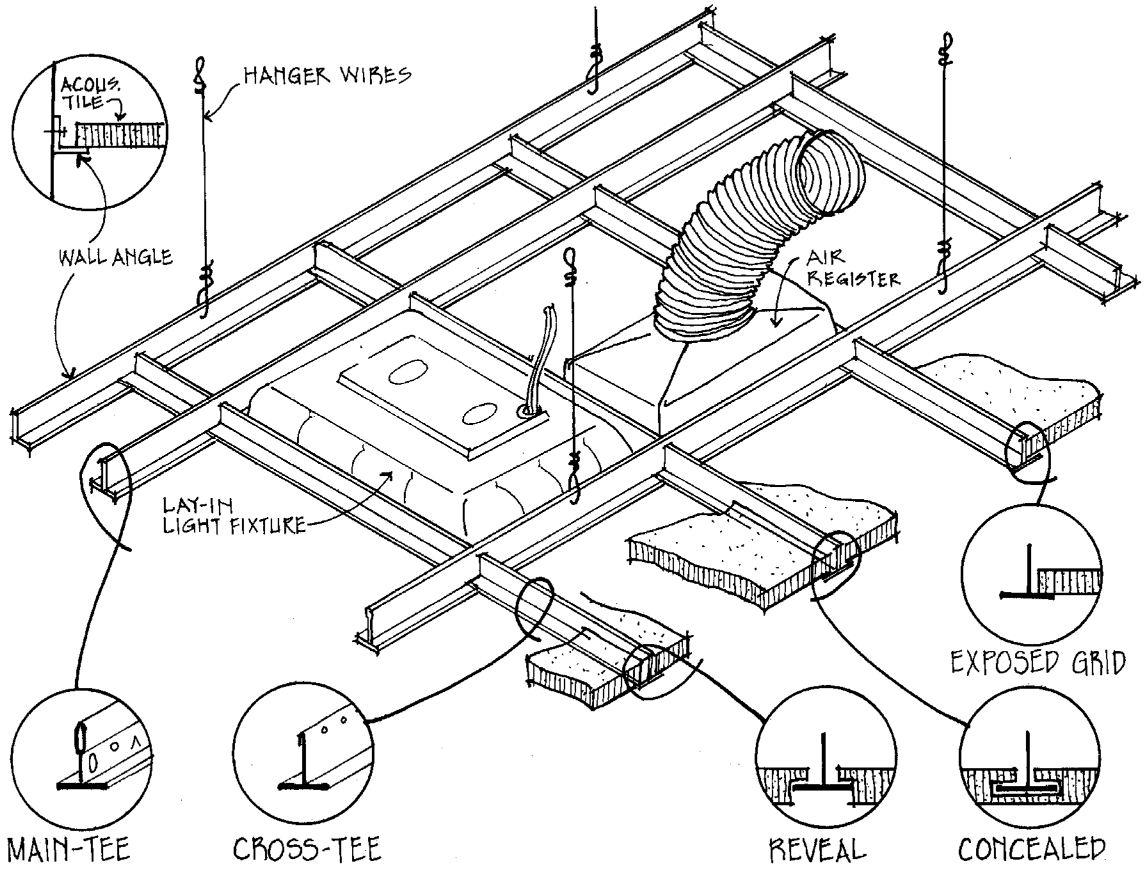


FIGURE 14.33 A ceiling assembly is composed of metal runners suspended by wire from the building structure above. Light fixtures and ceiling panels lie within this gridwork.

Ceiling Surface Materials

Several materials are available to finish ceiling surfaces: The most common are plaster, gypsum board, wood, and various tiles set in suspended ceilings. In turn, each of these surfaces can be treated in a variety of ways—with paints, ceramic tile, or custom ceiling tile products.

Plaster

Plaster is one of the oldest forms of ceiling finishes. It is durable, rigid, moisture resistant, and fire resistive. The surface can be smooth or textured and can be molded into many complex shapes, both straight and curved. Plaster offers the opportunity to mold wall and ceiling planes smoothly with curved surfaces, such as the cove. Other highly decorative shapes and patterns can be created with plaster, an advantage not possible with other finishes. Plaster can be painted or, if it is smooth, can have vinyls and papers applied over it. However, plaster ceilings take more time to install and are more expensive than the other types.

Plaster is either attached directly to a structural wood, metal, or concrete frame of a ceiling or installed on a suspended system. Both applications require a sound subsurface, generally a metal lath system to which the plaster is applied in several coats.

Gypsum Board

Gypsum board, sometimes incorrectly called Sheetrock (a specific brand name), is less expensive and quicker to install than plaster. It is durable, rigid, and available in different thicknesses, and can be highly fire resistive if layered. The surface can be smooth or textured. This texture, which can be light or heavy, can be applied by hand or sprayed. Gypsum board can be painted or not, or, if the finish is smooth, can have vinyls, papers, and other materials applied.

FIGURE 14.34 The ceiling in this restaurant is constructed of varying grid shapes and mirrors to reflect light and images throughout the space.
© H&L/W HEATH / age fotostock.

Wood

When wood is installed as a decking over ceiling or floor joists, the joist and decking assembly can be left exposed to create a wood ceiling for the space below. Tongue-and-groove assemblies of various widths, stained or painted for the finish desired, are generally used for such installations. Examples of these can be seen in many old industrial buildings that have been repurposed for residential or commercial facilities. In these, the original wood floor system is cleaned and left as an exposed ceiling. Wood strips, similar to the types used for flooring, can also be applied to the ceiling from below. They are either secured directly or attached to suspended ceilings. Hung ceilings are also made with wood grids or grilles.

Ceiling Tiles

Ceiling tiles can be glued to smooth ceilings or stapled to wood furring strips attached to ceiling systems. These tiles are generally 12 inches (304 mm) square and have smooth or tongue-and-groove edges that produce a geometric grid or a continuous surface when installed.

Ceiling tiles can be installed in suspended ceiling systems in 2 × 2 feet (609 × 699 mm) or 2 × 4 feet (609 × 1,219 mm) grids leaving the metal grid exposed, recessed, or concealed. These systems allow flexibility in rearranging if lights, mechanical diffusers, and damaged panels need to be changed or removed.

Panels of ceiling tiles can be designed with acoustical and fire-resistive ratings if required. These panels can also be vinyl or fabric coated, mirrored, plastic, or metal faced.

Metals

Metal or tin ceilings were mass-produced in the 1800s to imitate ornamental plaster without the cracking or damage to which the latter is susceptible. These ceilings are reproduced today in a variety of patterns. Linear metal ceiling materials are made in 3–7-inch (76–177-mm) widths that attach to runners made of various metals. Metal or tin ceilings can be finished with bronze, brass, aluminum, and plastic coatings.

Ceramic Tiles

Ceramic tiles are used on ceilings for decorative accents, durable finishes, or resistance to moisture in damp locations, such as showers and kitchens. Ceramic tiles are glued over special water-resistant gypsum board or installed using a cementitious lath and plaster technique. Many decorative ceramic moldings are available to coordinate with the tiles.

Paint

All the ceiling surfaces discussed in this section, except ceramic tiles, can be painted. Painting is often an economical solution for older ceilings, such as acoustical tile ceilings, that have faded or become discolored, yet are in good condition. The most common type of ceiling to be painted is made of gypsum board and already has a painted or stippled surface. Some surfaces will take paint better than others; all must be properly prepared before painting.

Other Materials

A combination of ceiling materials to provide variety in surfaces and shapes can be used within a space (Figure 14.34). Colorful fabric panels can be hung or draped to create interest and visual excitement and to provide directional emphasis. Assemblies are also available in a variety of materials as baffles that create an eggcrate look of various dimensions.

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Interior Components 15

This chapter will detail major components within interior spaces that interface with the architectural systems of floors, walls, and ceilings. Specifically, stairs, doors, and windows, since they provide functional and visual passage between spaces, will be discussed. The relationship of fireplaces to the floor, wall, and ceiling as integral components of an interior will also be discussed. The aesthetic considerations, design, methods of construction, and finishes of these components will be related to the interior systems and to the ways a designer incorporates them into those systems.

The styles and functional characteristics of typical forms of interior window treatments will also be detailed, and cabinetry will be discussed, since it falls between built-ins and furniture. Cabinetry functions, construction techniques, finishes, and aesthetic considerations will be looked at.

STAIRS

In addition to their functional use, stairs should reinforce the experience of visual movement through space and reflect the design character of the overall interior (Figure 15.1). Use, materials, and image determine whether stairs are designed for main or secondary purposes.

Safety factors and ease of ascent and descent are the governing functional factors of stair design. Building codes set minimum and maximum dimensions of stair widths, tread widths, riser heights, and handrail design. Stairways should be wide enough to accommodate a number of people passing (commercial stairs) or several people carrying items (residential and private stairs). Often, commercial buildings have two sets of stairs for each floor so that one can serve as an alternate escape route if the other becomes blocked during an emergency, such as a fire.

Ramps are sometimes used in place of stairs to accommodate people with physical disabilities, and are governed by the building codes.

Stair Construction and Design

Stairs are often designed as a part of the building's structural system and are incorporated into the framing. Although stairs can be designed in a variety of ways, six basic configurations, according to their runs and landings, predominate (Figure 15.2). These configurations are controlled by building codes for widths, required landings, locations, and ratios of riser-to-tread dimensions. Some stairs, such as the spiral, are not permitted as fire exits in commercial installations because it is difficult for a number of people to use them for quick evacuation in an emergency. For residential spaces, however, a spiral staircase is a convenient means of access between levels, using a minimal amount of floor space.

FIGURE 15.1 The stairway in this interior shopping mall is constructed with glass and steel, emphasizing its sleek design in harmony with the overall architectural structure.
Courtesy of Michiel Buijse

Codes specifically govern most proportions between risers and tread dimensions. At this writing, most commercial stairs are limited to riser heights of 7 inches (177 mm) or less, and treads are to be 11 inches (279 mm) or more in depth. Residential risers can usually be up to 8 inches (203 mm) high and treads a minimum of 9 inches (228 mm) deep. The total rise and runs of a stair are governed by these riser heights and tread depth variables, depending on the vertical distance between floor levels. Figure 15.3 shows the various parts and dimensions, as well as elements such as handrails and headroom clearance, required in most stair designs.

Wood is the predominant material for stairs in residences and small commercial buildings. Other materials for stairs include steel and concrete. Depending on use and visual appearance, stairs can be left exposed or covered with several nonslip coverings, such as carpet, vinyl, and rubber. In commercial installations, codes control the fire-resistive properties of these finishes.

DOORS

Doorways allow visual and physical movement between spaces. Doorways control access and affect the traffic patterns within the space. They provide security and help control noise levels both between spaces and from outside the building.

Doors are also selected for their visual compositions and character (Figure 15.4). Their type, size, and finish are important parts of a building's exterior and interior design elements. Doors give a sense of human scale to a building's form and can be simple or elaborate, traditional or contemporary.

Door Types

Door types are classified by the action or operation of the door's mechanism. These range from the simple swing door to special doors that fold and then recess into a wall pocket (Figure 15.5). Doors can be automatic, activated by sensors to detect people's approach, or operated by hand. They can be connected to fire detection systems so that they will close automatically to prevent the spread of flame and smoke.

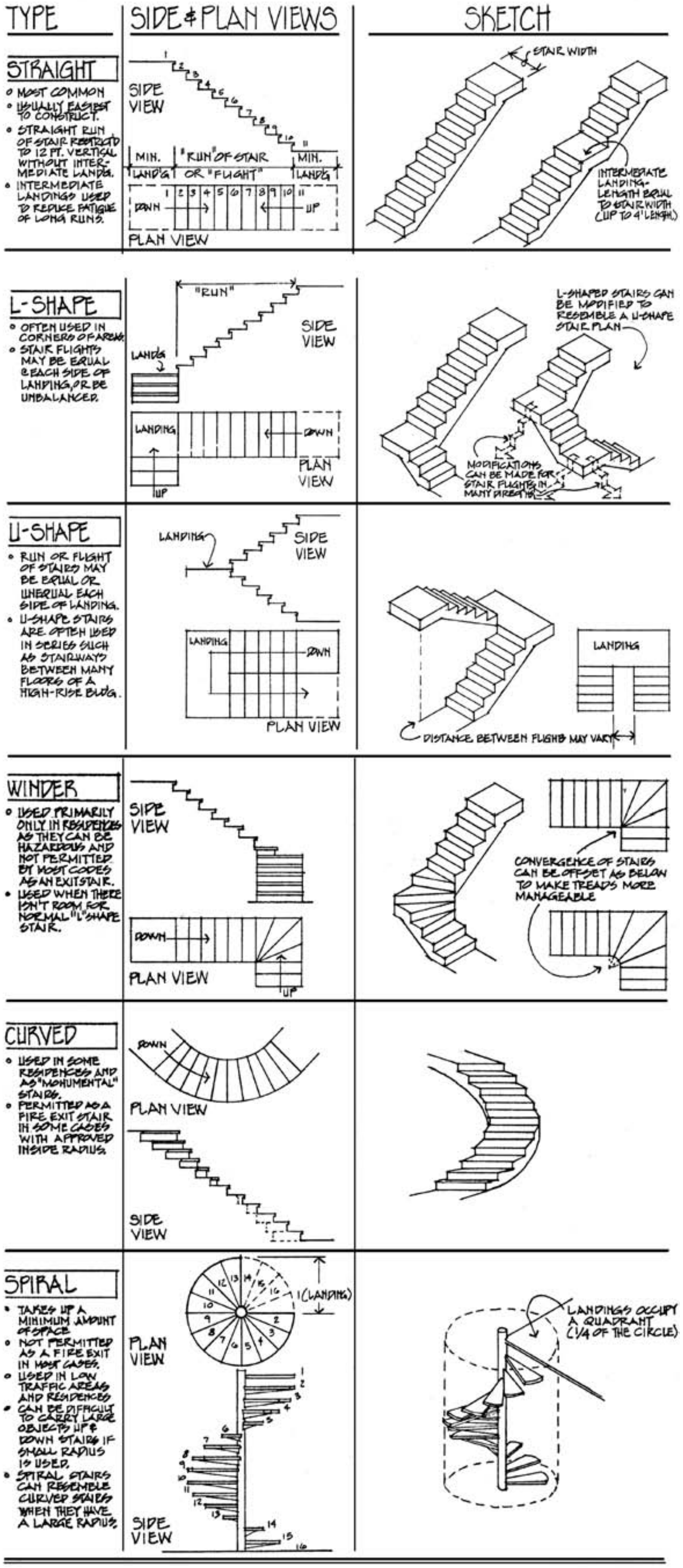


FIGURE 15.2 Six common types of stair design layouts

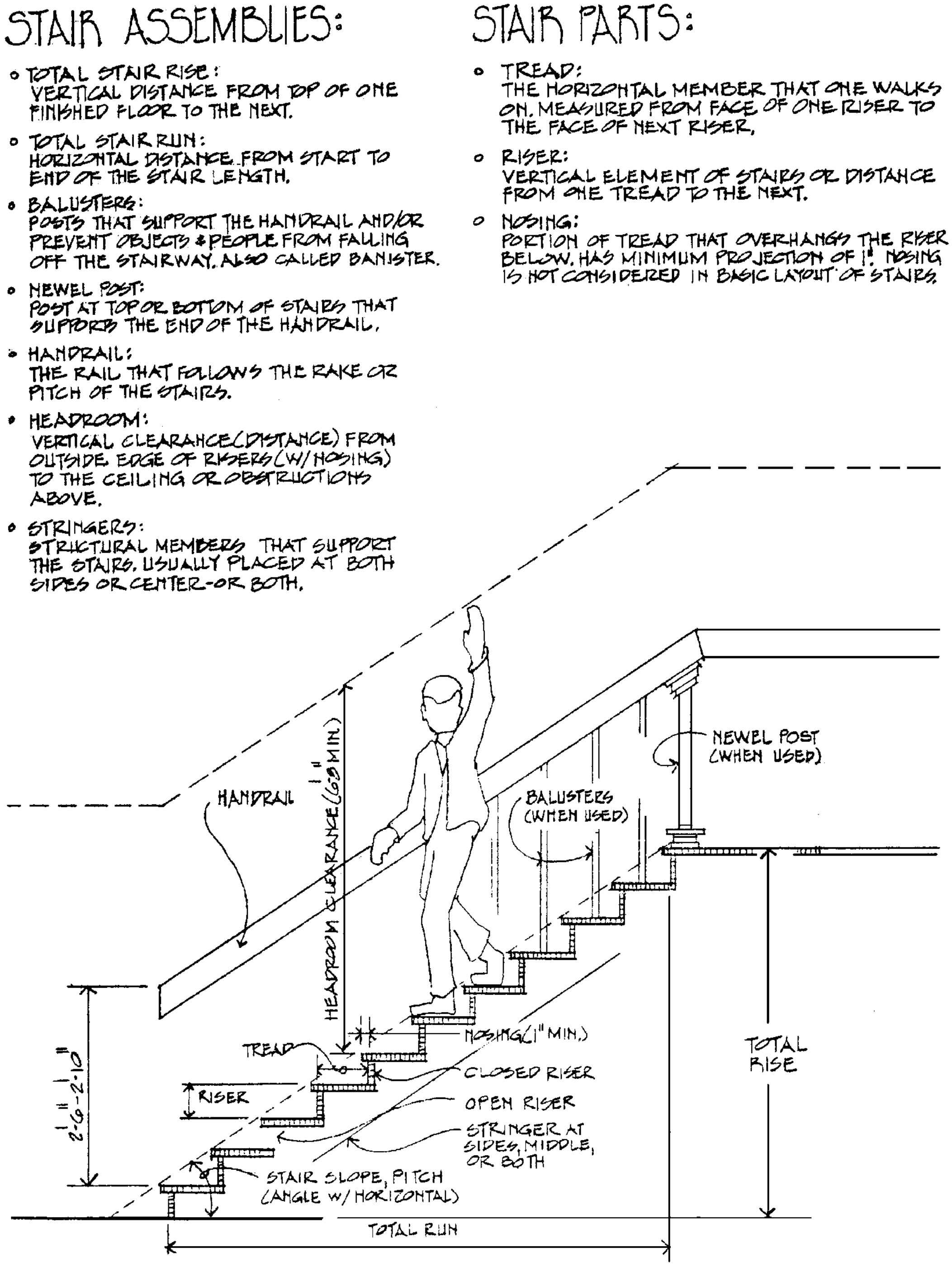


FIGURE 15.3 Parts and dimensions of common stair construction. The actual thickness and configuration of the framing members will vary according to the material used—wood, steel, concrete, or a combination of materials.

Doors in residences are generally 6 feet 8 inches (2.03 cm) in height and vary in width from 18 inches to 3 feet (45.72 to 91.44 cm). Most commercial doors are 7 or 8 feet (2.13 or 2.44 m) in height and range in width from 18 inches to 4 feet (45.7 to 121.9 cm). Door widths in buildings accessible to the physically disabled must comply with the dimensions and clearances required by various codes. (See Chapter 11 for these particulars.)

Swinging Doors

Swinging doors are the most common type, since they are easy to operate, have simple hardware, and are the most effective for providing weathertight and acoustical seals. However, space must be provided for the arc of the swing and an allowance for the door when it is open. Swinging doors are constructed in single or paired units, ranging in total width from 1 to 8 feet (304 to 2,438 mm).

FIGURE 15.4 The doors in this room are selected to match the other stained wood finishes and window mullions.
Courtesy of Andersen Windows

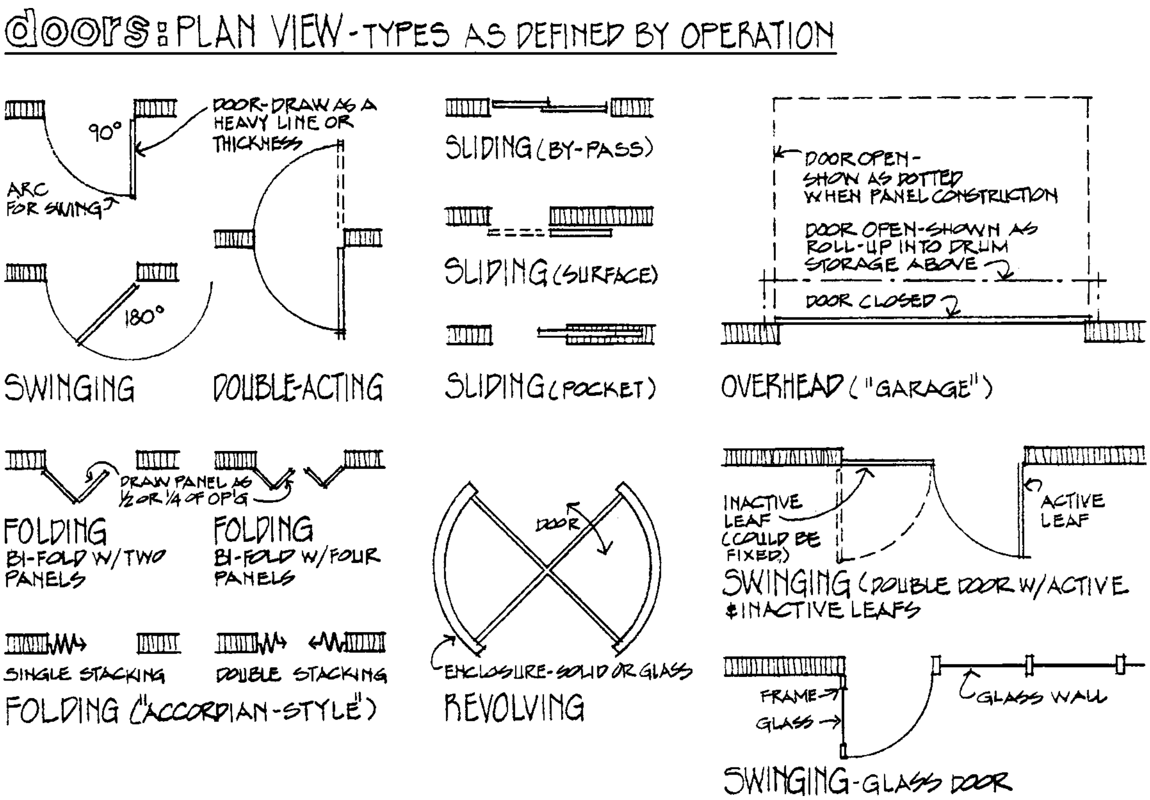


FIGURE 15.5 Various door types drawn in plan view

Sliding Doors

Sliding doors are supported by overhead and/or floor tracks and do not require usable floor space for the door arc. It takes more physical action to slide them back and forth in the track, but they are convenient when swinging doors cannot be used. Sliding doors are made as bypass, surface, and pocket units.

BYPASS DOORS Bypass doors are made as double, triple, and multiple panels that slide on adjacent tracks to bypass other door panels within a door frame. The typical double types are used primarily for interior closets or sliding glass doors. They restrict the open area to 50 percent, since both panels cannot be completely open at the same time.

SURFACE DOORS Surface doors are suspended from an overhead or floor track set in front of the surface of a wall rather than within the wall frame. They are used mostly for interior installations, although many farm and utilitarian buildings (such as garages) use them when weathertightness is not a major factor.

POCKET DOORS Pocket doors are suspended from an overhead track and slide into a recessed wall pocket when opened. Like a swinging door, this type provides a 100 percent opening and eliminates the space requirements for the door and its arc. Pocket doors are used in interiors where tight acoustical control is not a concern.

Folding Doors

Folding doors are used in interiors primarily for closets, storage rooms, and visual screening, that is, to seclude areas. They are manufactured with top and/or bottom tracks, as well as various hinging of the door panels. Bifold and accordion are two types of folding doors.

BIFOLD DOORS Bifold doors, used mostly for interior closets, provide almost a 100 percent opening. They can be constructed as hinged two-panel sections that open to one side of the door frame or as double configurations of four panels, opening to both sides of the frame. Although bifold doors project into a space when open, they do not require as much room as a swinging door.

ACCORDION DOORS Accordion doors are similar to bifold but have many narrow panels (alternately hinged and suspended from an overhead track). Accordion doors are used for large openings, particularly as dividers between rooms. When opened, they can be made to stack to either one or both sides. They can be custom-made from the typical 6 foot 8 inch (2,032 mm) height to as tall as 16 feet (4,876 mm).

Revolving Doors

Revolving doors, used in commercial installations, maintain a continuous weatherseal and prevent drafts into the building, cutting down on heat loss and gain. They can accommodate and quickly move large numbers of people. They are often flanked by swinging doors to accommodate physically disabled people and the transporting of bulky items.

Overhead Doors

Overhead doors roll up in hinged sections, forming a coil, or open as one piece, which requires special hardware. Although they are typically used as garage doors, overhead doors are also seen in commercial interiors, such as shopping malls and institutional spaces. Available in a great variety of widths and heights, they can be connected to smoke detectors and provide an automatic fire closing door.

Specialty Doors

Specialty doors combine the operating action of several door types, such as swinging and sliding. Sliding doors are also made as flexible units that move along a curved track and coil or spiral at the end in a tambour action.

Some doors have doors within them—for example, large sliding room dividers that have a swing door within. In fact, some of these doors, such as the ones that close retail store fronts, are more aptly termed gates because of their size and operation.

Door Styles and Construction

Although manufacturers produce many distinct door styles, such as French, Dutch, and louvered, in many materials, door styles are generally classified as flush or paneled (Figure 15.6), based on their appearance and construction. Flush-style doors are of solid-core or hollow-core construction. Paneled doors can be a flat panel (perhaps with glass inserts) or a combination of stiles and rails.

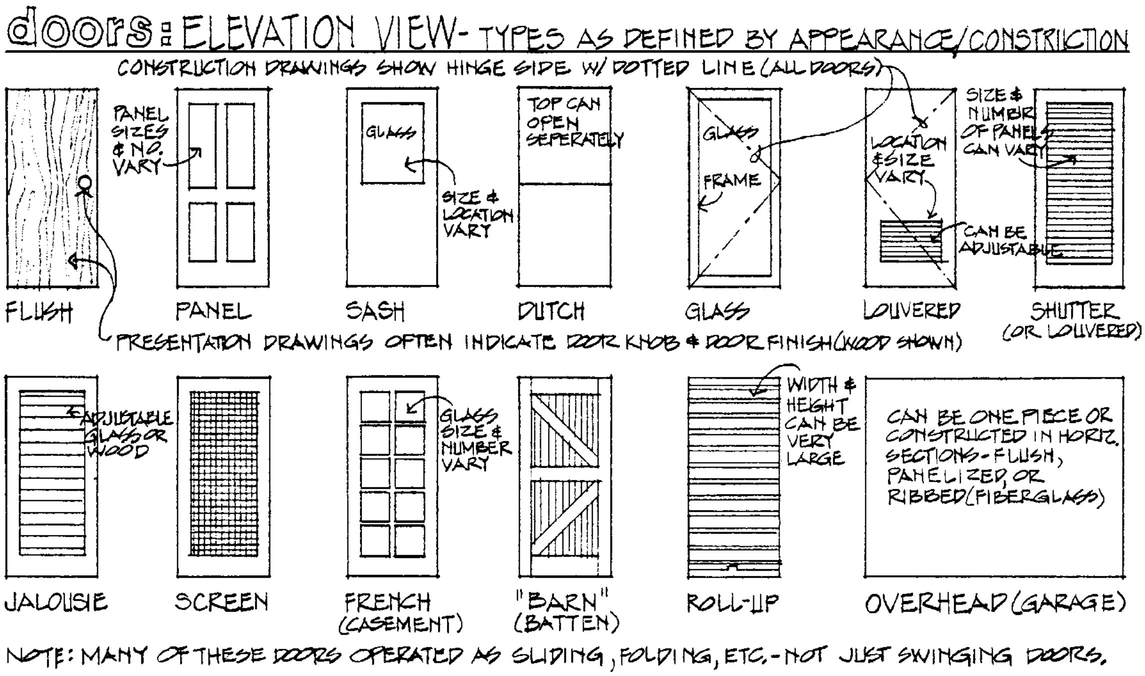


FIGURE 15.6 Door styles as drawn in elevation views. Styles are defined as to their appearance and construction features.

Solid-Core Doors

Solid-core doors were originally made of solid sections of lumber. Today they have solid cores of wood blocks, strips, and particleboard, covered with wood veneers, plastic laminates, or metal. Solid-core doors, used for both exteriors and interiors, offer fire protection, sound insulation, and weather resistance. They are generally heavier and more expensive than hollow-core doors. Solid-core doors can be flush style or can imitate panel construction.

Hollow-Core Doors

Hollow-core doors are not as strong and dense as solid-core doors and are primarily used for residential interiors. Their cores are made of a variety of materials, such as a cardboard honeycomb structure, plastic foams, and thin meshes. They are covered with wood veneers, plastic laminates, and metal. Their styles are similar to those of solid core, either flush or panel imitations.

Rail-and-Stile Doors

Panel doors were originally constructed of a wood framework of horizontal (rail) and vertical (stile) members. Today many are still made like this but use a combination of materials, such as plywood, solid wood, louvers, screen mesh, and glass sections. Both hardwoods and softwoods are used to make these doors.

Hollow Metal Doors

Hollow metal doors often imitate the styles of flush and paneled doors but are stronger and more durable. They are particularly effective for security, wet locations, and fire-resistive installations. Faces can be made of various metals or laminated with plastic in flush and panel styles. The interior construction is hollow or filled with insulation materials. Various louvers and glass sections can be installed in these doors.

Glass Doors

Glass doors can be made in a rail-and-stile construction using metal and wood members or can be solid glass sheets held with hinges and handles in an all-glass construction (Figure 15.7). All types of glass doors are required, by building codes, to be made with tempered or safety glass.

Door hardware consists of operating trim (knobs and levers), engaging mechanisms (locksets and latchsets), hinges, thresholds, and specialty items, such as door closers, kick plates, tracks, and weatherstripping. Most hardware is made of various plastics and metals in many finishes.

FIGURE 15.7 Large glass doors at the ends of this conference room glass wall match the frameless glass sections.
Courtesy of Kimball Office.

Door Frames and Hardware

Door frames (Figure 15.8) accommodate doors and their various hardware. The frame, consisting of a head (top), jamb (side), and sometimes a sill (bottom), also becomes the door "stop." Door frames, which are wood or metal, are manufactured as prehung (complete with door, frame, and hardware) or are handmade at the project. The frames are shimmed in the wall to permit proper alignment of the door and frame. Casing trim is then applied around the jambs and head of the door frame to conceal the shimming and fasteners.

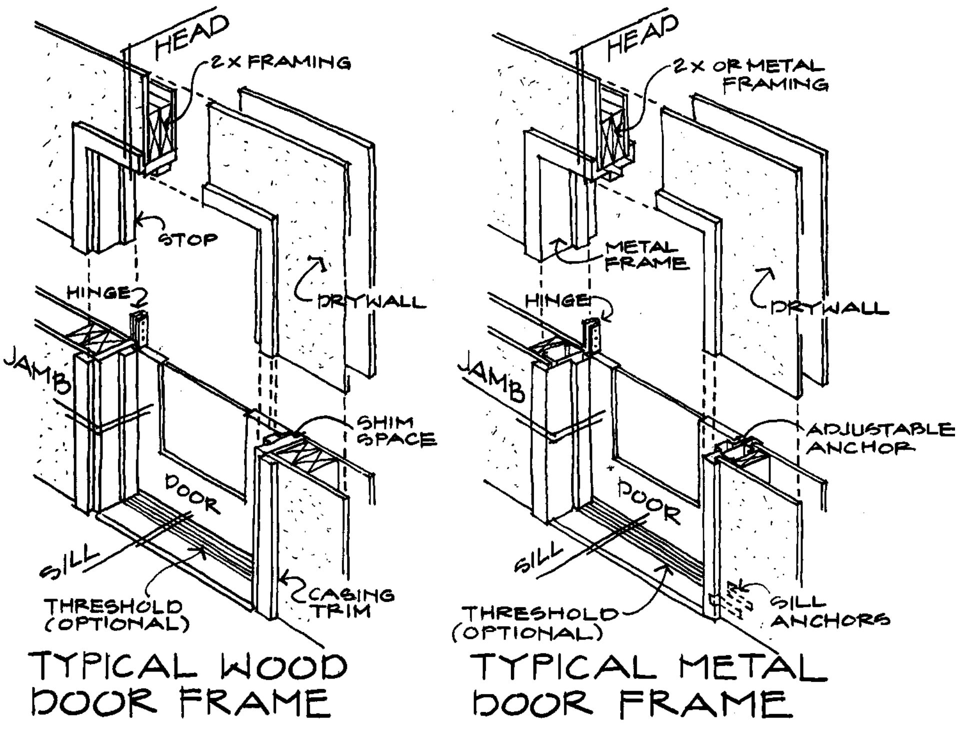


FIGURE 15.8 Door frames are made in wood or metal and have a variety of construction features and terminology.

WINDOWS

Windows and their treatments have a direct influence on the physical and aesthetic qualities of a space. Originally, windows were simple openings made in a wall to provide ventilation and light. Today, windows serve many additional functions, such as providing protection from the natural elements; providing privacy; and serving as a design element, adding visual excitement or view (Figure 15.9).

When selecting windows and treatments, the interior designer should consider a number of external factors, such as climate, building orientation, prevailing winds, views, and architectural style. Interior considerations include natural light availability and desirability, the view to the exterior, ventilation, safety factors, furniture arrangement, and available wall space. The way windows will affect solar gain, energy conservation, and privacy is also a major factor (Figure 15.10).

The selection of the glass for windows depends upon the location, use, and aesthetics of the window. The various types of glass are discussed in Chapter 13.

Today, many high-rise buildings are sealed environments; that is, they have nonoperable windows or no windows at all. Although this might be an energy-efficient method for the building design, it could be a potential health hazard, because research studies have shown that people need a balance of full-spectrum light and natural air.

Window Types

Windows serve as a complement to the interior and are selected for their function and style. They can serve to augment a historical style or add character to both the exterior and the interior. Windows are generally categorized

FIGURE 15.9 The windows in this room are designed to harmonize with the warm wood character of the space, and provide maximum views and ventilation.
Courtesy of Andersen Windows

FIGURE 15.10 These windows are designed to provide views; however, window treatments are needed for control of solar gain and privacy.
Courtesy of Kohler Co.

as either fixed or operable (Figure 15.11). Fire safety concerns (access and escape), ventilation, and maintenance must be considered when deciding between these two types.

Fixed Windows

Fixed windows do not open, their purpose being to admit light, serve as an acoustical or physical barrier, or provide a view. They are used when opening capability is not required, such as in store windows or sealed, air-conditioned spaces. Fixed windows, available in a number of sizes and configurations, can be placed with operable units. Round porthole windows and hexagonal, elliptic, and half-round shapes are popular variations that offer a contrast or can reinforce the lines of the architecture.

Operable Windows

Like fixed windows, operable windows are used to provide a view. Operable windows can also provide physical access, ventilation, and a means of escape in an emergency. They are also positioned where acoustical privacy is necessary, such as at a cashier's position in an office, to let items or communication pass from one area to another. Operable windows can be categorized as swinging, sliding, and pivotal. Swinging windows include casement, awning, hopper, and jalousie. Sliding windows include double-hung and horizontal sliders.

CASEMENT WINDOWS Casement windows swing outward or inward like small doors. They are good for ventilation and can be easily opened with a crank, push bar, or handle, but they can create a safety hazard when projected. Therefore, the designer should be sure that casement windows will not interfere with walkways and furniture.

AWNING WINDOWS Awning windows are hinged at the top and can swing inward or outward. They are opened with a crank or push bar. Good ventilators, awning windows offer protection from rain when they swing out. They are manufactured as either single units or multiple units stacked within a single frame. Awning windows, like casements, should be located so that they do not interfere with outdoor pedestrian traffic or indoor furniture arrangement or draperies.

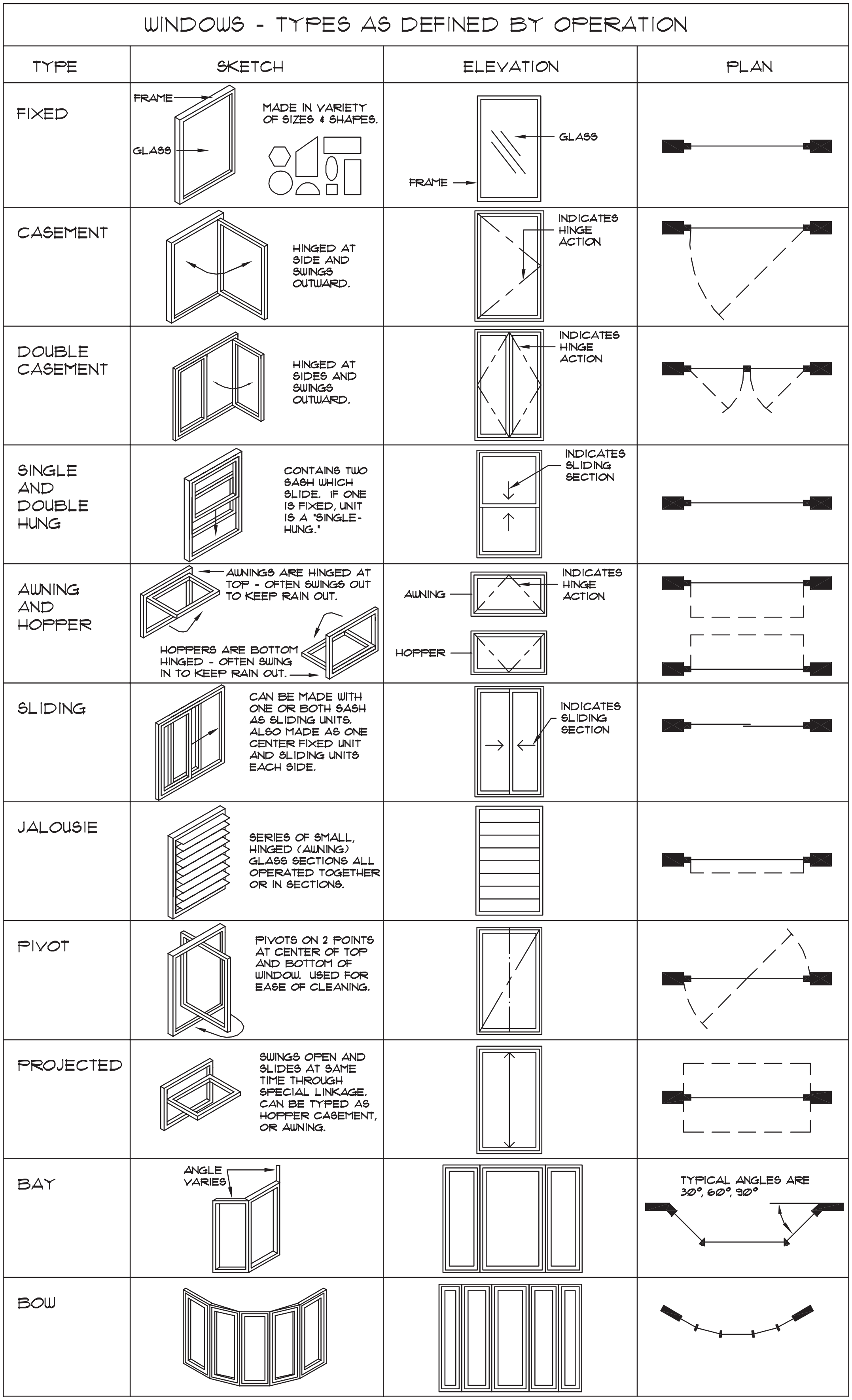


FIGURE 15.11 Fixed and operable windows, as seen in elevation and plan views

HOPPER WINDOWS Hopper windows are similar to awning windows but are hinged at the bottom and swing inward. These windows, designed for placement low on a wall or in a basement, are good for air circulation.

JALOUSIE WINDOWS Jalousie windows consist of a series of horizontal slats (3 to 8 inches, or 76 to 203 mm, wide) of glass, plastic, or wood that operate in unison. Because of their narrow size, they do not present a safety hazard when open. Jalousie windows are a good choice when ventilation is a major concern, since the slats can be adjusted to control the amount of ventilation desired. However, they are somewhat difficult to clean.

DOUBLE-HUNG WINDOWS Double-hung windows are the most common type of vertical sliding windows. These windows have two glass areas, called sashes, that slide vertically up or down for ventilation. Double-hung windows are generally taller than they are wide and seldom warp or sag. They do not project into the interior space, so they do not interfere with window treatments, furniture, or traffic.

HORIZONTAL SLIDING WINDOWS Horizontal sliding windows slide on top and bottom tracks mounted inside the frame. These windows come in a variety of sizes and consist of two or more sashes, usually only one of which is movable. Like double-hung windows, horizontal sliders have no projecting parts to interfere with window coverings, furniture, or traffic.

PIVOTAL WINDOWS Pivotal windows are similar to casement windows, but instead of side hinges they have a top and bottom pivot placed near the center of the window. The glass area pivots open to allow for ventilation. These are easy to clean and maintain, which is particularly important when the windows are located several floors above the ground.

Combination Windows

Any of the windows described can be combined to provide both operable and fixed elements. For example, sliding or swinging units can be placed on either side of fixed glass to form a three-section window. Awning windows are usually placed above or below fixed glass units to provide both ventilation and an unobstructed view.

Bay and bow windows are specific styles of combination windows. Bay windows project at angles from a building structure (Figure 15.12). The most common type consists of two double-hung or casement windows with a fixed section in the center. Side units are generally placed at 45° or 50° angles to the exterior wall. Bow windows form an arc projecting out from the exterior wall. They generally consist of fixed glass and operable windows and range from four to seven units.

Skylights and Clerestory Windows

Skylights and clerestory windows are used to admit light into interior spaces that receive little or no natural light. Mounted in the roof, skylights are made of glass or plastic. Clerestory windows are available in a variety of sizes and are placed high on a wall. Clerestory windows are either custom-made or consist of a series of standard-size windows. Both skylights and clerestories can be fixed or operable, insulated with double layers, and tinted.

Window Construction

Windows are constructed with a frame, which includes the head, jamb, and sill; a sash (glass area); and casing (Figure 15.13). The sash area can include one or more sections held together by a top and bottom rail and side stiles. Sashes can be divided into several smaller rectangular areas by bars called muntins or mullions.

Window frames are made of wood, aluminum, steel, or plastic. Although wood is a good insulator, it can expand and contract with different climate and moisture conditions, causing the frame to stick and create gaps. Wood needs to have protective coatings, such as paint, sealers, or vinyl, applied.

Aluminum window frames are generally less expensive than wood and have a maintenance-free coating applied to them. However, aluminum is not a good insulator; condensation can form when exterior temperatures differ greatly from interior temperatures. If that is likely, a thermal break of rubber or vinyl is installed. Vinyl frames are similar to metal frames but are better insulators.

FIGURE 15.12 This bay window expands the space within the interior and creates a dominant element.
Photographer: Erik Snyder

Metal-clad wood frames are covered with aluminum either on both the interior and the exterior sides or on the exterior side only. If the frame is on the exterior side only, the interior side might be either wood or vinyl finish. Metal-clad wood frames offer the insulating value of wood and the low maintenance of aluminum.

On the interior of a space, the window generally consists of a casing and trim, which are used to conceal and finish gaps between the rough opening and the window unit. A variety of interior trims can contribute to the overall design and character of a space (Figure 15.14).

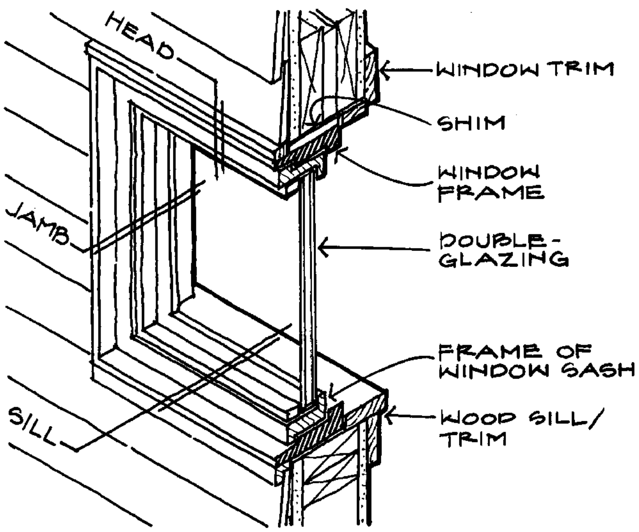


FIGURE 15.13 Typical window frame and its parts. These can be constructed in wood, metal, plastic, or a combination of materials.

FIGURE 15.14 The window and door trim in this restaurant are traditional in style and color to harmonize with the other materials and décor.
© Ernst Wrba / age fotostock.

INTERIOR WINDOW TREATMENTS

A large variety of options are available for interior window treatments. The first question is: Why cover windows? The decision to cover a window must be based on several considerations: function, aesthetics of the interior, the view, code requirements, and cost.

Functional Considerations

The functional variables in selecting window treatments include the need for privacy, glare control, sound absorption, building code requirements, energy conservation, and light transmission and reflectance. Daytime and nighttime privacy can be important to personal safety and comfort. Privacy can be achieved with a sheer, semi-sheer, or casement curtain, drapery, or shade. However, translucent material will not provide complete privacy and should be fully lined with an opaque material. Vertical or horizontal blinds or shutters can also be adjusted to partially restrict a view.

Window coverings can be used to reduce glare, while still allowing natural light to filter through. This is especially important in offices where glare on the computer or video screens must be eliminated or minimized.

Window coverings can help to absorb sound, but the sound absorption qualities of drapery fabric decrease as fabric openness increases. If sound absorption is a major concern, a closely woven fabric or compactly constructed material must be used.

Window coverings can reduce energy consumption. In winter, heat loss occurs when heated interior air rises and travels toward a cold surface, generally window glass. The heated air is then cooled and circulates within the interior space, which might cause the occupants to feel a draft. Window coverings can be used to prevent warm air from coming in contact with the cold glass. Window treatments insulate best if they are heavy and opaque: The most effective treatments to prevent heat loss include insulated fabric shades that are sealed on the top, bottom, and sides. Insulated shutters or heavily lined draperies that have sealed top treatments, reach to the floor, and are securely attached to the walls are also good choices.

During summer months, excessive heat gain within an interior is not only uncomfortable but can cause damage to or fading of interior furnishings. To prevent excessive heat gain, the most effective interior treatments are those that reflect a large percentage of sunlight back through the glass area. Either soft or hard window treatments can reflect most of the sunlight if they have a metallic or a light-colored backing.

All applicable building codes or fire codes must be considered when specifying window treatments.

Aesthetic Factors

The aesthetic choices available for window coverings depend on individual needs or preferences. However, window coverings and styles should not be selected on the basis of personal preference alone. The principles and elements of good design, such as proportion, scale, color, pattern, balance, rhythm, emphasis, and harmony, must be considered to ensure that window treatments complement and support the interior design of a space.

Structural factors or visual defects may determine the kind of window treatments selected. The structure may require two windows to be covered with a single treatment, for instance, or there may be a need to alter the visual dimensions of a window through the treatment, to bring it into harmony with the rest of the space.

Window treatments are selected not only for their aesthetic appeal but also to blend with and support the design and architectural style. Generally, window treatments should also harmonize with the exterior style and not distract from the architectural character. Windows can either blend in with wall treatments and become part of the background or they can contrast with the background and become a focal point. Another consideration is whether the space is to be of contemporary or historical design, which the window treatments must follow.

Cost Factors

Before the final selection of window treatments, various cost-related factors must be taken into account. The initial material, labor, hardware, and accessories as well as life-cycle costs (relating to the replacement and maintenance of a system over its expected life) should be considered.

Types of Window Treatments

Window treatments can be categorized as soft, hard, and top. Soft window treatments include draperies, curtains, and shades (Figure 15.15) and generally are made of soft fabrics.

Hard window coverings include vertical and horizontal blinds, shutters, and screens made of wood, metal, or plastic, either alone or in combination with other materials. Top treatments can be made of either soft or hard materials and used alone at the top of a window or in combination with the other types of window coverings.

Soft Window Treatments

Fabric at windows can visually soften the hard lines of the interior structure. Window fabrics can also screen glare, darken a room, absorb sound, add insulation, provide privacy, and add visual stimulation through color, texture,

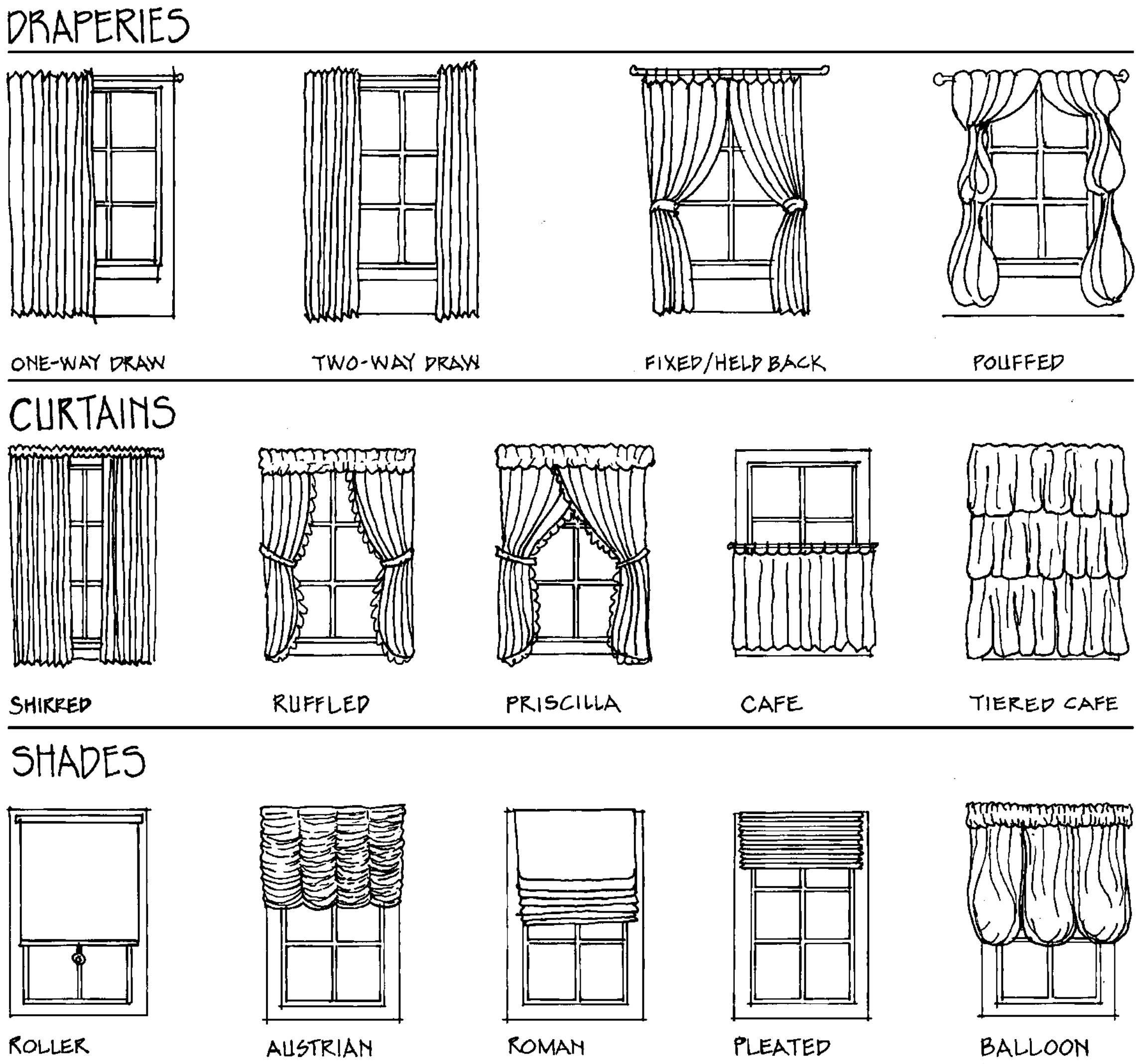


FIGURE 15.15 Soft window treatments are generally composed of draperies, curtains, and shades.

or pattern. Fabric window treatments can also augment a historical period, carry out a decorative scheme, or complement an architectural style. Many combinations of styles and fabrics can be used at the window to make it a creative design element.

DRAPERIES Draperies are fabric panels that are generally pleated and hung on a rod. In most instances, they are installed at the ceiling or just above the top of the window frame. They can be made of a heavy opaque, casement (semi-opaque), or translucent fabric. The many types of drapery pleats include pinch, French, and spring-rod pleats. Draperies are mounted on rods and can be drawn across a complete glass area, pulled to one side, or hung in a stationary position at each side. Draperies can be full and hang straight or be tied back. They can extend slightly below the bottom of the window frame or to the floor.

CURTAINS Curtains are soft window treatments that generally are less formal than draperies. Curtains are either stationary or hand-operable and can be hung inside a window frame or outside to unify a group of windows. Popular styles include shirred, ruffled, and café curtains in unlimited variations and combinations.

Shirred. Shirred curtains are gathered directly on rods and can hang straight down or be secured to another rod at the bottom. These treatments are sometimes referred to as sash curtains, since they are stretched across the sash of a window.

Ruffled. Ruffled curtains feature ruffles on the hem, in the middle (if to be pulled apart), and sometimes on the sides. They generally have a ruffled valance and tiebacks. The priscilla curtain is a ruffled curtain consisting of two panels that either meet in the center or crisscross, with one panel in front of the other.

Café. Café curtains, originally used in French cafés, covered only the bottom half of the window so that patrons seated by the windows would have some privacy without the natural light being blocked out. Café curtains are now made in tiers and cover either the entire window or only the bottom half, with or without a valance at the top. The tops of the curtains can be looped, shirred, scalloped, or pleated.

WINDOW SHADES The primary purpose of window shades is to control light by filtering or blocking it completely. Window shades come in a variety of styles and are made of fabric, vinyl, bamboo, or wooden slats. The main types are roller shades, Austrian shades, Roman shades, pleated shades, and balloon (pouf or cloud) shades. Some shades, such as roller and pleated, can block or filter the light and therefore are sometimes installed with decorative curtains to protect the curtains from fading. Most shades can be mounted either inside or outside the window frame.

Roller Shades. Roller shades consist of a strip of vinyl or fabric hung on a roller that rolls up when a spring mechanism is triggered. Most of these shades are pulled from the top down to cover part or all of a window sash; however, some can be operated from the bottom and pulled up. These inverted shades are held in place with a latch or a spring-loaded roller. Roller shades are available in translucent, opaque, or blackout material.

Austrian Shades. Austrian shades are pulled up by cords. These shades are made of sheer or semi-sheer fabric sewn into soft horizontal scallops and gathered vertically. They are more formal in character than Roman shades and can be used in residences or commercial structures, such as offices, theaters, or restaurants.

Roman Shades. Roman shades operate like Austrian shades but fold into horizontal pleats when raised and hang flat when closed. Roman shades can be made of fabric or a woven wood (a combination of wooden slats and textile yarns), the latter giving them texture in a natural color. Roman shades are energy efficient if they are made of a moisture-barrier material, interlined with an insulative material, and have a heavy lining.

Pleated Shades. Pleated shades are factory made and when folded resemble an accordion's action. These shades require very little stacking space when raised. Pleated shades are constructed of semi-sheer or polyester fabric in plain or printed patterns. They can be transparent, translucent, or opaque, depending on the compactness of their construction and the application of back coatings. A metallic coating is sometimes applied for better insulation and to reduce static electricity, lessening the attraction of dust.

Honeycomb-Pleated Shades. Honeycomb-pleated shades are generally constructed of spun-bonded polyester fabrics that are permanently pleated and put together as two shades to create an insulating layer of air (Figure 15.16). The exterior face is white to provide heat reflection and to create a uniform appearance from the exterior. The

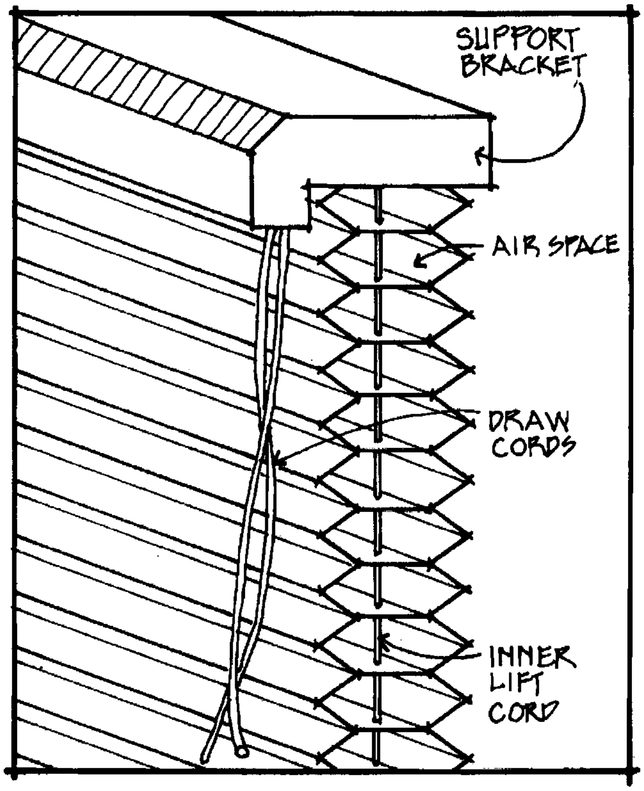


FIGURE 15.16 This honeycomb shade requires little stacking space when raised. It provides an insulative value from the air captured within the folds.

honeycomb shade has pleats smaller than those in the accordion-pleated shade and requires even less stack-up space: A 96-inch-long (2,438-mm) honeycomb shade requires only 31 inches (79 mm) of stack-up space.

Balloon Shades. Balloon shades are also referred to as pouf or cloud shades because of the balloon-like poufs they form when raised. Balloon shades are pulled up with vertical cords, like Austrian shades. The top of the shade may be shirred or pleated, with the shade tailored (flat) or full (with ruffles and trimmings).

Hard Window Treatments

New materials, patterns, and styles have made hard window treatments very popular. Hard materials generally require little cleaning and are very durable. They offer privacy, light, and ventilation control. They can be installed inside a window frame to produce a clean and contemporary appearance, or combined with soft window treatments to produce a more traditional or formal character. Generally, hard window treatments produce a simple yet versatile background that will coordinate with many different styles of furnishings. Hard window treatments include horizontal and vertical blinds, shutters, and screens (Figure 15.17).

HORIZONTAL BLINDS Horizontal blinds consist of a series of horizontal slats, or louvers, held together by fabric tape or cords and operated by pull cords. The slats were historically made of wood and then of aluminum, both coated with a cream-colored enamel, like the venetian blinds used in the 1940s and 1950s. Today, horizontal blinds have narrower slats and are made of wood, molded polymer vinyl, and fashion-colored aluminum. These miniblinds have 1-inch-wide (25-mm) slats; micro-miniblinds have ½-inch-wide (12-mm) slats. The fabric tape and operating cords have now been replaced with tough nylon cords in matching colors and with plastic control wands of various lengths. These blinds can be tilted to control glare, airflow, and privacy. They can be installed inside or outside a window or door frame, and can be used alone for a clean, contemporary character, as an undertreatment with draperies, or with a top treatment. They require very little stack-up space and are available in a wide variety of colors, patterns, and shapes. Custom graphics can even be incorporated into their design. Some slat blinds are designed to fit between double-glass window panes for better energy conservation and dust control (see Figure 15.18).

VERTICAL BLINDS Vertical blinds consist of a series of vertical slats made of plastic, metal, or wood. The slats can have fabric or wallpaper inserts to coordinate with the design of a space. The slats are suspended vertically from the ceiling or wall on a traversing or nontraversing track. They can be held in place by a bottom track if necessary. If they are on a traversing rod, they can have a one-way or a two-way draw. Vertical blinds can be rotated for

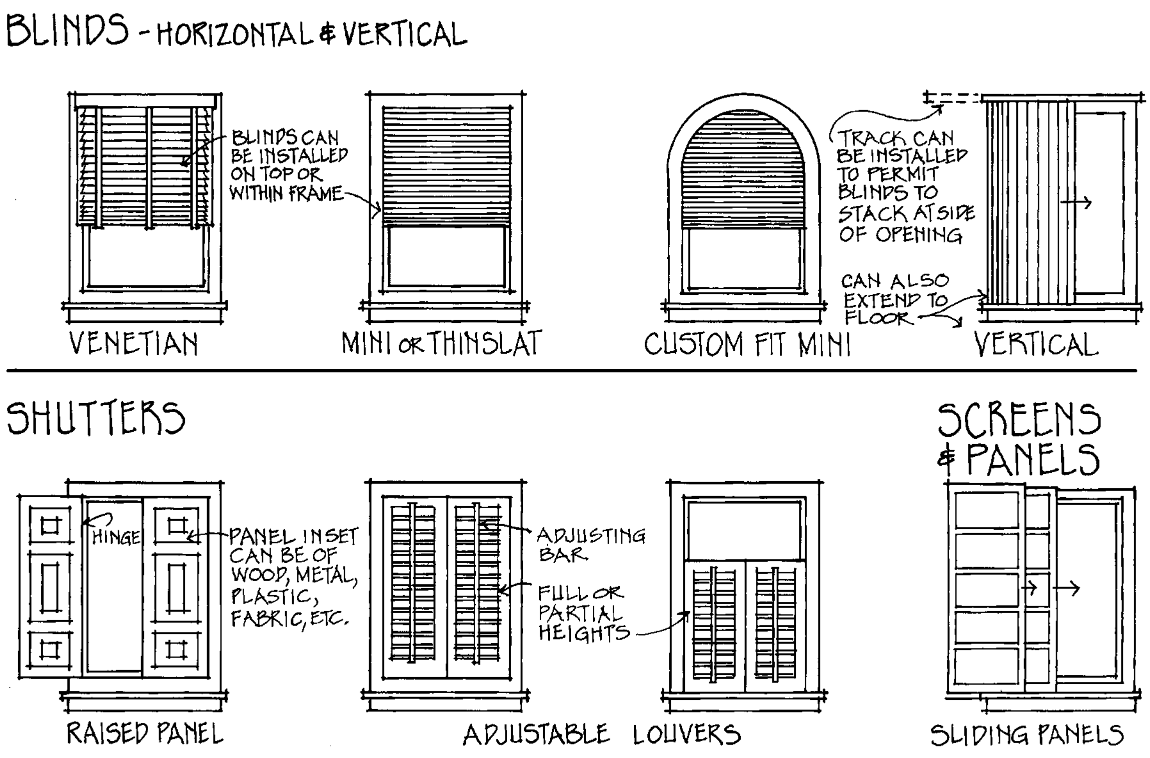


FIGURE 15.17 Hard window treatments are composed of blinds, shutters, and screens.

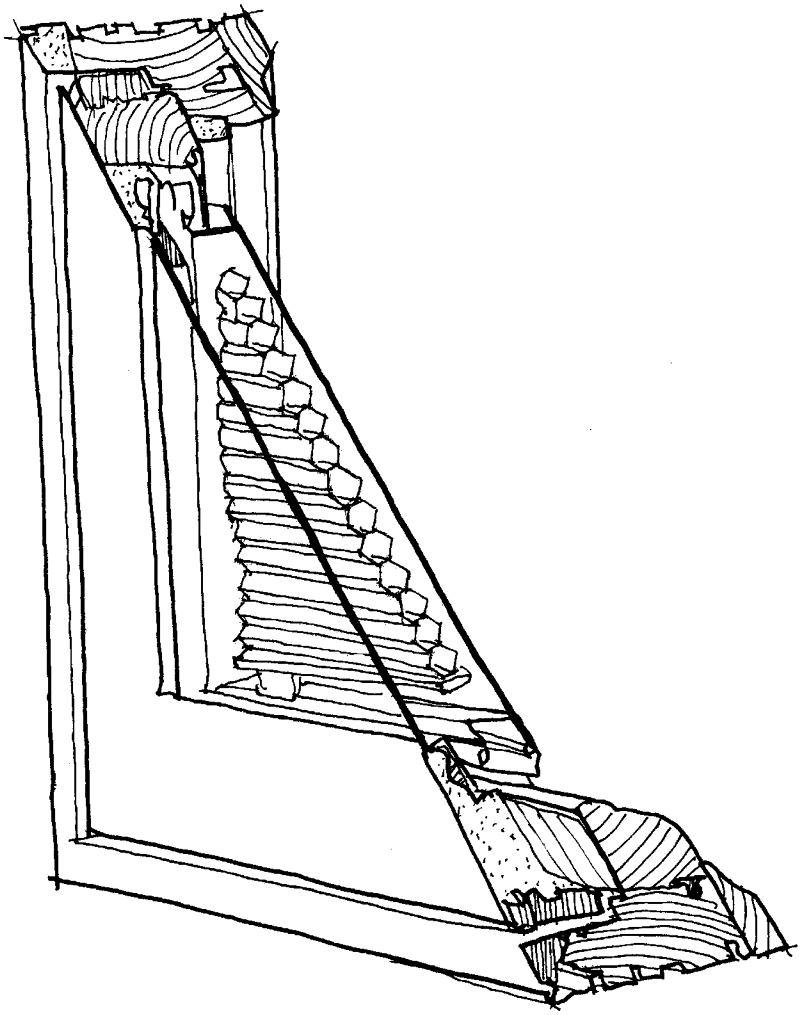


FIGURE 15.18 Pella makes a removable "slimshade" as horizontal slats or cellular accordion, which is sandwiched and protected between two glass panels.

increased outward views and for inward light transmission, or can be closed for complete privacy. They can be used to enhance the height of a room and made to fit odd-shaped openings. They gather less dust than horizontal blinds.

SHUTTERS Shutters are perhaps the oldest of the hard window treatments and are available in both contemporary and traditional styles. Shutters are made of rigid panel frames, usually of wood, attached with hinges to open and close like small doors, thus allowing more light and ventilation to be admitted. The most common panel insert is the adjustable louver with a center bar to lower or raise the louvers. The width of the louvers varies from one to three inches (25 to 76 mm).

Other panel inserts include fixed slats or raised panels. Raised panel shutters consist of solid wood panels raised in the center. These shutters are more formal in character and can be stained or painted. Also, fabric inserts can be installed in a shutter frame to coordinate the design throughout an interior. Shutters can be used in combination with other window treatments, such as curtains, blinds, shades, or top treatments.

SCREENS AND PANELS Screens and panels can be sliding or folding, either freestanding or installed on the outside frame of windows. These screens and panels can create a spectacular focal point within a space as well as mask views, filter light, or diffuse ventilation. They are generally constructed with a wood frame and can have inserts of lattice work, fabric, carved or painted wood, or a translucent backing. Japanese *shoji* screens and Chinese fretwork panels are considered classics and are used in contemporary, traditional, or Oriental interiors. Shoji screens are traditionally made with glazed mulberry or rice paper and set into a wooden frame of symmetrical panes. Since shoji screens are translucent, they do not provide complete privacy, but allow diffused light to enter a space. They can be installed in front of windows as sliding panels or can be used as freestanding screens or as wall-divider units.

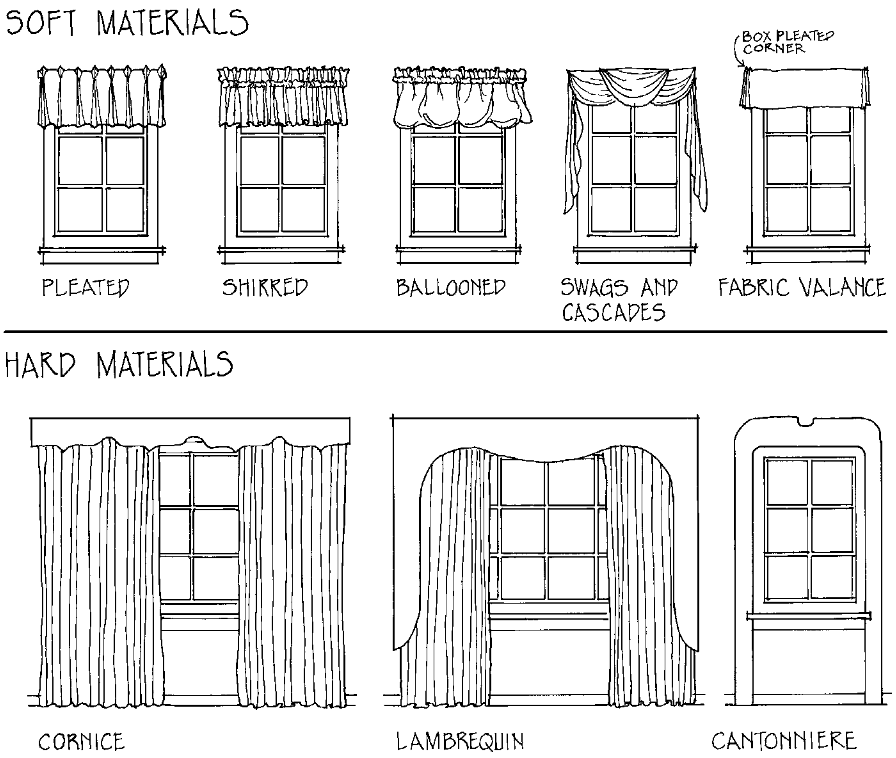


FIGURE 15.19 Typical top treatments for windows

Top Treatments

Top treatments are installed at the head of a window to add a finished appearance to a space, as well as to conceal the top of a window covering and its hardware. Top treatments can be designed according to architectural detail within a space or inspired by furnishings. Top treatments can be made of soft or hard materials (Figure 15.19).

Fabric can be an effective material for overhead treatments and can unify a space by carrying the eye along the top of the walls and around the perimeter of a space. Top treatments made of fabric are called valances; these may be pleated, ballooned, shirred, or scalloped. Valances are generally constructed in the same manner as draperies or curtains and, in essence, become short window coverings. They can be used alone as a window treatment or in combination with soft or hard coverings. Some valances, such as swags, jabots, or cascades, are very complex and decorative. Swagged valances are created by draping fabric horizontally over the top of the drapery or rod. Jabots and cascades are side treatments and generally are used in conjunction with a swag.

Cornices, lambrequins, and cantonnieres are rigid treatments generally constructed of wood or metal. They can be covered with fabric, painted, or stained. Cornices are either straight or shaped and generally project four to six inches (101 to 152 mm) from the wall. Cornices are typically mounted at or near the ceiling and extend down far enough to cover the drapery heading and hardware. A lambrequin is similar to a cornice, with both sides extended to or near the floor. Cantonnieres are fitted flush to the wall, exposing the frame of the window, and have shaped overhead panels and sides extending to the floor. Most top treatments are energy efficient, since they help to control the airflow around the window.

CABINETRY

Cabinets are components that can be built in or attached to a wall, or can be freestanding on the floor surface. They provide a multitude of functions, ranging from built-in storage to custom seating forms (Figure 15.20).

Cabinets are also called cabinetry or casework, although the latter term primarily refers to units premade at a plant, shipped to a project, and installed by carpenters. These units might be freestanding or be secured to a wall or floor and trimmed out with wood moldings.

Custom cabinetry is designed by interior designers and architects; it is sometimes constructed at the job site but preferably is built in a woodworking shop. The latter types are then taken to the site for final assembly and trim out. In custom work, the designer draws the design and specifies the dimensions and materials. A woodworking shop

FIGURE 15.20 A variety of custom wood millwork and standard cabinetry is used in this kitchen for storage and the matching refrigerator front panel.
Courtesy of National Kitchen & Bath Association

then produces detailed shop drawings that precisely correspond to the construction particulars. After the designer approves the shop drawings, construction is begun on the unit, and it is delivered to the job site for installation.

Cabinet Specifications

Cabinets can be constructed in a variety of ways, ranging from the simple and economical to the elaborate and expensive. Specifications and standards have been set by several agencies to rate cabinet materials and construction in certain categories. The Architectural Woodwork Institute (AWI) categorizes cabinets as economy, custom, and premium. The AWI publishes drawings and details that are characteristic of each type and specifies acceptable wood grades, finishes, joints, and hardware.

Cabinet Construction

When designing or selecting cabinetry, a designer needs an understanding of the way the materials and the construction details are combined to produce well-made cabinetry. Many of these materials and techniques (particularly the ones involving the joints) are similar to those used in furniture making.

Cabinets are generally classified as wall or base cabinets, depending on their placement. Standard wall cabinets are typically made to a depth of 12 inches (304 mm) and to heights of 12 to 48 inches (304 to 1,219 mm). Their width ranges in 3-inch (76-mm) increments. Base units are made in many sizes; the most common depth ranges from 20 inches (vanity) to 24 inches (508 to 609 mm) (standard). Heights generally are 30 and 36 inches (762 and 914 mm) for casework, with custom units either the same dimensions or varying 1 to 2 inches (25 to 50 mm). Widths are produced in casework in 3-inch (76-mm) increments; custom casework can be any dimensions. There are many special types of premanufactured cabinet units for sinks, ovens, computers, sewing centers, laundry rooms, and office systems.

The surfaces of cabinets are classified as exposed, semi-exposed, and concealed. The cabinet material and finish depend on which classification they correspond to. The exposed sections are those visible when all drawers and

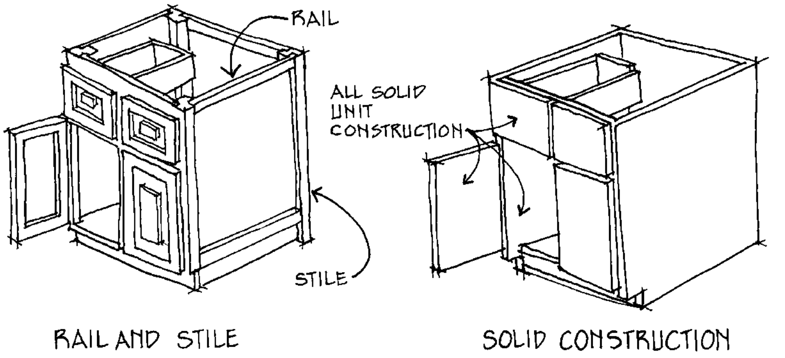


FIGURE 15.21 Cabinets are made as rail-and-stile or solid construction assemblies.

doors are closed. Semi-exposed sections are interior faces of doors, drawer sides, shelves, and other surfaces exposed when the unit is opened. Concealed elements, such as the underside of drawers and members used for construction, are normally not visible.

Cabinet Frames

Cabinets are made as rail-and-stile framed units or as solid-piece panel construction (no frames), as seen in Figure 15.21. Materials used for cabinet frames vary as much as the styles and sizes. Most cabinet frames are constructed of hardwoods, particleboard, and plywood. Softwoods are generally used only for minor blocking and concealed pieces. Surfaces can be covered with paint, plastic laminates, metal, vinyl, or exposed woods that are stained and sealed.

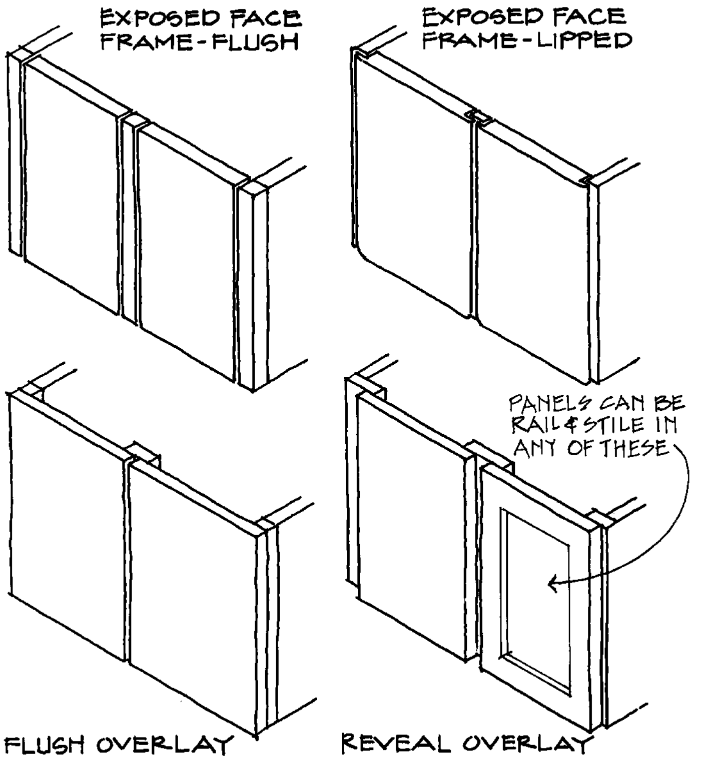
Joints for Cabinets

Joints made in cabinetry construction are similar to the basic wood joints discussed in Chapter 13. However, many more types of joints—some highly specialized—are used in cabinet and furniture construction. Joints are of particular concern both for strength and for visual appearance in fine cabinetry and furniture, since they can be exposed to let the beauty of both the connection and the wood grain be appreciated.

Doors and Drawers

Doors and drawers are designed and constructed in two basic ways: exposed frame and flush frame. These types refer to the way the door or drawer meets the face of the frame, exposing or hiding it by various methods (Figure 15.22).

FIGURE 15.22 Doors and drawers can meet the cabinet frame in a variety of ways that will create different visual and functional styles.



The exposed frame places the door and drawer flush with the face of the frame. Such frames require close tolerances, since space for operating must be left between the panel and the frame. The popular flush overlay frame is often referred to as having a contemporary or European look. This type conceals the frame below in varying degrees, partially revealing the frame behind or hiding it completely—showing only the doors and drawer fronts. This method allows for matching wood grain patterns on the fronts or for highlighting the clean, simple lines of the unit. Plastic laminates can be applied, becoming the dominant color and texture, since the frame is hidden in the "cracks." However, hardware pulls or special latches might be required when the panels are so close that there is no room for recessed finger pulls.

The type of construction and the details of doors and drawers depend on the function of the cabinet, the visual impression, and the durability required. Thicknesses and materials vary according to the style, weight, and size of the panels. Panels are wood, plywood, particleboard, plastic, glass, and metal. Faces can be flush, paneled, or grooved into different shapes. Inserts of routed finger pulls and other additions can be made to the doors and drawers. Woods are finished with stains and sealers; other materials are covered with plastic laminates or paints.

Shelves

Shelves are made of materials similar to those used for the doors and drawers. They can be fixed or movable, depending on the type of supports. Those supports include clips, pegs, grooves, and standards. Standards are metal strips specially punched to hold clips or brackets that are inserted at varying height positions.

Shelves are generally ¾ inch (19 mm) thick and span approximately 36 (914 mm) inches. Greater distances usually require intermediate supports, thicker sections, or supporting edges of metal.

Cabinet Hardware

The hinges, pulls, handles, and other mechanisms used to open, close, and operate movable cabinetry are called hardware. They are produced in a variety of styles and materials to fulfill different functions (Figure 15.23).

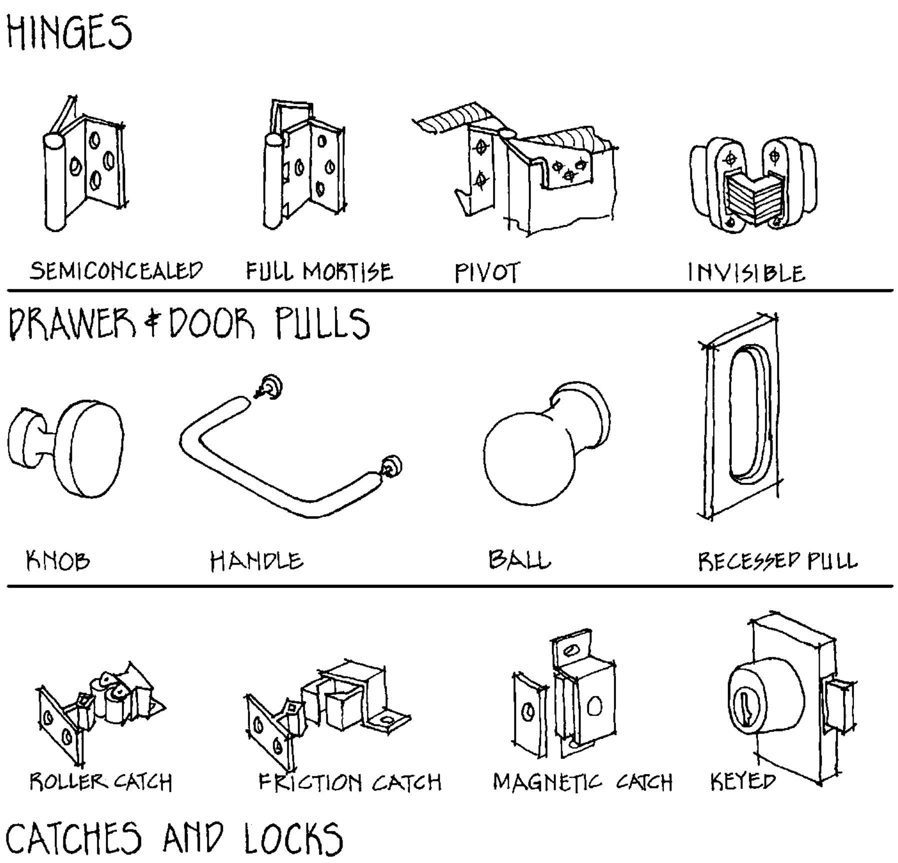


FIGURE 15.23 Various cabinetry hardware is produced in wood, plastic, and metal assemblies.

Hinges

Hinges are selected according to whether they are being used with a flush or an exposed door style. Hinges can be either exposed or concealed. They can be simple or very ornate. Most hinges are small, although some doors require a continuous or piano hinge for better support and operation.

Hinges can be designed as spring-loaded closing mechanisms. Pivot hinges are special devices that revolve around a central axis; these also can be either concealed or exposed.

Pulls

Cabinet doors and drawers can be opened by pulling on knobs, handles, or recesses of various shapes. These pulls are made of wood, plastic, metal, or porcelain. Finger pulls can be cut as an integral part of the panel front by routing out the top, bottom, or sides of an area. The type of hardware is selected to be compatible with the design and weight of the door and the drawer.

Catches and Locks

Cabinet doors can be self-closing or held by a catch. Just like doors, cabinets can be locked for security. There are five basic types of catches, with variations of each type. A roller catch engages a shaped tongue between one or two rollers; a magnetic catch relies on the placement of magnets; a friction catch holds by friction forces; a bullet uses a spring-activated ball held in place by a depression; and a touch latch releases when the door is pushed, freeing the door.

Cabinet Tops

Base cabinets are usually manufactured separately and are finished with various surface materials. The cabinet tops are made of plastic laminates, solid surfaces, stone, wood, plastic, metal, ceramic tile, and concrete. Most tops are generally manufactured in standard sizes and installed onto the cabinet base at the job site. Edge treatments are made in a variety of styles and materials.

FIREPLACES

Fireplaces can be constructed within a wall system or set freestanding, resting on the floor system, with their flues penetrating the ceiling and roof systems to exhaust gas, smoke, and sometimes heat.

In earlier times, fireplaces and stoves were used for both heating and cooking and thus became a focal point. Today, they are primarily used for heating and because people appreciate their warm glow (Figure 15.24). The warmth and flames of an open fire entice people to gather around it. Even unlit, well-designed fireplaces can be a focal point or a center of interest within an interior environment. They can be installed in residential as well as nonresidential spaces, for example, in restaurants, bars and lounges, hotel lobbies, or recreational areas, such as ski lodges. Traditional masonry fireplaces are not as efficient for heating as are airtight stoves. Rising fuel prices, however, have caused a renewed interest in energy-efficient fireplaces and stoves. Fireplaces can be an environmental concern today, since they contribute to air pollution; some cities have imposed "no-burn" days to help prevent this.

Since fireplaces are subject to building codes, it is important for interior designers to know how much space a fireplace takes; how it is constructed; and how the face, which includes the opening, surround, and hearth, can be treated with finish materials. In addition to these concerns, the designer must take into account that masonry fireplaces are very heavy and thus require special foundations.

Fireplace Construction

Fireplaces consist of a noncombustible base, a firebox, and a flue. Originally, fireplaces were made only of solid masonry; today they are also prefabricated as metal units containing the base, firebox, smoke chamber, flue, and damper (Figure 15.25). Metal fireplaces have double, and sometimes triple, walls to provide better airflow, insulation, and combustion, causing them to burn more efficiently than their masonry counterparts. Some units are built to draw outside air for combustion, and others draw in cool room air and recirculate warmed air back into the space. Prefabricated units are generally referred to as *zero-clearance* and can be built into combustible construction (depending on building codes), such as a normal stud wall. Most fireplaces burn wood, but some are gas or electric fired, yet give the appearance of a wood fire.

FIGURE 15.24 A fireplace can provide character to a space through its warm glow.
Courtesy of Herman Miller, Inc.

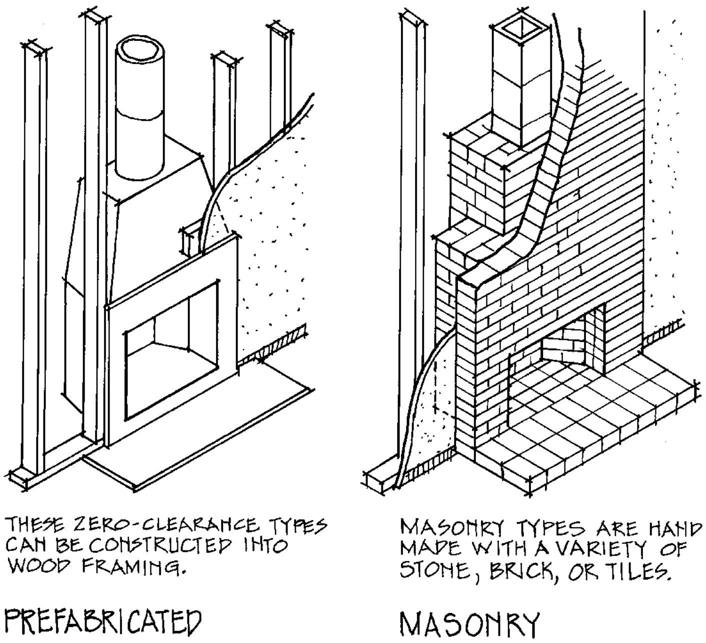


FIGURE 15.25 Fireplaces are constructed as prefabricated metal units or traditional masonry construction.

Fireplace Types

The way a fireplace fits into an interior is important in determining how the total space will be arranged. Fireplaces can be built in many forms, as long as the functional parts are not inhibited. Care must be taken to locate and orient a fireplace properly to avoid room drafts that could cause smoke problems. In addition to the common single-face opening, a fireplace can be open on two or three sides. If it is freestanding, it can be open all the way around (Figure 15.26).

Fireplace Locations

A fireplace should be located so that furniture can be grouped around it without disrupting the room's traffic patterns. The placement of a fireplace is important because it also affects a room's proportion. A fireplace with a double opening can be used as a wall divider, emphasizing the division of space. A fireplace centered on a long wall will make the room appear shorter. To prevent heat loss, a fireplace should be located toward the center of a building, rather than on an outside wall.

A fireplace can be located flush into a wall or projected into a room. The flush type can be treated with various materials for the surround and hearth, making the fireplace either an active focal point or visually unobtrusive. The

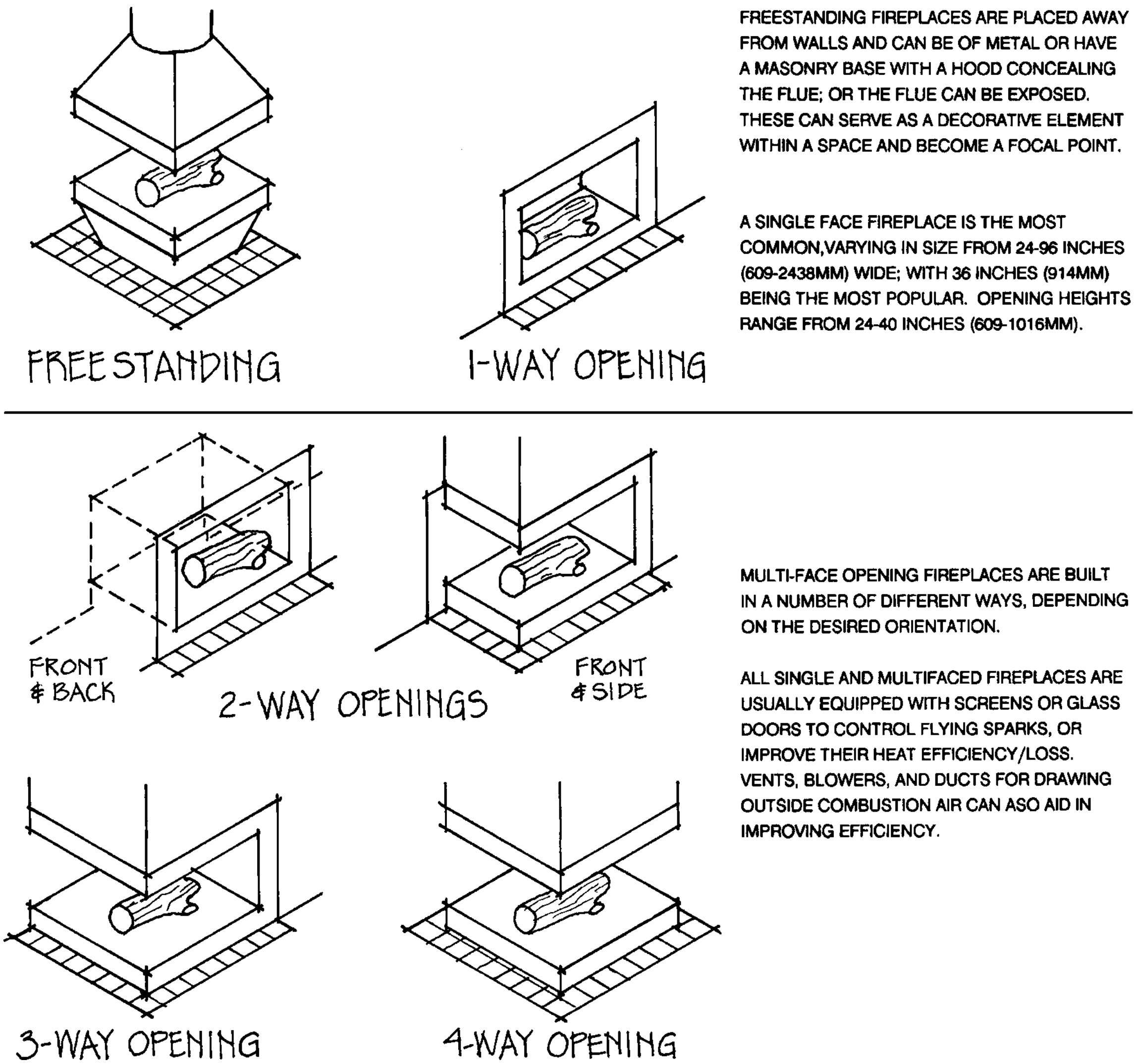


FIGURE 15.26 The placement, openings, and orientation of a fireplace can produce a variety of functional and aesthetic features in an interior.

projected type can be open on one, two, or three sides. Fireplaces can also be set at a 45° angle in a corner and finished out as a single-faced unit. The hearths of all of these units can sit flush with the floor or be raised as much as 18 inches (457 mm) for supplementary seating. Building codes require hearths to be of noncombustible materials; they also specify the minimum space allowable in front and to both sides of the opening. These dimensions vary according to which building code governs.

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Furniture 16

Furniture is an integral element in the design of an interior space because it affects human functions and desires, such as sitting, working, sleeping, and relaxing. Furniture also provides the personalization of a space as it reflects individual preferences, activities, and needs. Most interior spaces require furniture, which provides the transition between the people and the architecture of the space.

This chapter does not divide furniture into residential and commercial categories, since similar furniture can be used in both. Some residential sofas and chairs can be upgraded with construction materials and coverings to serve the heavier and more frequent use in commercial situations. For example, many companies produce mattresses in a residential and a commercial grade, but the standard sizes are common to both uses. However, in residential spaces, the selection of furniture closely reflects the personal lifestyle and tastes of the people who inhabit them. In commercial spaces, furniture might more accurately reflect the corporate or business image the entity wishes to portray.

The interior designer includes furniture as a part of the furniture, furnishings, and equipment (FF&E) package that completes an environment for the users' daily needs. This terminology is specified in printed documents available through professional design societies, such as the American Society of Interior Designers (ASID), the International Interior Design Association (IIDA), or the American Institute of Architects (AIA). Furniture is planned for early in a project or may even be a design generator. For example, furniture can be used as an element to organize a space by defining traffic patterns, conversation areas, or the aesthetic character of a room. It is also used to fulfill the users' needs for comfort, utility, and social and behavioral interactions with others.

It is rare that a client will choose to discard all existing furniture and permit the designer to select all new. Depending on the existing furniture and the budget for the project, some or all of the existing pieces might be incorporated into the new designs. These pieces can be used in their original condition or be refurbished to coordinate with the new visual and functional design concepts. Conservation or the reuse of materials is one of the goals of Leadership in Energy and Environmental Design (LEED) standards; the U.S. Green Building Council (USGBC) recognizes that by reusing existing furniture and materials, a company helps to avoid landfills and the need for new virgin materials. FF&E includes both freestanding and built-in items. These pieces can either be selected from manufacturers' product lines or be custom designed and constructed for a particular project.

DESIGNING WITH FURNITURE

Designing interiors with furniture is an integral part of the programming, space planning, and furniture selection processes and is not just furniture arrangement or choosing the pieces after the functional planning is complete. Although many of the details of exact placement and individual selection occur after the establishment of the space planning and design concepts, designing with furniture occurs throughout a project. Furniture selection occurs at different levels of involvement throughout the design process—from conceptual images and determining the functional needs of the pieces to exact selection, procurement, and placement.

Programming for Furniture

During the programming phase of a project (discussed in Chapter 7), the designer ascertains the client's activities in a space and what furniture is needed for seating, storage, conferencing, and other requirements. In this programming phase, furniture selection is generic, that is, exact furniture pieces are not yet specified. For example, a client might indicate that a conferencing or dining space needs individual seating and a table surface for eight people. The designer does not determine at this time whether the table is to be round, square, or oblong. Seating is specified only as to number of individual chairs; style and material are selected later.

Specifics would be noted, in this early programming stage, if the client has special needs. For example, a furniture piece may be needed to hold a certain type of computer, its printer, and other related equipment, or existing furniture may have to be incorporated into a new design, especially if the pieces are unique. In such cases, most program phases will document these requirements through an existing furniture survey listing the function, size, color, condition, and other special features of particular pieces.

Space Planning and Furniture

During the design phase of space planning (discussed in Chapter 6), a designer sketches in furniture on a floor plan that indicates the spaces and circulation paths. The early steps of this phase primarily involve quickly determining furniture number, groups, and orientation to support user activities. These elements are drawn to the same scale as the floor plan, to produce shapes that are in proper proportion to the activity, people, and space. The sketches are rough at this point. For instance, a designer will generally estimate and draw a chair at roughly 24 inches (609 mm) square; it can be refined to exact dimensions and even shaped later, during the design development phase (Figure 16.1).

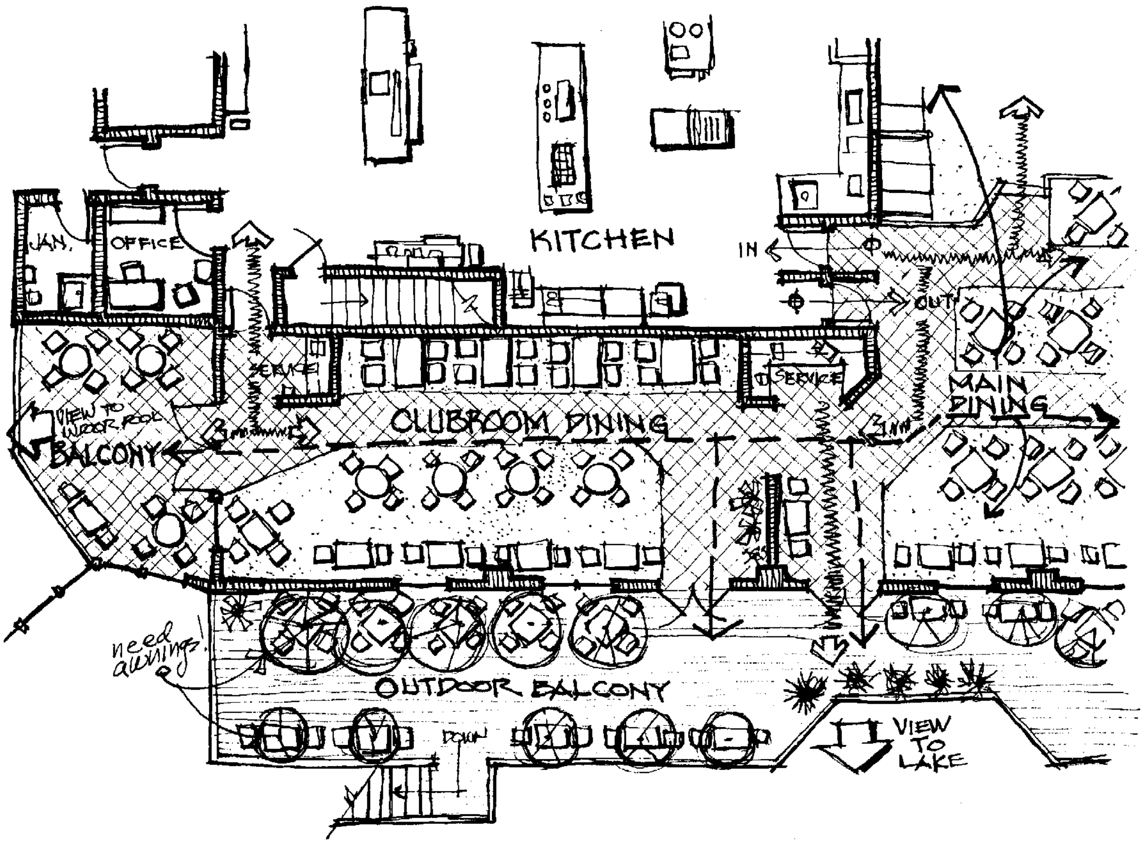

FIGURE 16.1 In the design phase, a designer sketches rough sizes, orientation, and seating requirements for furniture, as illustrated in this partial plan of a restaurant.

FIGURE 16.2 This is a computer image of Allsteel's Involve desking system.
Courtesy of Allsteel Office

Several aids to designing with furniture in the design phase include methods to allow for quick scaling and orientation. The experienced designer can often visually estimate and sketch furniture accurately in plan, but the less experienced designer might rely on an architectural scale or plastic templates. Some templates are made as generic-sized furniture types, whereas most furniture manufacturers provide their own specialized templates and/or computer aided design (CAD) files.

CAD programs offer a unique method of designing with furniture: A "library" of furniture can be called up on the computer screen and readily manipulated for space planning schemes. Some programs will even quickly produce a three-dimensional view of the furniture in the space from any angle (Figure 16.2). These designs can be plotted out on paper for reference, or the furniture can at this time be specified and a purchase order compiled.

Groupings, orientation, and required clearances of furniture for residential design are discussed in Chapter 8. This information is also relevant to commercial design; however, there are several building codes that relate to space planning and furniture placement that must also be followed in commercial design, such as codes regulating corridor widths and unobstructed egress paths.

Furniture Plans and Panel Installation

As the designer works through the design process to refine the functions and aesthetics of a space, the furniture specifics and selections become more detailed. Pieces are sized accurately on the plan, building sections, and elevations. Chapter 18 presents a detailed description of these drawing types, which depict the scale, characteristics, and relationships to the interiors. During the construction drawing process, a furniture plan is developed and keyed to the type and manufacturer of the furniture, the location of the furniture, and its coordination with other requirements of the building systems (Figure 16.3).

Coordination with Building Systems

Care must be taken when coordinating the placement of furniture with the various mechanical and electrical systems of a building. Furniture should be positioned to avoid blocking heating, ventilating, and cooling air registers and radiators (discussed in Chapter 11).

Coordination is also needed to ensure that furniture supporting telephones, computer equipment, or lamps is close to wall or floor receptacles. Of particular concern is furniture that requires special floor outlets because it is placed

FURNITURE SCHEDULE (PARTIAL EXAMPLE)											
MARK	QUANTITY	MANUFACTURER	DESCRIPTION	FABRIC/ FINISH	REMARKS	MARK	QUANTITY	MANUFACTURER	DESCRIPTION	FABRIC/ FINISH	REMARKS
C-1	90	MIKE INDUSTIES, INC.	20-483 NELSON CHAIR 20W, 22D,35H	SEAT:NUANCE, LIZ JORDON-HILL, MAHOGANY FRAME: POLISHED CHROME	CLASS A FLAME SPREAD FABRIC	T-3	11	FALCON PRODUCTS	CUSTOM WOOD TABLE TOP 30"X36"	SOLID OAK TOPS W/ NATURAL MAPLE STAIN	FIELD FINISH TO MATCH DESIGNER'S EXAMPLE
C-2	30	MIKE INDUSTRIES, INC.	35-670 SONAR BARSTOOL 19W, 19D, 45H - 30"SH	SEAT:2057-701 TALISMAN DESIGNTEX FRAME: NATURAL MAPLE CAPS: BRUSHED CROME	CLASS A FLAME SPREAD FABRIC	T-4	6	FALCON PRODUCTS	CUSTOM WOOD TABLE TOP 36" DIA. ROUND	SOLID OAK TOPS W/ NATURAL MAPLE STAIN	TOP WITH STAINLESS STL INSET STRIP - SEE DETAIL, SHT 22
T-1	16	FALCON PRODUCTS	CUSTOM WOOD TABLE TOP 48" DIA. ROUND	SOLID OAK TOPS W/ NATURAL MAPLE STAIN	BASE TB BRUSHED CHROME - SEE LISTING UNDER TB	T-5	5	FALCON PRODUCTS	CUSTOM WOOD TABLE TOP 42" DIA. ROUND	SOLID OAK TOPS W/ NATURAL MAPLE STAIN	FIELD FINISH TO MATCH DESIGNER'S EXAMPLE
T-2	12	FALCON PRODUCTS	CUSTOM WOOD TABLE TOP 42"X42"	SOLID OAK TOPS W/ NATURAL MAPLE STAIN		T-6	7	BROWN JORDON	2901-4800 DINING TABLE 42" DIA. ROUND	FRAME: POLISHED STAINLESS STEEL W/ VENEERED TOP	

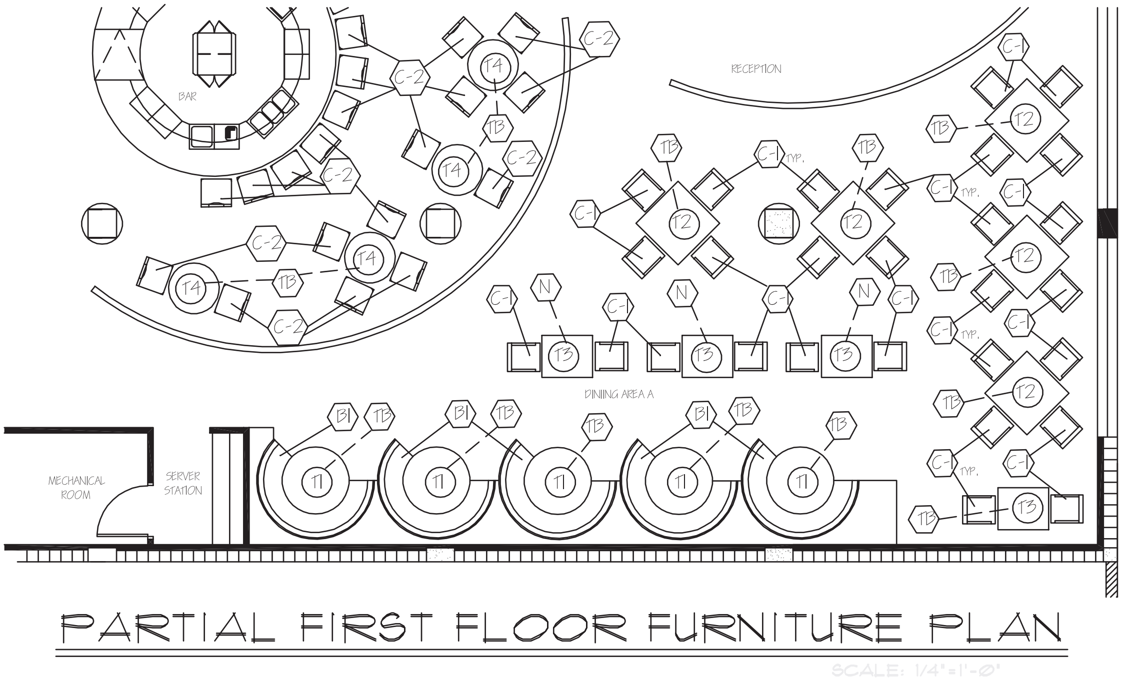

FIGURE 16.3 A furniture plan indicates where specific furniture, furnishings, and equipment are to be placed.

in the middle of a floor. These outlets are often more expensive than wall outlets and require removal, relocation, or capping if the furniture is later rearranged.

Lighting, both natural and artificial, must be coordinated with furniture placement in relation to user tasks. For reading and studying, the designer must ensure that, where possible, the furniture placement and orientation are designed to take advantage of natural daylight and are augmented with artificial light. Special furniture and equipment, such as computer screens, must be oriented so that there is no glare or reflection from windows or bright light sources. If strategic placement is not possible, window coverings and other screening devices must be used to alleviate these problems.

The latter stages of a project involve ordering the furniture, arranging for its delivery, inspecting goods for possible damage, and placing the furniture. Any problems or adjustments necessary are handled during this installation phase.

SELECTION CRITERIA FOR FURNITURE

Interior designers select furniture appropriate for the function it is to serve and for its physical and design relationships to the environment and the users. The designer should also include estimates of furniture costs, length of service expected, and replacement costs where applicable.

Function

Although furniture is primarily chosen to serve a general purpose, pieces can also serve one or more specific functions. For example, seating units or chairs provide comfort, but some are more specific in their use, such as a highchair for a child or a lounge chair for relaxing.

Comfort, Ease of Use, and Ergonomics

Comfort relates to the way furniture accommodates the human body. Comfort levels can vary for each person because of differences in size and proportion, as well as degree of psychological satisfaction. The physical fit, or interface, between the human body and furniture necessary to carry out a particular task, such as working at a computer station or reclining and watching television, requires proper posturing of different parts of the body. Furniture comfort must also satisfy several different users, since pieces are rarely selected for only one person's use.

Ease of use refers to the user-friendly aspect of furniture pieces. For example, the controls for a reclining section of a sofa must be easy to operate. Ease of use also refers to the convenience factor in moving furniture for cleaning or repositioning. Heavy, bulky pieces should be on gliders or casters for ease of movement.

ERGONOMIC CONSIDERATIONS Human beings vary in shape, size, and age, producing a wide range of anthropometric dimensions. However, most of our furniture and other parts of our built environment are designed to accommodate an "average" size, based on statistical studies of populations.

Some furniture, such as ergonomic chairs for office work, is kinetic, providing comfort for extended use by supporting the human form as it shifts and changes throughout the day's work activities (Figure 16.4). These self-adjusting chairs can properly support the body in an upright working position or adapt to a reclining position as the user leans back and body weight is transferred from the buttocks to the back and thighs, while the feet remain on the floor. These chairs reduce physical discomfort and contribute to user satisfaction and increased productivity. Other seating units and some desks can also be adjusted to accommodate different body dimensions or comfort positions.

PSYCHOLOGICAL CONSIDERATIONS People not only differ physically, but they also have distinct emotional and psychological profiles. Furniture selection and placement can complement or detract from these feelings and

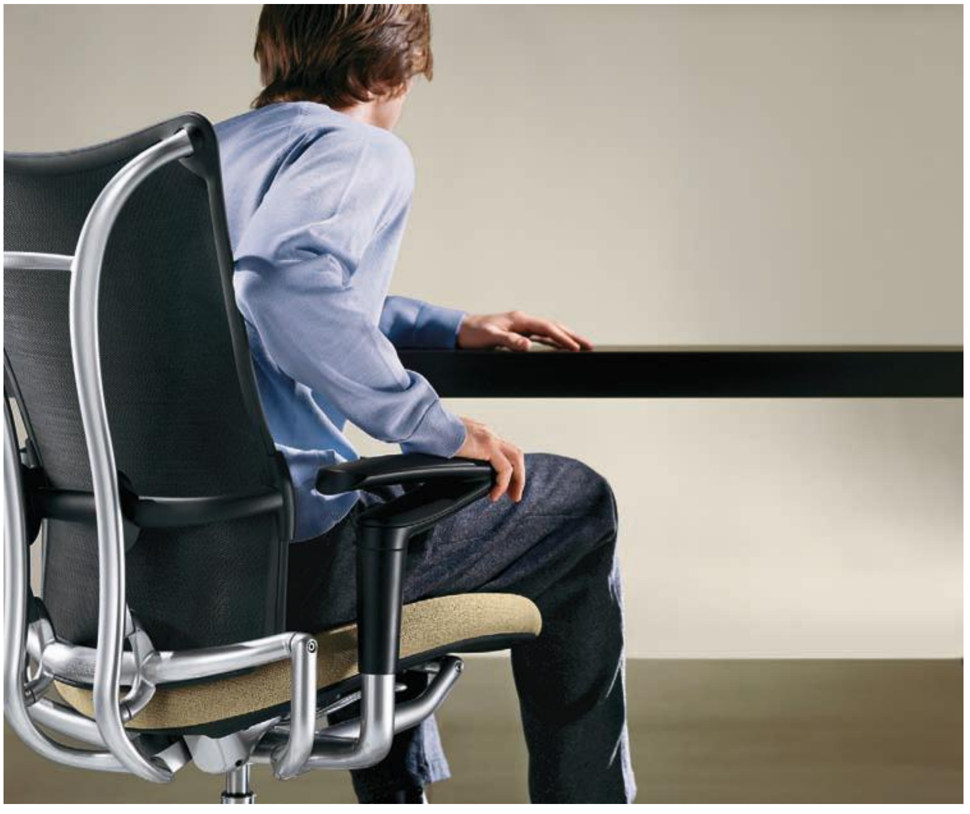

FIGURE 16.4 This ergonomic chair has a flexible shell that provides physical support for many task positions.

Hedrich Blessing ©Scott McDonald

needs. For example, some pieces that are large-scaled can seem to overpower a person, and storage units that require too much stretching or are difficult to operate can be frustrating for the user. Territoriality, or the need to have a space of our own, is a psychological characteristic and an important consideration in furniture selection and placement. A designer must understand how people use furniture. A sofa generally can accommodate three people comfortably, yet in commercial spaces, it is most often occupied by only two, since few want to sit in the middle. The selection of separate chairs or ganged chairs with arms might be a better solution. Tolerance for crowding varies with culture and personality. Some people enjoy simultaneous interaction with many others and can tolerate crowded conditions. However, others enjoy less involvement with many people and might find the effects of crowding confusing, undesirable, or overstimulating. When selecting and planning furniture placement, the designer must be sensitive to the psychological differences in personality and perception, because the type, amount, and placement of furniture will affect the way people feel and react within an environment.

Multiuse Pieces

Furniture can be used for many functions or specifically designed for one or two. A rocking chair serves a single specific function, but a bar stool used for seating in a residential kitchen can also have foldout steps that permit it to be used as a step stool.

Knockdown Furniture

A considerable amount of furniture is purchased by consumers in an unassembled, or knockdown, condition. Items such as shelving, end tables, storage units, entertainment centers, and computer desks are just a few of the popular knockdown pieces. Although quite a few of these products are of medium- or low-quality materials and construction, they can be economical, and they do serve utilitarian purposes for many people.

Furniture for Special Groups

Very young, elderly, and physically disabled people have specific needs for size, proportion, coordination, mobility, and visual perception when functioning in the environment and interfacing with furniture units. For example, much of the furniture for the very young and elderly should be devoid of sharp edges that could cause accidents or injury if fallen on. Consideration must also be given to the physically disabled, who might use furniture while in a wheelchair or while using other physical supports. For furniture to be user friendly, it must meet these special needs.

The designer must be careful when using chairs or tables for average sizes, because such selections can fail to address the special requirements of these user groups.

Design Characteristics

Furniture style and personal preference must be considered in terms of the intended us and whether the design of the piece is appropriate to the environment. Two office desks might be identical functionally, but the design of one will be more suited to the interior in which it is placed. Also, a person might prefer one style over another, such as a traditional Queen Anne rather than contemporary piece, for a formal area.

Historical Influences

Furniture produced by various cultures in the past directly influences furniture made today. Some of these pieces are used today, some are being reproduced, and some serve as inspirations for new designs.

The designs of some antique pieces have endured over the ages, whereas other early designs have been fads or fashions and have fallen from popularity. The enduring designs are considered classics and are still produced today (Figure 16.5). Unfortunately, some manufacturers have made inexpensive imitations that do not measure up to the originals in material, craftsmanship, proportion, or durability.

ANTIQUE FURNITURE Although the U.S. Customs Service considers any article made before 1830 to be an antique, furniture is generally recognized as antique after a century of time. Antique furniture is often readily identifiable with major cultures, periods, countries, or individuals. Authentic antiques in good condition are generally very expensive.

Antiques can be incorporated into almost any design scheme as a feature or focal point. They are selected as much for their investment value as for their functional and aesthetic use. (See Chapter 2 for specific historical periods and styles.)

FIGURE 16.5 This chair and stool were designed by Mies van der Rohe for the German Pavilion at the Barcelona Exhibition of 1929. The sofa and table were designed in 1930.
Courtesy of Knoll, Inc. / Michael Cullen

MODERN FURNITURE The term *modern furniture* applies to those pieces produced about the late 1800s by individuals such as Michael Thonet (1796–1871), Charles Rennie Mackintosh (1868–1928), and the craftsmen of the Bauhaus movement. (Refer to Chapter 3 for a discussion of the most notable modern designers and their furniture creations.) Although people often interchange the terms *modern* and *contemporary*, the former is more accurately identified with the Bauhaus and international movements in design history.

Some postmodern furniture and other current creations bear little similarity to classics or, indeed, to anything produced before. Many of these pieces are finely conceived and crafted, yet some represent curiosities or perhaps passing fads.

Scale and Size

Furniture is manufactured in many sizes and proportions. In addition to purpose and comfort, selections should be made on the basis of space available, proportion to the overall environment, and scale of the human body.

Some chairs may seem visually scaled to a space, such as the chairs in the waiting area of a physician's office, but may actually be too small for a person to sit on comfortably. Sometimes furniture may seem appropriate because of its dimensions, but the visual scale does not work in harmony with the space. For example, a large, overstuffed chair might be very comfortable but out of scale and context with a visually "light" interior that has small-scaled details throughout. In some cases, a chair might seem to overpower the person using it. Conversely, a chair can be scaled to create the illusion that a sitter is larger than he or she really is.

Quality of Construction

Craftsmanship and durability are important factors in materials and construction methods used for furniture. Since much of the evidence of furniture construction is hidden, it is important for a designer to be aware of the reputation of various products and manufacturers.

Durability

The durability of a piece of furniture depends on its intended use. Furniture does not necessarily have to be indestructible. For example, a dining chair in a residence usually does not take the wear and prolonged use that a chair in a hotel room or restaurant might.

Some manufacturers supply information about the recommended care and cleaning of finish materials used with fabrics or other soft materials, such as vinyl. Other manufacturers coat their fabrics with protective films (such as Scotchgard) to improve soil resistance and durability.

Guarantees and Warranties

Manufacturers of furniture, textiles, and other products provide a guarantee or warranty that their merchandise will perform and last for a specified period of time, generally one year. These two terms are often used interchangeably, but some federal and state laws do specify differences. Some manufacturers will provide these promises as a limited warranty for a part of the product. Some warranties are implied or understood—for instance, an "adjustable" chair obviously must be adjustable. These warranty and guarantee programs can help a designer ascertain how reliable a product is, particularly if the covered periods are longer than usual.

Life-Cycle Assessments and Costs

Before furniture is specified or purchased for a project, designers should perform life-cycle assessments to evaluate the "cradle-to-grave" cycle, especially those related to the demand for natural resources. Designers should select furniture that demands fewer raw materials, and select more with recycled content or rapidly renewable content, to protect the environment.

The initial cost of furniture is another aspect to be considered in the overall assessment of selected furniture. Life-cycle costs, including maintenance expenses for the expected life of the piece of furniture and replacement costs, must also be considered. Maintenance includes cleaning, repairing, reupholstering, and refinishing. Cleaning entails vacuuming and stain removal for upholstered pieces and the protection of fine wood units.

Budgets might provide for the initial acquisition and installation of furniture, but life-cycle costs might outweigh funds available to maintain the pieces. Usually it is better to invest more money initially for high-quality pieces that will not require as much expenditure over their expected life. Selections must be balanced to obtain the best quality for the best price. However, available money may limit the selection. The designer might then select less expensive items for appropriate places and choose better-quality pieces for prime locations, for extended use, or for image.

FURNITURE TYPES

Furniture types can be freestanding or built in as an integral part of the building. It may even be difficult to distinguish the furniture from the building. Some units are so well integrated into the architectural design that they become a dominant design element as well as functional pieces.

Furniture pieces can vary in form from linear or planar to volumetric (an overstuffed chair or sofa, for example). The lines of furniture can be curvilinear, rectilinear, angular, geometric, or freeflowing. Proportions can be horizontal or vertical, solid and sturdy, or light and airy. Finishes vary in appearance—slick or shiny, warm or soft, rough or heavy, multicolored or monochromatic.

The countless varieties of furniture available today are best classified by use rather than style or materials. Major categories include seating, tabular (tables), sleeping, storage, task (desks), and systems.

Seating

Today, most people spend the greater part of their waking hours sitting, as they eat, study, work, relax, and travel. The functional requirements of a chair are simple. However, seating design is not simple, because the prime consideration should be proper body support. Sitting is actually an unnatural position for the human body, since it can strain the thighs, buttocks, neck, shoulders, and especially the back. Poorly designed seating units can cause backaches and contribute to varicose veins and a variety of heart and other circulatory problems.

Different types of seating units are available for different uses. Some units, such as sofas and modular units, seat two or more people; most seating units are available with or without arms and can be folded or stacked. No matter what type of seating is preferred, all units should be selected for proper body support. General guidelines for selecting all types of seating include specifications for the seat, the backrest, and armrests, if any (Figure 16.6).

The seat should be designed so that a person's feet rest on the floor without dangling (approximately 12 to 18 inches, or 304 to 457 mm, from the floor). There should be no pressure on the underside of the thighs, and the seat should not be too deep for comfort. If designed properly, a chair should provide the sitter some space between the front of the seat and the back of the knees so that his or her feet will not "fall asleep."

The backrest must support the lower segments of the spine in order to maintain a natural, concave curvature. The small of the back should be in contact with the back of the seating unit. If the chair back is too soft or cushiony, it will not support the spine and will cause it to curve conversely. A backrest should be high enough to support the back and shoulders in either an upright or a tilted position.

Armrests should be long enough to support the forearm and base of the hand. If a seating unit is intended for use by several different people for long periods of time, armrests should be adjustable.

Chairs

Unfortunately, some seating units, especially chairs, are selected for appearance or to show status, ignoring the comfort aspects. Through the ages in many cultures, authority has been signified by a seated person. Our culture has endowed "chairs" in a university, we "chair" a committee, and we elect "chairpersons" of the board or of a department. Some executive chairs for offices are chosen for their throne-like aspect, having high backs in an expensive upholstery or leather fabric to compliment the user.

Types of chairs include armchairs, side chairs, lounge chairs, desk chairs, and stacking and folding chairs. The main consideration in selecting one of these types is its comfort in relation to a particular use. A chair with an upright back for proper seating posture is better suited for dining or studying than is an overstuffed armchair. However, for extended use, a more ergonomically designed chair is a better choice (Figure 16.7).

ARMCHAIRS Armchairs are generally more comfortable than side chairs and are good for relaxing, conversation, or reading. Armchairs can be fully upholstered and are constructed of wood, plastic, steel, or a combination of materials.

SIDE CHAIRS Side chairs are usually lighter in weight and scale than armchairs. Their relatively upright backs are appropriate for dining and keep sitters alert, so they are also good for studying.

LOUNGE CHAIRS Lounge chairs provide relaxation in a semi-reclining position. This type of chair can range from a slightly lowered and back-tilted position, appropriate for reading and conversation, to a nearly fully reclined

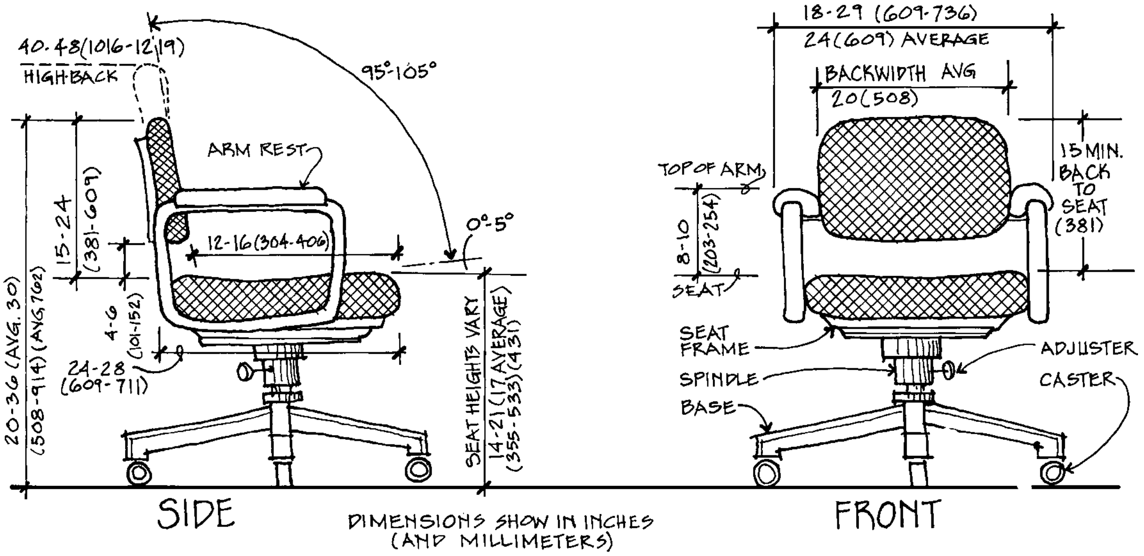

FIGURE 16.6 Seating units are made in a variety of styles, sizes, and features but conform to some general guidelines and dimensions.

FIGURE 16.7 These ergonomic chairs in this office provide support and posture for sitting at long work sessions.

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position suited to total relaxation or sleeping. Lounge chairs should be easy to get into and out of, neither too low nor too soft. They should not put the body into awkward or uncomfortable positions and should provide proper back support (Figure 16.8).

DESK CHAIRS Desk chairs are specifically designed for tasks at a desk or table. Although armchairs and side chairs might occasionally be used at a desk, they are an inappropriate selection for ergonomic comfort. Desk chairs or office chairs have been traditionally identified by job category, such as secretarial, managerial, and executive. Generally, secretarial chairs are small in scale and armless; managerial chairs have open arms and are larger in scale; and executive chairs are of large dimensions with closed arms, wide seats, and tall backrests. However, chairs should not be selected solely on the basis of the user's status within a company. An executive might be physically small, so a large executive chair would not be appropriate. More emphasis should be placed on whether the chair ergonomically fits the user's body and whether the chair is appropriate for the user's tasks. If the user might spend many hours seated, the proper chair selection is critical to provide comfort and increase productivity.

Desk chairs are designed to be flexible and mobile. They should have a swivel mechanism to make it easy for the user to rotate to reach different working surfaces. Tilt mechanisms can accommodate a variety of body positions, and rolling casters allow easy movement across a floor (Figure 16.9). Different sizes of casters are made for different flooring materials. Large, hard casters (usually stainless steel) are recommended for carpet; small, hard rubber ones are best for hard-surface floors.

FIGURE 16.8 This classic 1956 lounge chair and ottoman by Charles Eames, seen here in his residence, is still manufactured by Herman Miller for residential and commercial use.
Image Courtesy of Herman Miller, Inc.

STACKING AND FOLDING CHAIRS Stacking (Figure 16.10) or folding chairs are used for large gatherings of people or as auxiliary seating. They must be lightweight and modular for ease of moving, assembly, and storage. Stacking chairs are generally made of steel, aluminum, or plastic. Seats and backs can be made in matching or a combination of materials. Stacking and folding chairs are also available with a minimally upholstered pad and with or without arms. Other attached accessories might include tablet arms, book racks, or even ashtrays.

One of the most popular types of folding chair is the *x* chair, reminiscent of the familiar director's chair of Hollywood fame. This chair is available in a variety of lightweight, flexible materials and is a convenient portable armchair. Other folding types are the front-to-back units that are made in many different patterns and materials (Figure 16.11).

Some stacking and folding chairs have special coupling devices attached to interlock the chairs. Some fire codes require this interlocking to prevent injury to the users in places of assembly. Unattached seating could be overturned or be pushed into an aisle, obstructing safe egress of occupants in a fire or emergency.

Sofas

A sofa provides for seating of two or more people. Although some people call a sofa a couch, the latter term was originally applied to a long upholstered unit with one raised end and a low back for reclining. "Loveseat" refers to a small sofa with only two seating positions. Sofas generally are upholstered units and can be curved, straight, or angled. They are made with or without arms. Sofas can be arranged in L shapes or U shapes to provide conversation groups, and they can seat as many as eight or nine people. Sofas and chairs are arranged in conversation groups and used for residences, reception areas, large private offices, hotel lobbies, or other waiting areas (Figure 16.12).

Modular Seating

Modular, or sectional, seating is a good choice for large public spaces, such as airports, lobbies, and lounges. The term "modular seating" refers to single seating units that can be arranged in a variety of ways to suit changing

FIGURE 16.9 The Multigenerational Hybrid chair provides flexibility, ease of movement, and body support to accommodate a variety of user tasks.
Courtesy of Knoll, Inc. / Jens Mortensen

FIGURE 16.10 The Sprite Stacking Chair can be stacked 10 high for ease of transport and storage.
Courtesy of Knoll, Inc. / Mikkio Sekita

FIGURE 16.11 This molded "Folding Air-Chair" by Herman Miller is lightweight, comfortable, and foldable for storage.
Image Courtesy of Herman Miller, Inc.

FIGURE 16.12 A variety of seating and conversation groupings is provided by the sofa and chairs in this waiting area.
Courtesy of Knoll, Inc.

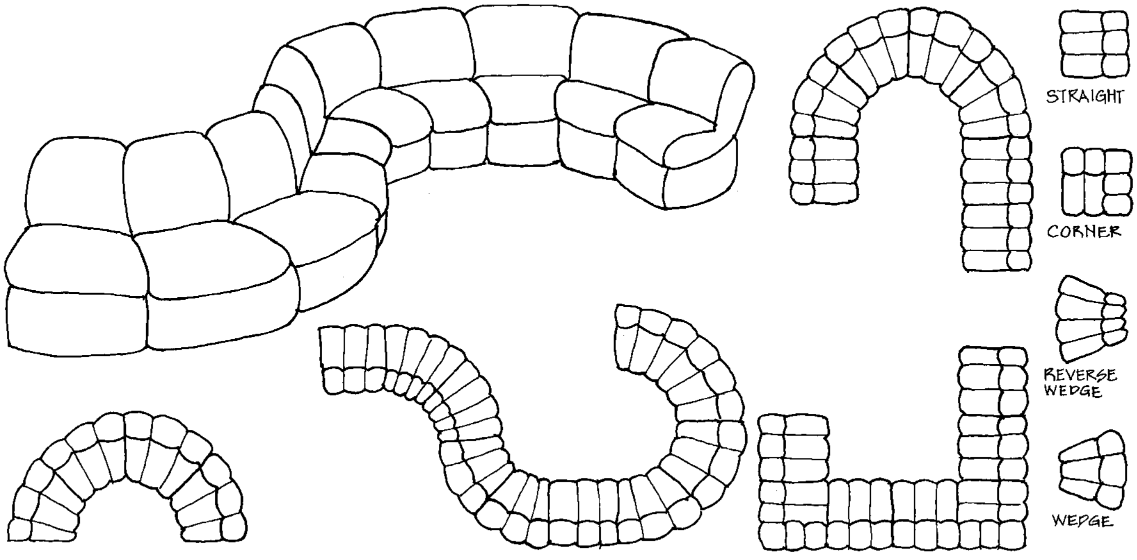


FIGURE 16.13 Modular seating can be rearranged into many configurations by changing different individual components.

needs and locations, providing flexibility (Figure 16.13). These single units are available armless, with a single right or left arm, or as a corner section. Modular seating can be arranged in straight, angled, curved, and many other configurations. End-table or corner-table elements or planters are also available to create groupings for specific spaces or locations. The term also refers to seating systems that have a continuous base with individual seats or elements added.

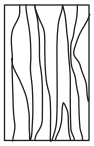
FIGURE 16.14 This large conference table can accommodate up to 18 people for meetings. Natural and artificial light are provided for a variety of resources in this meeting room.

Courtesy of Knoll, Inc.

SQUARE TABLES

WIDTH	30	36	42	48
LENGTH	30	36	42	48
SEATING	2	4	4	6

RECTANGULAR TABLES (NO SEATING COUNTED AT END)



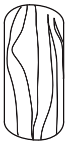
WIDTH	24	24	24	24	30	30	30	30	30	30	36	36	36	36	36
LENGTH	48	60	72	96	36	42	48	72	84	96	48	60	72	84	96
SEATING	4	4	6	6	4	4	4	6	6	8	4	4	6	6	8

WIDTH	42	42	42	42	48	48	48	48	48	48
LENGTH	48	60	72	84	60	72	84	96	120	144
SEATING	4	4	6	6	6	6	8	8	10	12

ROUND TABLES

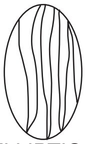
DIAMETER	30	36	42	48	54	72
SEATING	2	4	4	4	6	6

OVAL TABLES



ROUND END

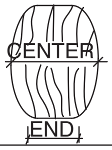
WIDTH	30	34	36	36	48	60
LENGTH	42	44	54	82	90	120
SEATING	4	4	6	8	10	12



ELLIPTICAL

WIDTH	30	34	42	48	48	48
LENGTH	60	72	84	96	108	144
SEATING	4	4	6	6	8	10

BOAT TOP TABLES



END	30	32	32	34	36	38
CENTER	36	40	40	48	56	60
LENGTH	72	96	120	144	192	216
SEATING	6	8	10	12	16	18

NOTE: ALL DIMENSIONS IN INCHES. SEATING NUMBER IS AN APPROXIMATION, DEPENDENT ON CHAIR SIZE AND REQUIRED CLEARANCES.

FIGURE 16.15 Various sizes, configurations, and seating capacities of tables

Tabular Units (Tables)

Tables are used for a variety of activities, such as dining, working, storage, games, display, and conferencing (Figure 16.14). Regardless of the function, tables should be designed for strength and stability, and should be the appropriate size, shape, material, and height for their intended use. See Figure 16.15 for common table sizes and shapes.

The top surface construction and finish of tables should be of durable materials. Tabletops should be level and resistant to moisture, burns, scratches, and impact. They can be made of glass, plastic, wood, tile, metal, marble, or granite. Tabletops can be supported by legs, trestles, or rectangular and circular pedestals, either hollow or of solid materials.

Table bases also, in terms of weight, size, and design, should be of durable construction. Bases should be designed in proportion to the size and shape of the tabletop. If a base is too small or not of a proper weight, the table will wobble or shake. Many people, especially the elderly, will use a tabletop for support when rising. This could cause the table to tip if the base is not properly weighted, or if the supports are not appropriately proportioned.

Sleeping Units

Furniture for sleeping can consist of one or more components. A bed can be a simple pallet or mattress placed on the floor, a mattress or a mattress and box springs set on a base or frame (the most common type), or a whole sleeping environment, including headboard, footboard, canopy, bedside tables, lighting, storage, and electronic controls.

Beds vary in size from a narrow single, or twin, to a king-size. Various bed (mattress) sizes and recommended clearances are shown in Figure 8.26.

FIGURE 16.16 The bed in this small solar home provides comfort and is bathed in light from the exterior.
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

Providing comfort and allowing rest are the main functions of a bed (Figure 16.16), which should be selected to respond to and support a person's body weight and shape. Mattresses are constructed of springs and padding or foam, or they can be air-inflated. Personal preference and individual physical comfort are generally the governing factors in the selection of a mattress.

The selection or design of a sleeping unit depends on the amount of space available. Beds can be integrated into a wall storage system, can be built into a corner or alcove, or can simply rest on a platform in the middle of a room, emphasizing the bed's horizontal surface. Fold-up and wall beds are good solutions for efficiency apartments or other areas in which space is limited. Sofa beds and futons, which convert into beds, are also good solutions for limited space or short-term sleeping arrangements. Bunk beds and loft beds utilize vertical space, stacking sleeping levels, storage, or working surfaces. The trundle bed is also a good choice for limited space. Other methods for limited space might even have the bed lowered from storage near the ceiling, as in this small house in the 2009 Solar Decathlon (Department of Energy) designed by several schools in Ontario (Figure 16.17).

Storage Units

Adequate, properly designed storage is an important consideration in the designing of residential and commercial interior spaces. Basic types of storage units include shelves, drawers, and cabinets. Storage can also take the form of built-ins, be suspended from the ceiling, be mounted on a wall, or be a freestanding piece of furniture.

Storage requirements should be analyzed according to accessibility and need, convenience or frequency of use, the sizes and shapes of items to be stored, and visibility—that is, whether items are to be displayed or concealed for an uncluttered and clean appearance. Other considerations, such as the type and size of storage units, should be based on how far a person can reach while standing, seated, or bending over (Figure 16.18). Frequently used items should be readily accessible, and little-used or seasonal items can be placed in out-of-the-way spaces.

Modular Storage Systems

Modular storage system furniture consists of standard components, such as open or closed shelving, drawers, fold-out writing surfaces, and cabinets (Figure 16.19). These systems can be grouped in a variety of configurations

FIGURE 16.17 This bed lowers from its storage area near the ceiling by use of steel cables, to provide more living space when the bed is not in use.
Photo by Jim Tetro/U.S. Department of Energy Solar Decathlon

to suit specific storage needs. They can be assembled into a full floor-to-ceiling storage wall, fit within an existing closet in residential cases, or serve as a freestanding partition wall with storage accessible from one or both sides. Storage systems also commonly incorporate elements for special purposes, such as pull-out swivel bases for televisions and other electronic devices. Shelving can be made adjustable with bookshelf standards or other assemblies. Units can be open for display or be equipped with transparent or opaque doors.

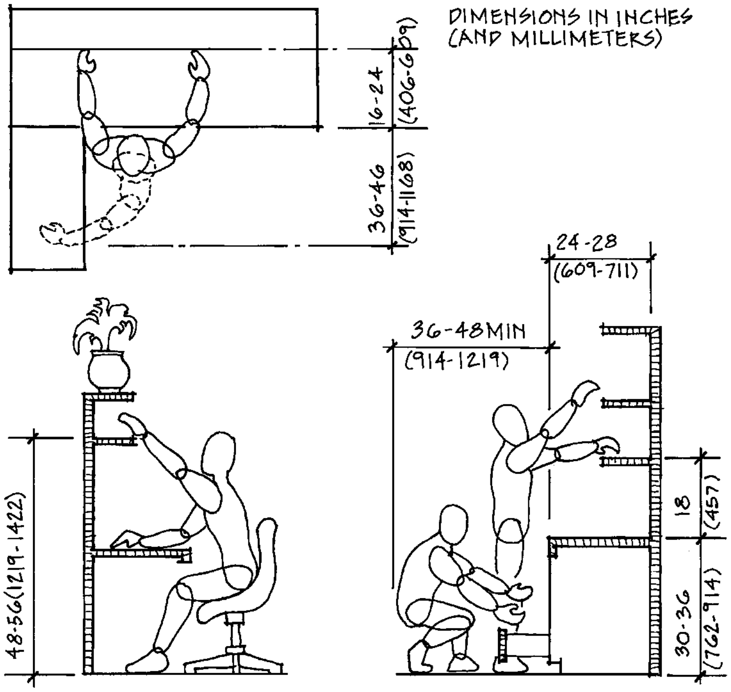


FIGURE 16.18 Storage areas should be designed for ease of retrieval within a range of dimensions convenient to the users.

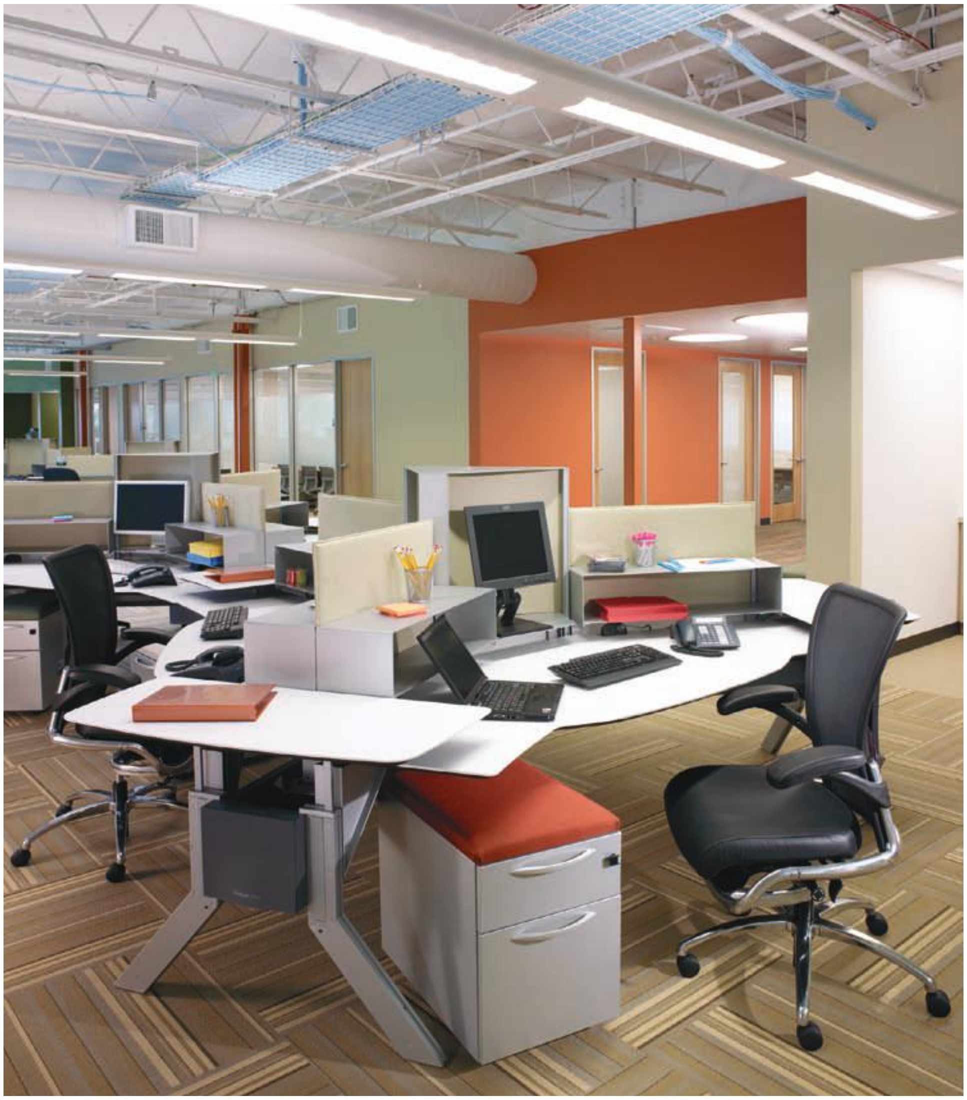


FIGURE 16.19 This movable storage drawer also serves as a seating system for a visitor to the workstation.
Courtesy Kimball Office

FIGURE 16.20 This workstation by Herman Miller incorporates a series of modular file storage bins and credenzas, all within easy access from the working desk.
Image Courtesy of Herman Miller, Inc.

Credenzas

Nonresidential spaces, such as offices, have specific storage needs that can be met by credenzas and filing systems. The credenza was first used during the Italian Renaissance as a sideboard for serving, as well as for storage of dishes, silverware, and linen. Today, credenzas serve similar purposes. For office use, they are generally in the same style as the desk and are placed directly behind or to the side of the desk for easy access from a swiveling desk chair (Figure 16.20). Most credenzas are 29 inches (736 mm) high, the same as the desk, and 18 to 20 inches (457 to 508 mm) deep. The width varies, according to storage capacity required and space available. Credenzas can have box drawers, file drawers, or doors with shelves inside. Other options include pull-out shelves for machines and bar units. Some credenzas have open knee space instead of storage space and function as a second desk. If the unit is placed against a wall, the space above the credenza can be used for display or shelving, with task lighting incorporated below the shelves.

Filing Systems

A variety of types and sizes of file cabinets are available to serve storage needs (Figure 16.21). When selecting file cabinets, the designer should consider the filing needs of the client, the available floor space, and the quality of workmanship.

The traditional type of file cabinet is a vertical unit with one to five drawers. Tall units provide more storage space, of course, but may present problems for users less than 5 feet 4 inches tall (1,625 mm) or for physically disabled workers. Vertical filing cabinets are generally 15 inches (381 mm) (letter size) or 18 inches (457 mm) (legal size) wide; their depth varies from 18 to 29 inches (457 to 736 mm). They might also be available as options to desk assemblies (Figure 16.22).

Lateral files allow side or horizontal filing, and storage capacity is measured horizontally. Depth is either 15 inches for letter-size files or 18 inches for legal size. Lateral files usually store more files per lineal inch than do standard files. Lateral files, like vertical files, vary from two to five drawers high. These files can be equipped with side tabs

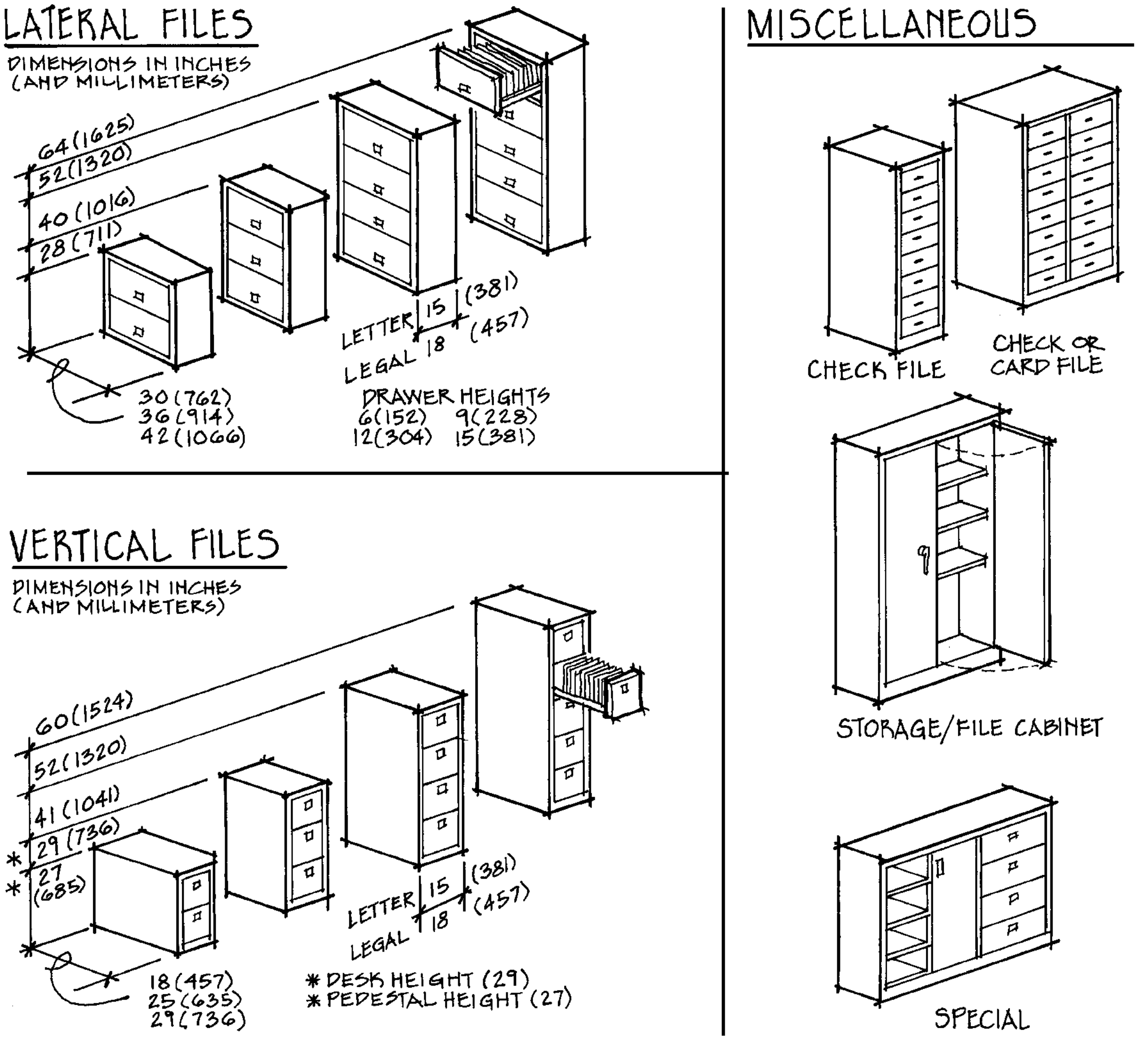


FIGURE 16.21 Filing cabinets are available in a variety of types and sizes. Consult the manufacturer's literature for exact dimensions, as these can vary.

rather than top tabs for ease in reading. Optional drawer heights, ranging from 6 to 12 inches (152 to 304 mm), are available for special filing needs, such as card files. Lateral files can often fit into spaces too narrow for traditional file cabinets. The top surface of a two-drawer lateral file can also function as a credenza or secondary work surface.

Other filing systems include high-density, open-shelf units that move on tracks, eliminating permanent aisles and requiring less floor space. This type of filing system is often used in offices for the storage of large numbers of files.

Task Units (Desks)

Desks can vary as much as seating in style and function; selection of a desk is dependent on the user's needs. Desk requirements can range from a simple work surface to multipurpose working surfaces, storage, and conferencing space.

Freestanding desks can take the form of a pedestal or a table. The traditional pedestal desk originated in the eighteenth century in England and consisted of a writing surface and two pedestals that contained cabinets for the storage of books and writing supplies. Today, these desks are available with a single or double pedestal. Usually, desks have at least one file drawer and as many as four storage drawers. An extension (return) is available that forms an L shape, providing a secondary work surface or a space for a computer with keyboard and monitor (Figure 16.23).

FIGURE 16.22 Double-drawer cabinets are incorporated into Allsteel's benching system.
Courtesy of Allsteel Office

The standard desk height is 29 inches (736 mm); however, a 28-inch (711-mm) height is comfortable for people shorter than 5 feet 4 inches (1,625 mm), and a 30-inch (762-mm) height is best suited for people taller than 5 feet 11 inches (1,803 mm). For keyboarding, 26 inches (660 mm) is most appropriate. Desks, like office chairs, are often classified as secretarial, middle management, or executive. However, job function and activities are better criteria for desk selection.

An executive who does not require much desk storage may prefer a large table desk rather than a pedestal. Table desks are a good choice for the user who spends most of the day meeting with others. Even small offices can accommodate a freestanding table that will seat three or four (Figure 16.24). An office with a table desk could also double as a conference room.

FIGURE 16.23 This executive desk has a left-handed return to provide additional work surface and storage.
Courtesy of Kimball Office

FIGURE 16.24 This small office provides a desk plus a small conference table for and meetings and collaboration.
Courtesy of Kimball Office

Table desks are available in many shapes and materials, depending on the room size, number of people to be accommodated, and personal preference. Tops can be of glass, wood, stone, plastic laminate, or leather. Shape can be round, oval, rectangular, or a truncated circle. The shape of a desk can also suggest a position of authority: Square or round shapes do not visibly indicate who is in charge, but other shapes can.

Back storage units or credenzas are generally necessary for other desk functions, such as storing documents, supporting telephones and other machines, and displaying work in progress. The credenza keeps the table desk free of clutter and eliminates distracting material (Figure 16.25).

Systems Furniture

Systems furniture includes vertical screen panels, work surfaces, and storage units that can be arranged in a variety of configurations (Figure 16.26). In office design, systems furniture forms what is generally referred to as workstations. These can be semi-enclosed areas that accommodate one or more users, located within a room or private office, or in an open office environment that integrates several workstations to enhance user communication

FIGURE 16.25 The desk in this office has no storage capacity, as it is used primarily for conferencing and decision making. The back credenza provides for other needs.

Courtesy of Hedrich Blessing © Scott McDonald

and collaboration. Open office systems generally offer greater flexibility and efficiency in space utilization and in suiting individual needs and specific tasks.

Workstations generally consist of vertical panels, work surfaces, storage components, and accessories, such as lighting and raceways for utilities. The size and number of components in a workstation are based on the needs and function of the user (Figure 16.27).

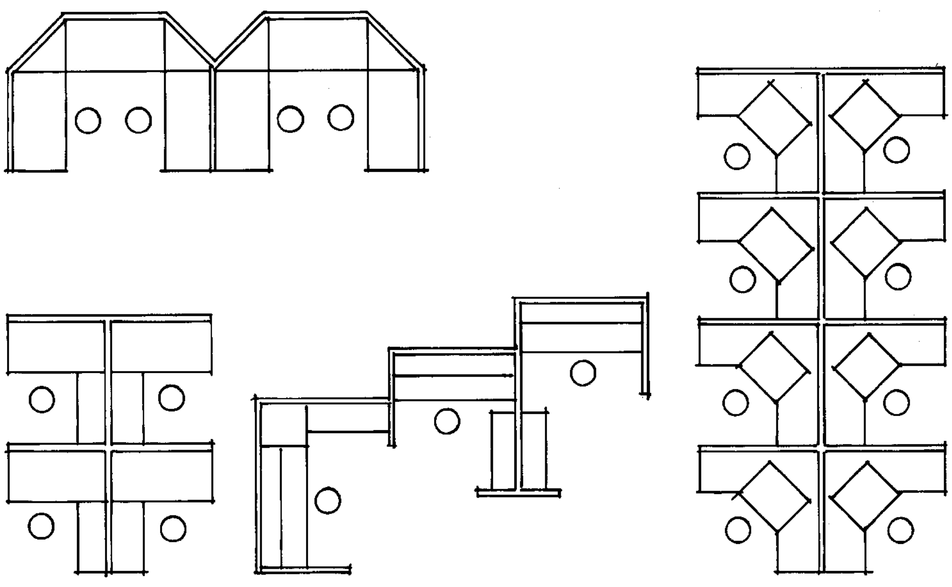


FIGURE 16.26 Systems furniture is manufactured to be assembled in a variety of configurations.

FIGURE 16.27 The soft seating incorporated into the Involve line by Allsteel accommodates both individual focus work and small, impromptu collaborative meetings.
Courtesy of Allsteel Office

FIGURE 16.28 High, glazed panels are used for this office to provide privacy and collaborative spaces without building full-height walls.
Photo Courtesy of Haworth, Inc.

Freestanding Panel Systems

Open office systems range from the simplest arrangement of conventional office furniture (such as desks and credenzas with freestanding vertical panels) to panel-hung components. Where the latter type is used, it is often difficult to tell where the screens and components end and the desks begin. Freestanding panels are also useful for defining spaces, such as conference areas or separate departments.

Panels generally are available in three basic heights, ranging from low panels (generally 30 to 48 inches, or 762 to 1,219 mm, high) to high panels (approximately 80 inches, or 2,032 mm, high). Low panels offer privacy when a person is seated, yet allow the user to communicate with standing individuals. Medium-size panels, approximately 60 inches (1,524 mm) high, are tall enough for visual privacy without fully enclosing the user. High panels offer maximum privacy without full-height walls (Figure 16.28). Given the concern for human comfort and indoor air quality, LEED recommends the panel height for open office plans be no higher than 42 inches (1,067 mm) so more workers have access to daylight and views to the natural environment. Panels can be glazed, sound absorbing, equipped with a pinup surface for displays, or can incorporate a chalkboard and writing surface. Panel systems are made in a variety of horizontal increments and produced as solid, open, or glazed types.

Panel-Hung Systems

In panel-hung systems, components are supported by the panels along one edge or along two or three sides, or they can be cantilevered. These systems can form one workstation, or multiple stations can be back-to-back, sharing a panel (Figure 16.29).

Panel-hung components consist of adjustable primary and secondary work surfaces that can be panel or floor supported. The components can be tilted or removable and can have pull-out surfaces. Storage components

FIGURE 16.29 This panel-hung system by Steelcase has a variety of accessories and can be put together in a number of configurations to serve specific functions.

Courtesy of Steelcase Inc.

include panel-supported or mobile filing units, drawer units, shelf and overhead storage units, and wardrobe units. Accessories include pin-up surfaces for display, coatracks, chalkboards, and modesty (privacy) panels.

Today, most manufacturers of systems furniture offer electrical power distribution integrated within a panel or component, permitting electronic equipment to be plugged directly into the system. This gives the panels internal raceways to conceal wiring and power connectors to the building, and also permits one workstation to be plugged into the next (see Figure 11.15).

Most systems offer task and/or ambient lighting fixtures as optional components. Task-lighting fixtures can be attached to the underside of upper storage cabinets so that the fixtures will be close to the work surface. Plug-in lamps, which offer mobility, are another form of task lighting. Ambient lighting, or general illumination, can be supplied by fixtures designed to be integrated into the furniture system or by separate components mounted above eye level on top of a panel or vertical storage unit.

Specialized Furniture

Nonresidential design often calls for specialized furniture. Many of these specialized units are tailored specifically for commercial offices, restaurants, libraries, hotels, or healthcare facilities (Figure 16.30). For example, furniture for healthcare facilities, such as hospitals or physicians' offices, includes pieces designed for examinations or surgery. Other examples include special banquet seating unique to restaurants or other food-service facilities.

In the office environment, desks with tough finishes for durability can be made to accommodate a variety of attachments for specialized functions. Special desks, tables, and stands are made to accommodate computers, keyboards, printers, projectors, and screens. Storage is also customized for these electronic pieces and their supporting hardware and software.

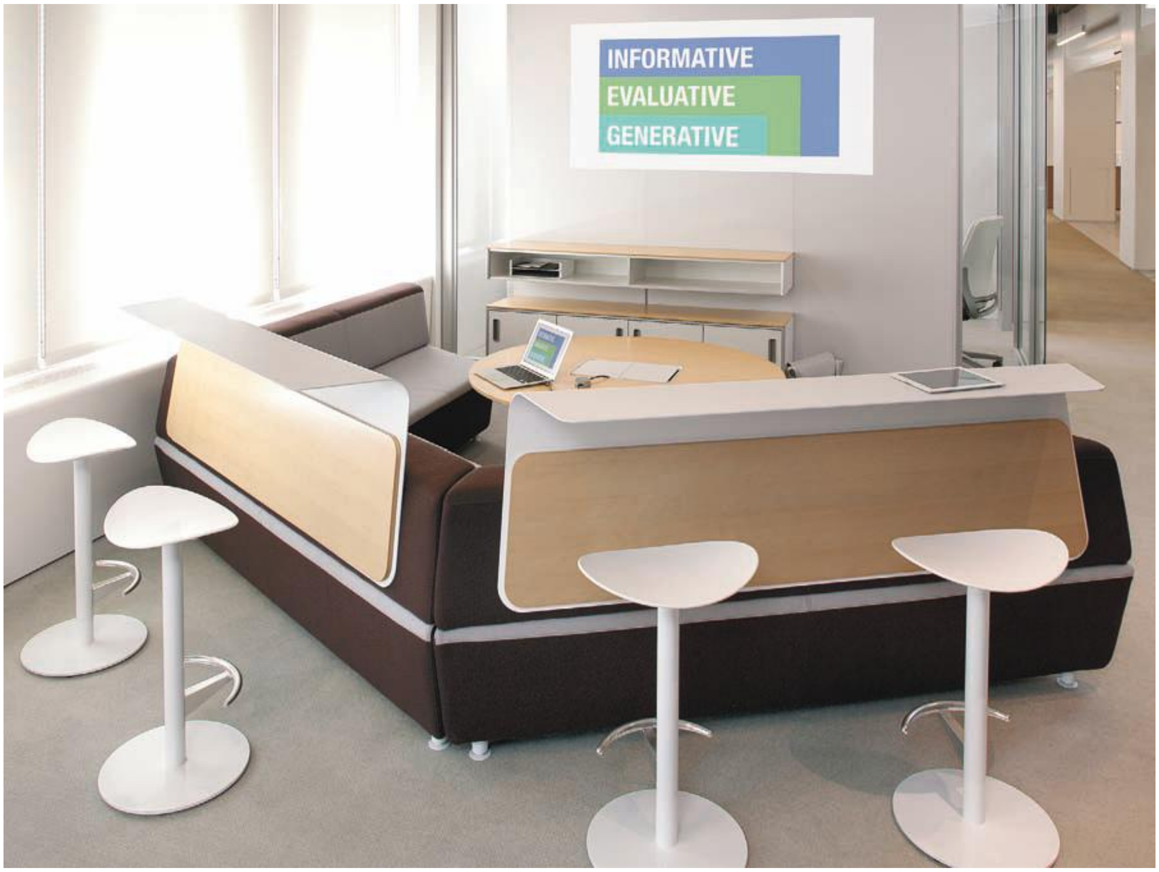


FIGURE 16.30 This Media-scape collaboration furniture grouping by Steelcase is specialized for team interaction.
Courtesy Steelcase Inc.

Many facilities use furniture common to residential design, but the construction and materials are often more durable for increased public use. Hotel furniture can be similar to residential units, but the finishes, doors, drawers, and mattresses are constructed of a commercial quality for durability. Fabrics for these facilities, as well as for restaurants and public lounges, are stronger and more resistant to soiling and wear than their residential counterparts. Commercial fabrics to be used in high-occupancy areas must also be treated for flammability resistance.

Manufacturers generally list their specialized products as commercial grade, because they must meet quality standards set by building codes or other regulatory organizations. The Business and Institutional Furniture Manufacturers Association (BIFMA) sets standards to be met by their members for performance of products. The Architectural Woodwork Institute (AWI) sets different levels of standards for woodwork materials and for craftsmanship (Chapter 15) in furniture and cabinet work.

FURNITURE MATERIALS AND CONSTRUCTION

Many materials are used in furniture construction, and the following sections cover the most common types.

Wood

Furniture can be constructed of wood alone or with other materials. Wood is easy to carve and shape into various forms, is strong, and can be finished in numerous ways (see Chapter 13). Most wood furniture is constructed of oak, maple, birch, or walnut. However, some softwoods, such as pine, are used for utilitarian pieces or for concealed blocking where strength and finish are not a major concern. Many pieces from American colonial times were of softwood construction.

Solid Woods and Veneers

Solid wood refers to the use of whole pieces of wood, such as the legs of tables or chairs, chair frames, and trim. Wood veneering can be used for decorative surface treatments or for the finish covering of a structural panel, such as plywood or particleboard. Because wide boards of solid wood tend to crack, warp, or shrink when drying, veneered panel construction is more stable. It can produce larger areas of finished wood surfaces, such as large sheets of veneered plywoods. The term *genuine* means that all solid woods or veneers in a furniture piece are made of a particular type of wood.

Plywood and Composite Boards

Veneers are applied as facings over strong panels made of plywood or various composite boards. Particleboard is used more than plywood for subsurfaces because the construction of the former is more stable and less inclined to warping, particularly if plastic laminates are applied only on one side. However, plywood can be molded by forcing the ply construction and wet glues into shaped molds to cure. Plywood's great strength is derived from alternating the layers at right angles to one another, which produces strength in two directions. Once released, the plywood retains the shape of the mold. This molded technique was originated in the early 1900s, and the molded plywood chair by Alvar Aalto (Figure 3.23) was one of the first classics to employ this process.

Bentwood and Laminated Wood

Bentwood furniture is made by placing thin strips of solid wood under pressure and steam to bend around various molds. When the piece has been dried and released, the shape remains permanent and can be joined with other shapes to produce a completed assembly. Michael Thonet used this process in the 1800s to produce his classic chairs (Figure 16.31). This technique is still used today, mostly in Europe.

Solid wood is laminated by layering thin strips or blocks (and glue) to produce various shapes, as in the curved bentwood process. Laminated wood is strongest in the direction of the grain but has a spring, or give, in all directions. Lamination is also a popular process to apply finished sheets of wood veneers, plastics, or metals to decorative and utilitarian surfaces.

Connections in Wood Furniture

Wood furniture can be connected by many methods, such as bolting, screwing, gluing, or joining. (The basic wood joints are discussed in Chapter 13.) The rabbeted, mortise-and-tenon, dovetail, doweled, and mitered joints are used primarily for furniture construction. These joints can be further secured or reinforced with dowels, screws,

FIGURE 16.31 Michael Thonet perfected the process of mass-producing bentwood furniture in the mid-1800s. Thonet Industries still produces these pieces.
PD-User: FA2010

metal splines, or strong glues. Some connections are exposed for their aesthetic qualities, and others are hidden from view.

Wood blocks and wedges are used to reinforce joints, corners, and subframes (Figure 16.32). These wood shapes are glued or screwed at corners and other hidden areas that need additional support, such as beneath a tabletop or where a back rail and side rail connect.

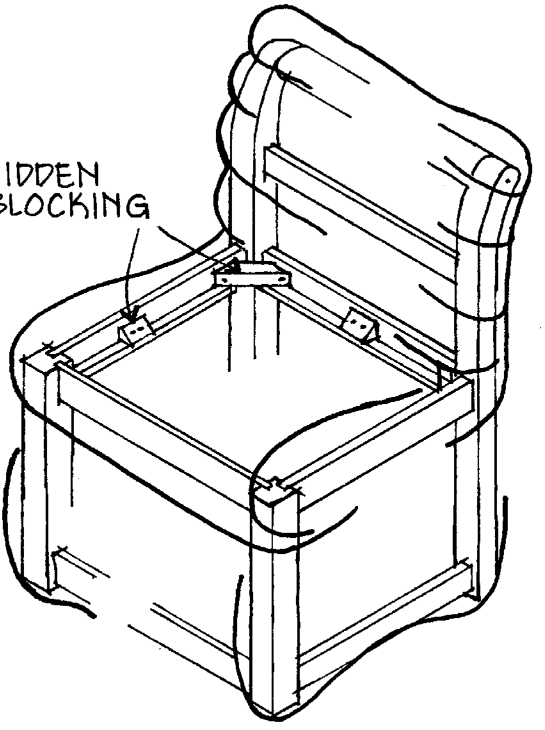


FIGURE 16.32 Blocking is used to reinforce joints and assemblies in furniture. It is often hidden from view by final coverings or located in inconspicuous areas.

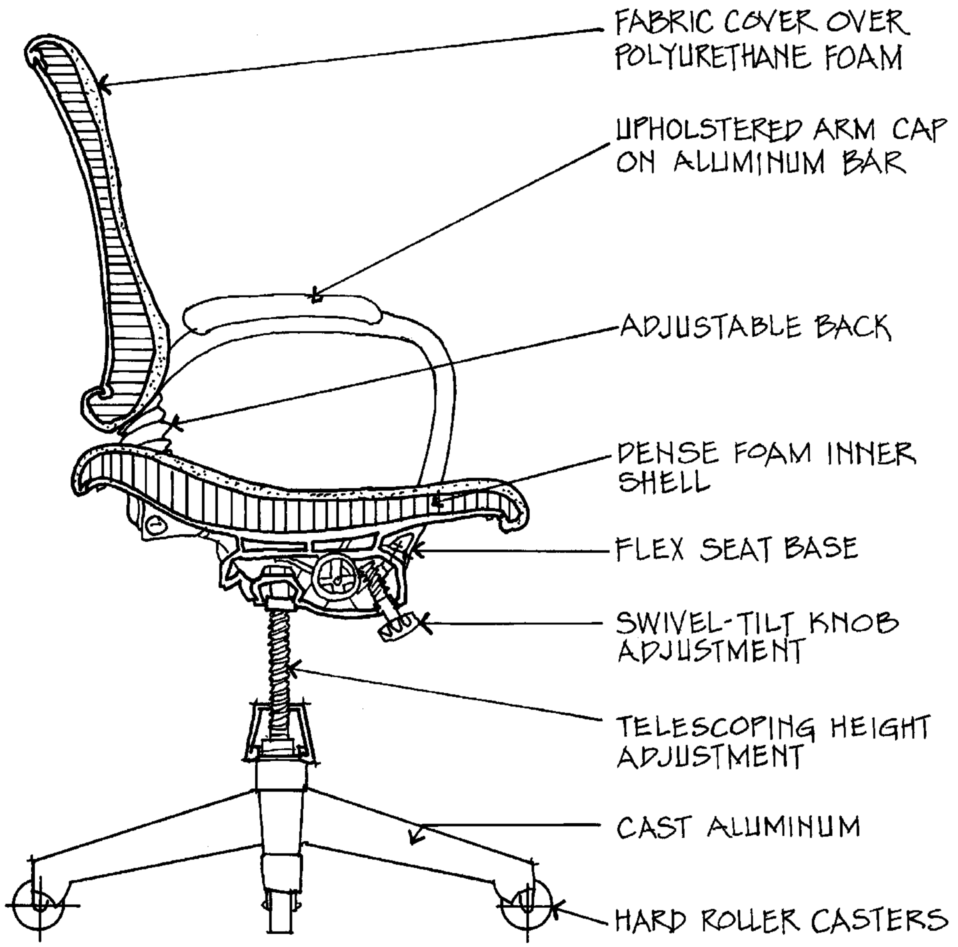


FIGURE 16.33 This cutaway view of an office chair shows the many adjustable and construction features that make it user friendly.

The hardware and construction of doors and drawers of furniture are similar to those discussed in Chapter 13 under cabinetry. However, adjustable furniture, such as chairs and tables, has many unique operating mechanisms (Figure 16.33). Sophisticated interlocking metal mechanisms are also used for some connections in wood furniture.

Rattan, Bamboo, Cane, and Rush

The plant materials of rattan, bamboo, cane, and rush are included with wood techniques since they are also living material that is renewable and used in making furniture. Rattan is produced from the tough, solid, slender stems of the Asian palm tree. These poles, generally less than two inches (50 mm) in diameter, can be bent into many shapes, and then secured by lashing, screws, or nails. Thinner sections are often woven into wicker furniture. Wicker is not a material, but a technique that utilizes small twigs or strips to fashion furniture or baskets.

Bamboo is a tropical grass that can be small or large in diameter and has hollow stems and ringed joints. Sections or strips of this material are used in furniture making and in light building construction.

Cane refers to thin, flexible strips of plants, such as rattan and bamboo. The outer surfaces of these plants can be stripped to weave into a mesh for decorative panels or chair seats and backs. Cane produces a strong, airy, and comfortable surface for furniture making.

Rush is a tall marsh grass that is twisted into cords and woven into chair seats, baskets, mats, and ropes. It can also be made artificially with tough paper cords.

Metals

Metals are used in many strong, fairly economical mass-produced furniture components and connectors. The quality of metal furniture can vary considerably—from well-crafted assemblies to inexpensive, poorly constructed pieces. Much modern metal furniture is made of hollow, tubular steel (Figure 16.34). Finishes vary widely and include plating or baking with enamels and lacquers (see Chapter 13 for a discussion of finishes).

The most common metals used for furniture are steel, aluminum, chromium (chrome), brass, and iron. Other metals are used primarily in a secondary role, such as for connectors, trim, or accessories. Metal has an advantage in some uses for interior spaces subject to fire hazards because the metal will not burn or contribute to a fire source. However, use of flammable coverings of foams and fabrics could offset these positive aspects. Metal furniture

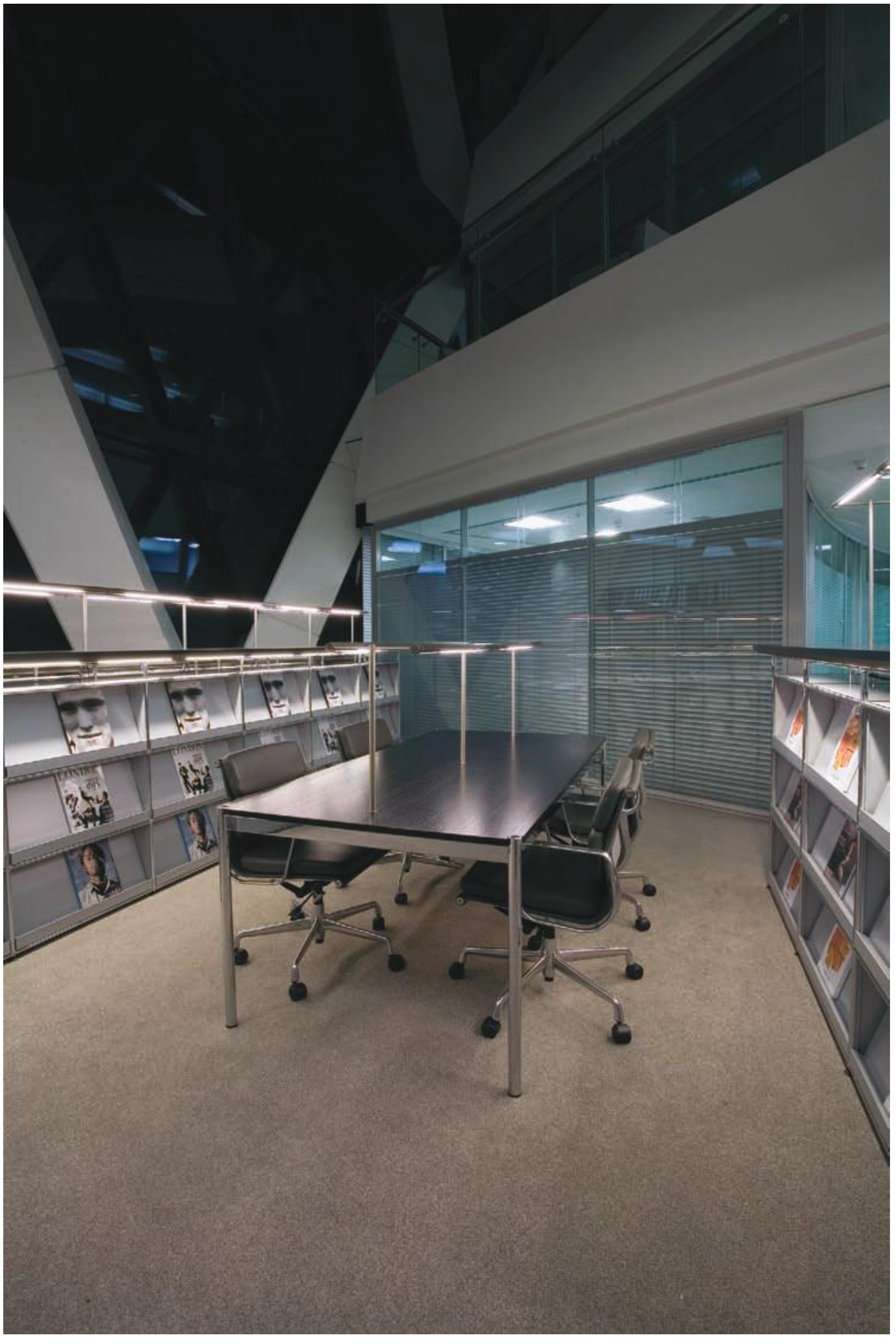


FIGURE 16.34 Metal chairs and a table are selected for this reading area for durability and in keeping with the sleek metal design theme of the interior.
© Skidmore, Owings & Merrill LLP © Jimmy Cohrssen Photography

connections are made by welding, bolting, riveting, and gluing. Welding is very strong but not as flexible as bolting. The latter allows for adjustments, disassembly, or easy replacement of damaged parts.

Plastics

Plastics can be molded, foamed, sprayed, vacuformed, blown, or rolled into a seemingly infinite variety of shapes and surface characteristics. Plastics can be used with other materials, such as wood and steel, or alone. Most plastics are durable and easy to clean, such as the laminate finishes over particleboard subsurfaces. Integral coloring allows nicks and scratches to be nearly invisible on some plastics compared to other materials, such as wood, where the finish frequently is applied only on the surface.

Plastic furniture can be well designed and crafted if the medium is explored for its own composition and integrity. Foamed plastics offer unique features in the production of soft cushioning or lightweight structural sections. Plastic can easily be joined using synthetic glues and heat or screws and bolts.

Upholstered Furniture

Upholstered furniture generally consists of a frame, cushioning materials, and an outer covering (Figure 16.35). Much of the inner materials and craftsmanship of upholstered furniture are hidden, making it difficult to ascertain the quality and durability of a piece. Some manufacturers provide information detailing the construction particulars of the inner workings.

Frames and Springs

The frames and wedges of upholstered furniture are made of hardwood, metal, or plastic and should be structurally suited to the intended use of the piece. Frames should be securely connected with strong joints appropriate to the material, and reinforced where necessary to ensure a long service life. The failure of the hidden frame can cause many of the problems associated with the durability of upholstered furniture. Upholstered furniture used in commercial spaces must be constructed of high-quality material in order to support a variety of different users (Figure 16.36).

Springs of various types are used to add support and a certain amount of give to the cushioning (Figure 16.37). Springs are made as coil, flat, and sinuous (or s-type) shapes, and are commonly found in furniture seats and backs. Flat and sinuous springs and webbing made of metal, rubber, and plastic produce a minimum amount of bulk compared to coil springs, which require more depth. Coil springs are attached to steel bands or webbing and are tied together at the tops to resist twisting or interlocking.

In bedding, the construction of innerspring mattresses is similar to that of seating units but can vary in the sizes of coils within the mattress, and the coils can even be individually covered or pocketed. Box-spring mattresses are made with coil springs and support foam or innerspring units.

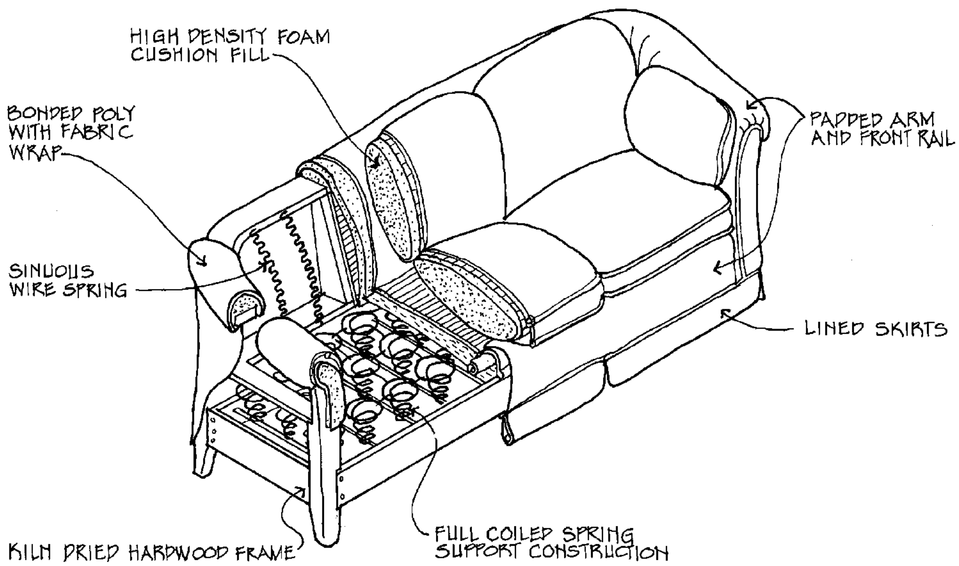


FIGURE 16.35 The inner construction features of upholstered furniture

FIGURE 16.36 Upholstered furniture was selected for this innovative testing headquarters for its worker-friendly comfort, recyclable content, and durability.

Photo Courtesy of Haworth, Inc.

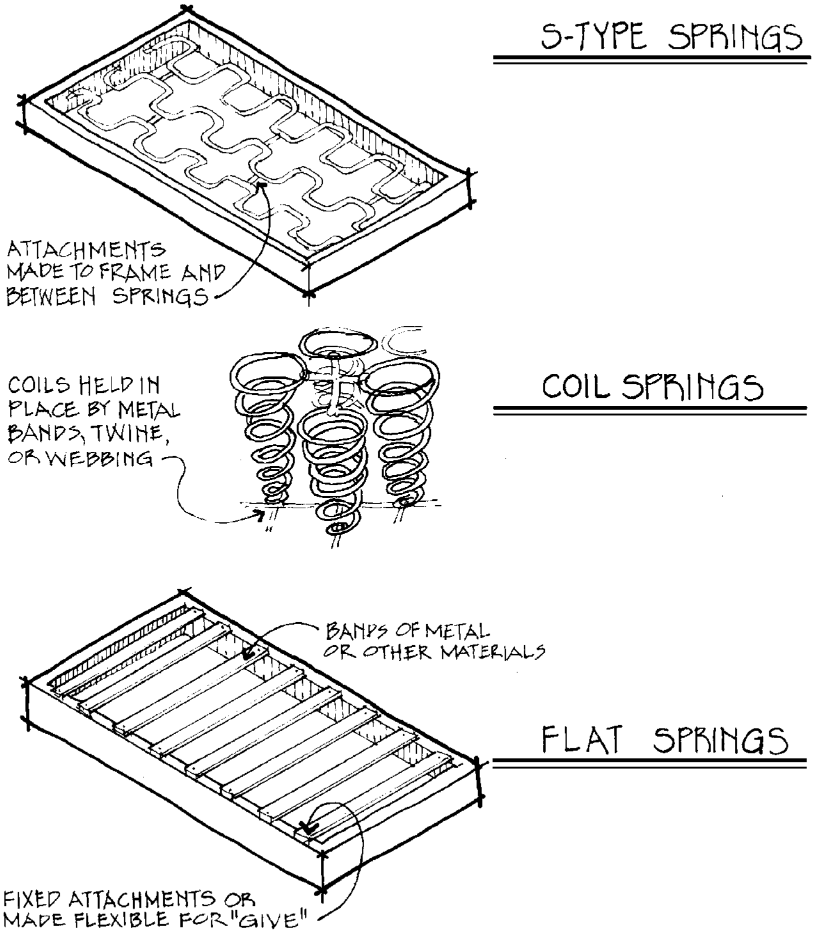


FIGURE 16.37 Various types of springs used in furniture construction

Cushions

Cushioning, or padding, consists of a layer of material placed over the springs to give shape and comfort to the upholstered piece. Generally, burlap or other breathable materials are installed directly over the springs. This prevents the cushioning from working into the spring assembly.

Cushioning materials consist of feathers, down, cellular foams (primarily polyurethanes), polyester fiberfill, or a combination of these. In commercial uses, the choice of these materials is strictly governed by fire and building codes. Cushioning is also made in the form of loose pillows and pads that can be removed for cleaning or reversed for extended use.

Coverings

Coverings are the outer layers of upholstered furniture that are either permanently attached or removable for cleaning. Slipcovers can be replaced as they wear out or be removed for periodic changing.

Coverings are made in a range of materials that vary in design, cost, and quality. (Refer to Chapter 13 for specific information on textiles.) They can be purchased as a part of the manufacturer's product or specified as COM (customer's own material). COM means the designer can select fabrics from one manufacturer and have them shipped to a furniture manufacturer to be installed on the piece selected. Many dealers or manufacturers carry a supply of fabrics that can be selected from their catalogs or sample swatches.

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17

Furnishings and Equipment

Furnishings and equipment constitute two areas of the total furniture, furnishings, and equipment (FF&E) program. They are an important part of the total interior environment and are generally selected by the interior designer. Interior spaces consist of more than walls, floors, ceilings, and furniture. Secondary elements support and enrich a space to make it "feel" completed.

These supporting elements are referred to as furnishings in the interior design profession. They can be utilitarian or decorative, enhance the architectural features of a building, or perform all these functions.

Equipment consists of the specialized items that are necessary in a project for occupants to carry out their daily activities but that are not a part of the building systems, furniture, or furnishings. For example, equipment needed in commercial kitchens and teller equipment needed in banking facilities are specialized products unique to those operations.

FURNISHINGS

Furnishings not only serve user needs and aspirations but add the finishing touches to an interior. Furnishings can impart a person's personality and individual character to a space (Figure 17.1). They might be attached to the building, although most are freestanding and not an integral part of the structure. Furnishings generally include accessories, such as figurines, baskets, personal collections, or clocks; artwork; plants; signage; and graphics. Specific furnishings that will need to be ordered to finish out a project are often detailed in the specifications (see Chapter 19).

When selecting supporting furnishings for a space, the designer must consider the principles and elements of design and the suitability of these furnishings to the total environment. Furnishings should be suited to an interior in terms of space, form, style, texture, scale, and color, in addition to serving a specific function and enhancing the overall design concept.

Residential furnishings are important supporting parts of the interior environment for the people who live in the residence. Many items, such as cherished photographs, personal collections, or a child's art creations, elicit memories and provide a sense of continuity. Most people like to surround themselves in their homes with objects that have special meaning. Planning where and how to place these keepsakes can be a difficult task for an interior designer because the aesthetic qualities of some objects may not be suited to the designed environment. However, these accessories, artworks, and other items can be integrated into the environment with some careful planning. It is better to work with a client to coordinate these objects than to ignore the objects and have them "misplaced" into the design later.

Nonresidential furnishings can often require selections to be keyed to a theme, for example, an English Tudor motif for a restaurant. This aspect of commercial design is similar to creating a stage setting and can involve research into a particular style or historic period to ensure that the items are appropriate (Figure 17.2).

FIGURE 17.1 The furnishings of artwork and collectibles reinforce the humanistic feel to an interior and provide a visual accent and interest throughout the space.
Courtesy of National Kitchen & Bath Association

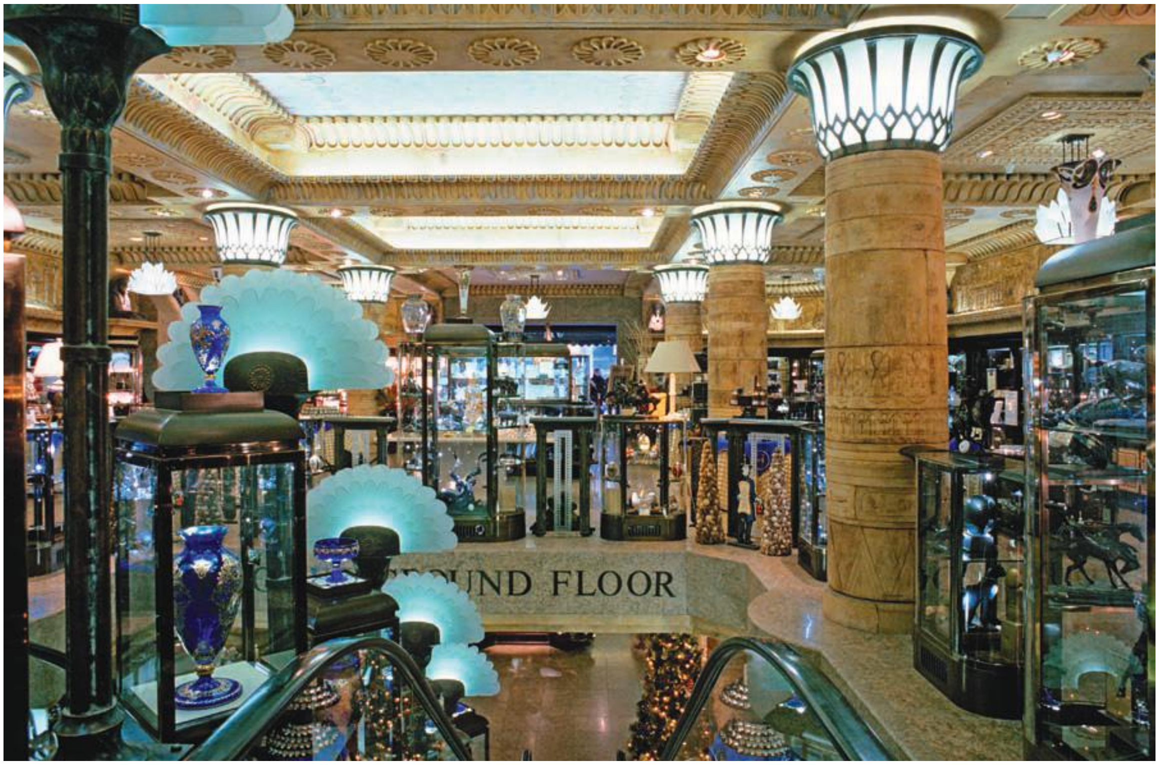

FIGURE 17.2 This retail space is designed with a theme of ancient Egyptian motifs.
© Bertrand Rieger/Hemis/Corbis

FIGURE 17.3 A special display case was designed into this wall for a collection of art pieces and figurines.
Courtesy of Kimball Office

In work environments such as offices, people often want to surround themselves with personal items that support their feelings and territoriality. Designers should realize that workers might add pictures and personal mementos to their desktops or adjacent wall space. Although the environment might function well without these personal items, it will not meet the emotional needs of the users; that shortcoming could in turn be detrimental to workers' feelings of self-worth, perhaps lowering productivity.

Many people enjoy collecting objects that relate to their background, travels, or experiences (Figure 17.3). Some of these, such as pieces of fine art, antique dolls or toys, bottles, coins, or photographs, may be worthy of displaying and add a personal quality to the space. However, space may not be available to display an entire collection, and discretion should be used to select the items most in harmony with the overall space design.

The designer should be aware that the significance of a space is added by the users, not just by the objects. The users return day after day to these spaces, and that experience should be meaningful.

Accessories

Accessories are used for adornment and ornament and generally are helpful, but not essential, to a space, whether residential or nonresidential. Some accessories are both functional and decorative, for example, a decorative umbrella stand, clock, or wastebasket. Others may be purely aesthetic and serve no function, such as a wall hanging. Whichever is the case, accessories are important in any interior space, because without these elements a room can appear sterile and impersonal. Nonresidential spaces designed for work or public use generally are neutral or nonpersonal in character, since they are used by many different people and cannot reflect a particular personality. However, since people are what humanize a space, the designer should be careful not to overdo the accessories and allow them to get in the way of the users or appear to clutter a space.

Functional Accessories

A number of objects that appear in our interior environments are important functional elements, such as lamps, glassware, coatracks, and letter trays. These items are generally selected for their utilitarian aspects, but they may be creatively incorporated into the design as well (Figure 17.4). Accessories should be considered an important part of the total design concept and should be selected with sensitivity to their aesthetic qualities as well as their function. Repetitive elements, such as color, pattern, scale, or form, can act as unifiers and help tie these accessories to a design scheme. Well-designed accessories do not need to be expensive to be effective visual complements to the total design.

Decorative Accessories

Accessories can be serious or provide a sense of freshness or uniqueness to an environment—a large print of comic book characters, for example. Decorative accessories include both nonutilitarian objects, such as rocks and shells, and purely decorative objects, such as sculptures or other pieces (Figure 17.5). Some accessories are so highly ornamented that their function is almost secondary; an elaborately carved and gilded mirror frame is an example.

Designing with Accessories

Accessories such as a large clock or an area rug can be used to create a visual center of interest. By their design and placement, they can serve to unify other interior elements. By careful arrangement and composition, they can create an illusion of height, width, or a particular shape in a space. The designer should be careful not to overload the senses by displaying too much in one area. The designer must decide on a concept—a feeling, mood, or

FIGURE 17.4 Desk accessories and the back unit of this workstation provide for the daily activities of the user.
Photo Courtesy of Haworth, Inc.

FIGURE 17.5 Decorative accessories in this room serve as both utilitarian and functional items.
© Kim Kulish/Corbis

emotion—and relate the supporting elements to it. A balanced relationship is necessary in order to achieve harmony. All components within a space, including the accessories, should relate to one another. Some movement and change in the use and selection of accessories is necessary; however, living, working, public, and special environments are never static and should not be designed as such.

Accessories include many different kinds of items that can be unique for different user needs and types of facilities. For example, in an office setting, accessories could include an accessory "package" that might consist of a wastebasket, letter tray, memo box, pencil cup, nameplate, and desk calendar. This kind of package could be further categorized into secretarial, management, or executive units, depending on the users' tasks. These packages simplify the ordering and distribution process.

Other accessories might include functional and decorative umbrella stands, or waste receptacles for public lobbies, hallways, or elevator areas. For restaurants or executive dining facilities, accessory packages might include tableware, flower vases, candle holders, and linens (Figure 17.6). The designer then must choose the specifics, such as type of flatware (stainless, silver plate, or sterling) and might also consider including vases and serving trays.

Artwork

Art can be an integral part of interiors, used to enrich the design of a space and satisfy our needs for artistic expression and aesthetic delight (Figure 17.7). An interior is seldom complete without the addition of some form of artwork—an individual work, part of a collection, memorabilia, a historical artifact, or other expressive pieces. Art can also be a good investment, with high-quality works generally escalating in value. Many individuals and corporations are very knowledgeable about artwork, have regular investment programs, and display their acquisitions.

Selecting and Acquiring Artwork

Selecting artwork can involve choosing individual works for specific locations (Figure 17.8). The designer might select artwork from a client's collection, to determine which pieces will be displayed; select new works to complement an existing collection; or acquire artwork to begin a collection. In the case of a collection, pieces might be

FIGURE 17.6 Designers selected tableware accessory items to complement the materials, finishes, and furniture in this dining room.
© ANTHONY WELLER / age fotostock

used in more than one space or on two or more floors of a building, and might even be periodically changed through a program of rotation. The interior designer and the client should work together to decide on the types of art mediums and their placement.

Although actual pieces of artwork generally are selected toward the end of a project, concepts concerning their integration should be determined early in the design stages. Budgets, lighting, and finishes can be tentatively outlined with artwork in mind, and the possible mediums and sizes of artwork to enhance the interiors can be conceptualized. If art is not considered as an integral part of a space early in a project, the art budget is generally one of the first to be cut when a project has cost overruns. However, some states have laws that require a percentage of the construction budget in public buildings to be allocated for art.

FIGURE 17.7 The colorful artwork in this reception area adds accent and interest to the large wall.
Courtesy of Knoll, Inc.

FIGURE 17.8 A major art piece was selected to accent this office lobby and serve as a focal point.
© Skidmore, Owings & Merrill LLP © James Steinkamp Photography

Artwork can be acquired from a number of sources, including galleries, museums, retail shops, art dealers, festivals, or directly from artists, whether professionals or students. Although the latter have not established reputations, their relatively inexpensive prices and potential for future renown can make their work an attractive alternative. An artist can also be commissioned to produce a work, such as a tapestry or mural, of a specific subject matter or for a particular space.

Specialized art consultants are available as independents or through galleries and dealers. They can help the designer and the client make proper selections from the vast variety and large amount of artwork available. These professionals can also assist in advising on purchase prices and investment potential.

Corporations and some individual clients have an art program that manages acquisition goals, type of art desired, inventory control, budget, and monitoring of the works. Pieces are catalogued according to title, artist, date, description of medium, date and price of purchase, and location displayed.

Usually, art is purchased, but rental, loan, and consignment programs are available as well. Galleries and dealers often lease artwork, and some artists allow their works to be displayed in order to obtain exposure.

Two- and Three-Dimensional Artwork

Works of art are produced in many mediums and sizes. They can be mounted on a wall, occupy small niches or shelves, sit on desktops, or occupy large amounts of floor space (Figure 17.9). They can also be in the form of sculpture hanging from the ceiling. Art is executed as realistic or abstracted forms, such as a realistic bird or an abstracted interpretation of flight.

Artwork falls under generalized categories, such as fine arts, crafts, folk art, applied arts, and decorative arts. Although these categories seem fairly definitive, many works overlap. Fine arts are those generally recognized over the centuries, including drawing, painting, printmaking, and sculpture. Photography, posters, reproductions, ceramics, metalsmithing, weaving, and other decorative arts are additional forms of art mediums. The medium does not always define the art form, since the work can incorporate many materials and techniques into the same piece.

DRAWING. Drawings are works done in pencil, charcoal, ink, grease pencil, or pastels, primarily on paper mediums. A drawing can be an original finished work or a preliminary study for other mediums, such as paintings or

FIGURE 17.9 The wall art piece in this conference room provides a focal point to the space.
Photo Courtesy of Haworth, Inc.

sculpture. Drawings are generally less costly and smaller in scale than the other fine arts. Drawings require frames, mats, and other protective surfaces (of glass or plastic) to preserve and display them.

PAINTING Paintings are one-of-a-kind works executed with colored pigments carried in various vehicles to canvas or other backings. These vehicles include oil, watercolor, tempera, and acrylics. They can vary considerably in subject matter, size, and price. Most require a frame and need protection from direct sunlight and other harmful conditions, such as moisture and excessive handling.

PRINTMAKING Printmaking involves producing prints (often called multiples) on paper by processes such as silk screening (serigraphy), etching, wood cutting, drypointing, engraving, and lithography. Prints are made in limited editions, numbered in sequence, and signed by the artist. The numbers, such as 6/30, indicate that the print is the sixth of a total of 30 produced. Prints are often less costly than original drawings or paintings and are framed in a manner similar to that used for drawings.

PHOTOGRAPHY, REPRODUCTIONS, AND GRAPHIC ART Photography, a medium introduced in the 1800s, is produced either in black and white or in color. Photographs can be composed of literal images or produced from darkroom or digital techniques creating abstract images. Photos can be one-of-a-kind works or, like prints, produced in limited editions. Although most photographs have protective coatings, some are encased beneath glass for protection.

Reproductions are copies of an artist's original work and are made as photographic prints or through commercial digital printing processes for multiple copies. However, some are reproduced in various media, even an occasional hand-copied technique. High-quality copies can be a good source of aesthetic pleasure and serve where the original work is too costly or unattainable.

Graphic art is two-dimensional work that includes posters, often advertising plays, concerts, and exhibitions. It can also be reproductions of work by well-known artists. Maps, logos, fashion drawings, and other graphic creations also provide sources of artwork (Figure 17.10).

SCULPTURE Sculpture is three-dimensional art that can be large, freestanding pieces or small items placed on a shelf, table, or display unit (Figure 17.11). Placement should be carefully considered, because many pieces of sculpture are subject to handling by viewers. Sculpture is created in many different mediums and can be realistic or abstract in subject matter. Sculpture can be either static or kinetic—hanging mobiles, for example. Kinetic pieces can be moved by air patterns, motors, water, or viewer participation. Large pieces can be heavy and must be carefully placed because they are not easily moved.

CRAFTS AND DECORATIVE ARTS Crafts include pottery (ceramics), glass (stained, beveled, and blown), metalwork, art fabrics, basketry, and folk art (Figure 17.12). Some of these, such as ceramics, are seen as both fine art and applied art, which is considered functional art. Crafts can be produced as large objects or small, personalized pieces for collections. Generally, crafts are smaller and less costly than sculpture and paintings.

Folk art and other primitive artworks occupy a unique place in art, often providing a look at the culture and time of the peoples who produced them.

Decorative arts can be utilitarian or purely aesthetic displays. Many are mass-produced, and the pieces can range from high-quality art forms to clichéd or poorly conceived and executed pieces associated with bad taste. The German term *kitsch* is often used to characterize these latter pieces as foolish or pretentious art forms.

Other crafts and decorative arts that can be displayed include quilts, rugs, blankets, antiques (tools, weapons, glass, coins, and the like), tapestries, and weavings. Historical objects or documents such as letters, manuscripts, and charts, can also be displayed as a visual composition.

Preparing and Displaying Art

Important design decisions must be made concerning the preparation of artwork to be displayed and its positioning in an interior space. The interior designer has an important role in these decisions and should work closely with the client and users of the interiors to create placements that satisfy both functional and visual compositions (Figure 17.13).

A frame, matboard, and glass must often be selected and coordinated to complement two-dimensional artwork. Stands have to be purchased or made for small sculpture that is not large enough to stand alone. Art supply stores and frame shops provide both unassembled frame kits and custom framing for two-dimensional work. They also offer colored mats for accenting and protecting the work, as well as clear and nonglare glass covers.

FIGURE 17.10 This collection of artworks makes a visual statement in color and interest to this waiting room.
Photo Courtesy of Haworth, Inc.

FIGURE 17.11 A bronze sculpture of four women dancing around a fountain provides a focal point for the lobby in the Pan Pacific Hotel, San Francisco.
David Pick / Alamy

FIGURE 17.12 A lighted wall niche is designed to display this large ceramic artwork in the hall of a dental office.

Courtesy of EnviroMed Design Group

Art provides a complement to the total design and use of the space. Wall art, such as paintings, prints, and drawings, should be carefully positioned at eye level for proper and comfortable viewing. Large works are often placed alone on a wall to create a dominant effect.

Smaller pictures can be grouped in a composition; be placed over an object, such as a piece of furniture or a fireplace; or be hung on a smaller wall surface.

Sculpture and other three-dimensional works require careful placement, taking into account the movement of a viewer and the proper viewing angle of the piece. Some pieces require the viewer to circle them, while other, smaller pieces might rest on a shelf, table, or special display unit.

FIGURE 17.13 Art was selected for this office collaboration space to provide accent and color.
Courtesy of Allsteel Office

All art requires both proper lighting for viewing and protection from abuse or deterioration. This lighting can be either artificial or natural; however, more control can be achieved with the former. Time of day and season can affect the quality and direction of natural light. Strong sunlight striking a work of art can cause glare, shadows, and reflections, affecting the visual appreciation of the piece. In some situations, sunlight will cause deterioration or other damage to a work of art.

Correct artificial lighting for artwork is specific to the type of art to be viewed. For example, two-dimensional work often requires either a good overall ambient level in the space or special accent luminaires, such as a framing projector, to highlight the work. Wall washers and spotlighting can also be used to bring the appropriate level and direction of light to the art. Three-dimensional work often requires special direct lighting to bring out the texture, color, shape, and other qualities of the piece. Consideration must also be given to multiple lighting for larger pieces that are meant to be viewed from more than one angle.

Plants

Plants have become as important as artwork for interior design elements. Human beings seem to have a natural affinity for a green environment. Plants are living art, like sculpture. They bring color, texture, and a variety of forms and shapes into our interiors (Figure 17.14). As our built environments expand and natural greenery disappears from the urban landscape, we find that plants bring a natural element to an otherwise artificial environment. Plants are used in interior environments as focal points, sculpture, screening, softening, and psychological elements. Commercial enterprises, designers, and employers have increasingly incorporated interior gardens and plants as an integral part of our environments, at work and at play, for the enrichment of the spaces and the well-being of users.

Plants serve both functional and aesthetic purposes within an interior. Some large species can serve as design components to divide space, accent the interiors, or define areas within large spaces (Figure 17.15). They can also be used to define circulation paths and to separate or visually screen workstations in open office areas. Plants can be used to create a center of interest. They can emphasize or deemphasize architectural details, create specific mood settings within a space, and identify status by setting apart an executive area.

FIGURE 17.14 The plants and flowers in this hospital space provide variety in shape, color, texture, and interest to the space.
Courtesy of Robin Connell; Grant L. Harrison Photography

Health Concerns

Plants return vital oxygen to the air and raise humidity levels by combining expelled water vapor with air. Although some individuals are allergic to particular plants, generally air quality within buildings can be improved by the addition of plants and foliage. Low levels of indoor pollutants may be the cause of what the Environmental Protection Agency (EPA) calls sick building syndrome, which causes workers in a new or poorly ventilated building to experience eye, nose, and throat irritations, as well as headaches, lethargy, and lack of concentration. Research conducted by the National Aeronautics and Space Administration (NASA) on the effects of live plants and flowers on indoor air pollution has shown that living plants absorb gaseous substances from the air and release fresh oxygen and water vapor back into the air. NASA concluded that live plants and flowers are beneficial to human beings

FIGURE 17.15 Plants are placed throughout this hotel atrium to create a unique outdoor feeling and accent the mythical setting for the restaurant.
Courtesy of Robin Connell; Grant L. Harrison Photography

beyond the plants' visual and psychological impact. These studies have shown that plants absorb noxious gases through tiny openings in their leaf surfaces. They do not merely filter the material but actually metabolize or break it down physically and chemically to use as their food.

Plants are currently being tested and used for their effectiveness in "cleaning" the air. Studies conclude that a small ratio of plants-to-area (square feet of space) can do an effective job. For example, only 15 mother-in-law's tongue plants would maintain a formaldehyde-free atmosphere for a 1,800-square-foot (167 m^2) area of heated living space with an 8-foot (2.4-m) ceiling. Research is also being conducted on the material in which the plant is grown and the amount of time a plant is exposed to light to determine their effect on the indoor environment.

Some types of plants can be poisonous or harmful to pets and small children, so the interior designer should be careful when selecting interior plants where these potential problems might occur.

Selection Criteria

Designers should select plants that will functionally and aesthetically complement the design scheme. Aesthetic considerations include the plant's foliage color, size, shape, height, spread, and outline. Of vital importance is a compatible climate in the interior environment in which the plants will live. In order to select plants that will thrive in a particular interior environment over time, the interior designer must either have a working knowledge of plant types and needs or consult a qualified local plant services contractor or an interior plantscaper.

LIGHT REQUIREMENTS Both the placement of plants and the amount of light available are key factors in a design scheme. A plant's position in relation to natural light from windows can affect its survival (Figure 17.16). Some plants require natural light, whereas others can survive on artificial lighting. When selecting interior plants, the designer must take into account the kinds and amount of light the space has—direct or indirect daylight, fluorescent or incandescent artificial light.

Lighting can be used for dramatic highlighting or to bring out the sculptural qualities of plants. Uplights can be used to create dramatic effects on plants, since most plants are seen with light from above.

FIGURE 17.16 These plants receive a combination of natural and artificial lighting in this hotel atrium.
Courtesy of Robin Connell; Grant L. Harrison Photography

WATER AND HUMIDITY REQUIREMENTS The ease with which interior plants can be watered is an important consideration in their selection. Plants suspended high overhead or placed high on a shelf may be difficult to water and can dry out more quickly. Generally, indoor plants are watered too frequently and inconsistently. Plants must be allowed to dry out so that the roots will take in oxygen. It is important for plants to be watered on a scheduled basis, rather than intermittently. In commercial installations, it is often best to leave the watering to plant specialists as part of a plant program.

Plant Programs

Clients can purchase and maintain their own plants, lease them on a monthly basis, or buy them and pay for a monthly maintenance and replacement program. Frequently, these decisions are based on initial costs and maintenance factors. A maintenance program is highly recommended for the survival and growth of plants in an interior environment because they need consistent care. Plants must be sprayed for insects, pruned, fertilized, rotated, and polished on a regular basis.

The interior designer will generally prepare specifications for interior plants, specifying details of plant size (height and width), trunks, stems, branches or canes, foliage, root system, and growing medium. He or she includes a schedule that lists individual plants selected, their location, and the container or planter to be used. The specifications generally request two alternate quotations: one for leasing the plants with maintenance and replacement guarantee and the other for the purchase of the plants, with a replacement and maintenance guarantee included.

Another option offered by some plant services is the nonguaranteed maintenance program. With this program, the client pays a flat fee for monthly maintenance and pays an additional charge for plants that need to be replaced.

Another consideration in a plant maintenance contract is the inclusion of inspecting employee-owned plants that might introduce bugs or diseases. One infested or infected plant can transmit problems to many others within the same environment.

Types of Plants

It is difficult to categorize plants because they are living organisms and have many different qualities. However, plants for an interior environment are usually categorized as live plants, artificial plants, and cut flowers.

LIVE PLANTS Live plants are available in many different varieties and can be broadly categorized as flowering plants, foliage plants, and cacti or succulents. New methods of propagation and hybridization have made it possible to bring many outdoor plants (grown mainly in tropical regions or only in greenhouses) indoors. Also, tissue-culture technology has produced new varieties by genetic engineering and cross-pollinating the best characteristics of one plant with those of another.

Live plants are generally specified according to the variety of plant as well as to their size and height. Small plants are those less than 12 inches (304 mm) tall; medium plants are 1 to 3 feet (304 to 914 mm) tall; and large plants are more than 3 feet tall. Other considerations must include minimum width, recommended interior light requirements, and moisture requirements (Figure 17.17).

ARTIFICIAL PLANTS Artificial plants are generally not acceptable to designers. However, silk plants and flowers of high quality are a good alternative to using either live plants in hard-to-reach places or cut flowers, which can present an ongoing expense if they must be changed weekly or daily.

Dried flowers or other types of preserved plants, such as cat-o'-nine tails or grasses, work well in areas with no daylight and intermittent artificial light

CUT FLOWERS Cut flowers can add sparkle, warmth, and lively color to an interior space, whether on tables in an executive dining room, or on a desk (Figure 17.18). If a client desires cut flowers, the designer should specify appropriate vases in the accessory package. Arrangements for the delivery of live flowers weekly or daily can be included in the plant contract or handled separately through a local florist.

Containers

The container or planter is also a design element and must be selected to accommodate the size and shape of the plant as well as to complement the design of the interior space (Figure 17.19). Large containers would be considered part of the furnishings and would be drawn as such in the floor plan. Planters can be either leased or purchased and should be included in the plant program.

Signage and Graphics

Interior designers are often involved in signage and graphics selections for clients. These might be simple desk signs or elaborate graphic programs identifying directions, departments, and individuals in a large building (Figure 17.20). Signage can also include menu designs for restaurants, graphic designs for uniforms, or packaging for a client's products. Other forms of signage are displays for advertising and exhibitions.

Signage

Signage is generally classified as directional, informational, or emergency. The interior designer can control the type of directional or informational signage. However, building codes and regulatory agencies usually control the size, shape, and location of emergency and accessibility signage; these signs have to be immediately recognizable and standard in their appearance throughout the country.

Directional signage is used as an informational "directory." Signs are designed or selected by the designer to complement the interior design scheme, as well as to be clear and visually informative. Directional signage for organizations that anticipate changes is designed to be flexible.

Informational signs can identify a company; label spaces, conveniences (such as Internet access, toilets, conference rooms), and closets for electrical or mechanical equipment; and provide names of people (Figure 17.21).

Emergency signage includes exitways for stairs, escape doors, fire extinguishers, and other life-safety concerns. Signs should be uniformly designed, be concise, and have clear, distinctive graphic images with a background that contrasts with the lettering for legibility and visibility. Signs should be appropriately sized to the distance at which they are to be encountered and read. They should be lighted where illumination levels are not adequate or where it is required by building codes.

Signage for accessibility for the physically disabled is of great importance. These signs address both emergency and safety concerns, such as exit ramp locations and the locations of accessible restrooms, drinking fountains, parking, and elevators. Many of these signs have been standardized in their graphics for universal recognition (Figure 17.22).

FIGURE 17.17 Selected interior plants and their characteristics

COMMON NAME	SIZE	WATER	LIGHT
ASPARAGUS FERN	Sm/Med	Moist	Med
BAMBOO PALM	Lg	Moist	Low
BENJAMIN FIG	Lg	Moist	High
BOSTON FERN	Med	Moist	Med
CANDELABRA CACTUS	Med/Lg	Dry	Med/High
CHINESE EVERGREEN	Med	Moist	Low
COLUMN CACTUS	Med/Lg	Dry	Med/High
CORN PLANT	Med/Lg	Moist	Med
CROTON	Med	Moist/Dry	High
DIEFFENBACHIA	Med/Lg	Moist/Dry	Low
ENGLISH IVY	Sm	Moist	Med
FALSE ARALIA	Med/Lg	Moist	Med
FISHTAIL PALM	Med/Lg	Moist	Med
GOLDEN PATHOS	Sm	Moist/Dry	Med
GRAPE IVY	Sm	Moist	Low
HAWAIIAN SCHEFFLERA	Med/Lg	Moist	Med
HEART-LEAF PHILODENDRON	Sm	Moist/Dry	Med
JADE	Sm	Moist/Dry	Low
MOTHER-IN-LAW'S TONGUE	Med/Lg	Moist/Dry	Low
NEPHTHYTIS	Sm	Moist	Med
NORFOLK PINE	Med/Lg	Moist	Med
PARLOR PALM	Med/Lg	Moist	Low
PEACE LILY	Med	Moist	Low
RUBBER TREE	Med/Lg	Moist/Dry	Low
SPIDER PLANT	Med	Moist/Dry	Med
SPLIT-LEAF PHILODENDRON	Med/Lg	Moist/Dry	Med
UMBRELLA TREE SCHEFFLERA	Lg	Moist	Med
WANDERING JEW	Sm	Moist/Dry	High

SIZE (in feet; metric shown in millimeters)

Sm = 0–1 (304 mm)

Med = 2–3 (609–914 mm)

Lg = 4 and over (1,219 mm)

WATER REQUIREMENTS

Moist = Keep plant damp: water once a week.

Moist/Dry = Thoroughly dampen media and allow to dry (approximately 2 weeks) before watering again.

Dry = Water thoroughly and allow to dry. Water once every 2 or 3 weeks.

LIGHT REQUIREMENTS

High = Direct sun or over 200 fc (footcandles)

Med = Indirect sun or 80–150 fc

Low = Shade or 50–80 fc

FIGURE 17.18 The cut flowers add a splash of color and interest to this meeting room.
© Matthew Millman © Skidmore, Owings & Merrill LLP, 2012

FIGURE 17.19 This large tree requires a large container to grow properly.
Courtesy of Robin Connell; Grant L. Harrison Photography

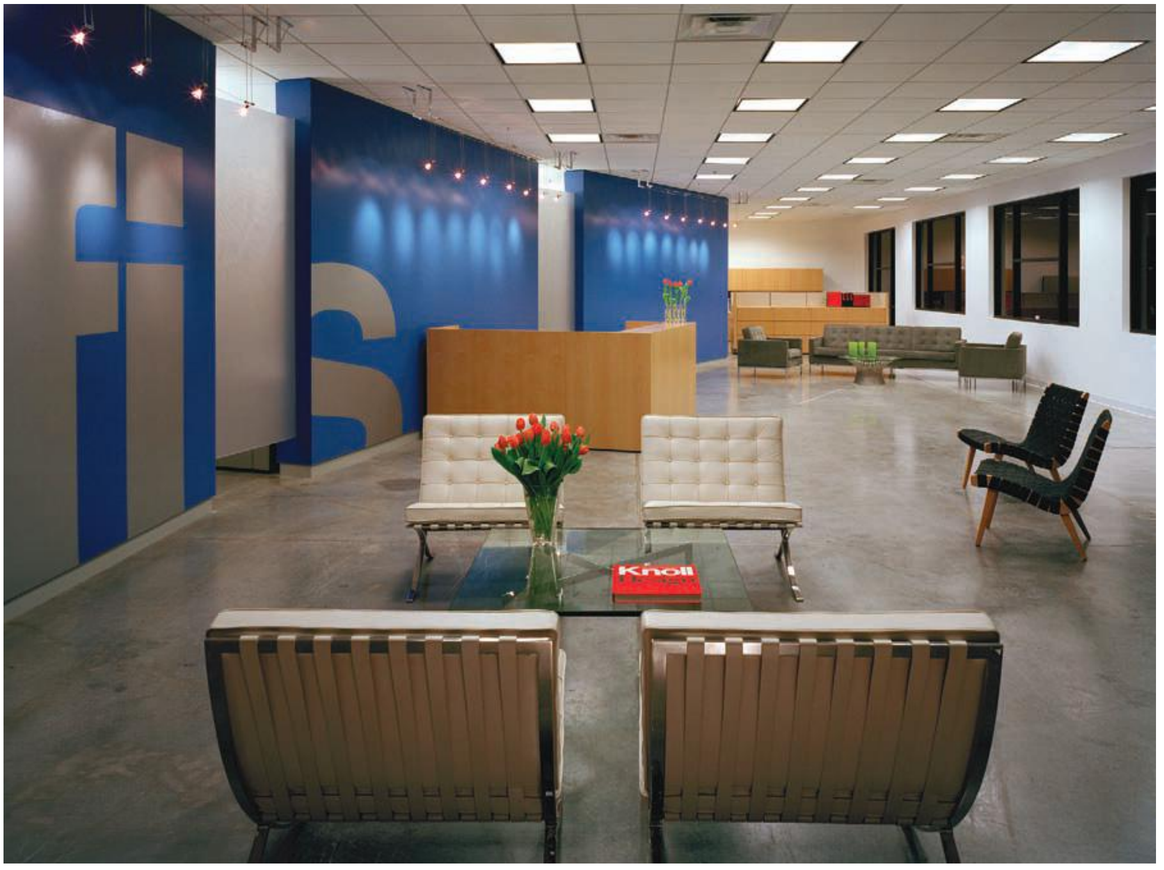

FIGURE 17.20 Wall graphics reflect the company's name in the reception area of the OFIS showroom.
Courtesy of Knoll, Inc.; Photographer: Aker/Zvonkovic

FIGURE 17.21 The company logo is used for identity and is placed at eye level for easy recognition, which is also reinforced by its contrast to the wall material.
Photo Courtesy of Haworth, Inc.

FIGURE 17.22 Signs utilizing distinct international symbols can assist the physically disabled in locating proper facilities.

GRAPHICS

Graphics include the design and lettering of signage and other artwork for a client's logo, business cards, and letterheads. The graphic designs of restaurant menus, retail signs, and custom artwork creations are all a part of the interior designer's role. He or she might create these in-house or retain independent graphic designers to produce these works.

EQUIPMENT

Selecting equipment for interior design projects involves items either physically attached to a building or freestanding, including equipment for restrooms, kitchens, libraries, and laboratory spaces. The term *fixtures*, which includes bank teller, beauty shop, and other specialized equipment, is sometimes used (Figure 17.23). Fixtures include a

FIGURE 17.23 A number of electronic devices are incorporated into the design and functions of the workstations in this office.
Courtesy of Kimball Office

FIGURE 17.24 Healthcare design and equipment are often very specialized, as seen in this dental office.
Courtesy of EnviroMed Design Group

variety of items and interfaces, such as computers, video displays, copy machines, computers, vending machines, x-ray equipment, and retail display fixtures.

Interior designers work with the user, installer, dealer, and manufacturer to gain specific information and guidelines for use when selecting this equipment. Consultants, such as commercial kitchen specialists, might be called upon to make presentations on equipment or to give recommendations on budgets and specific equipment. Because much of the equipment is specialized for particular facilities, close coordination is needed to select the correct items and provide proper lighting, electrical, spatial, and other requirements, in addition to choosing finishes, color, and style. The designer assists in coordinating the placement of equipment in a project with the architect and contractor.

The designer selects specialized equipment in the areas of residential, office, healthcare, hospitality, retail, and institutional design (Figure 17.24). He or she consults with other professionals, varied consultants, and manufacturers to select the proper equipment.

Residential Equipment

The designer selects equipment for both single- and multifamily housing. The interior designer works directly with a client in specifying single-family residential equipment, or with the client and the architect in multifamily housing. The equipment includes appliances as well as built-in ironing boards, intercom systems, security systems, and other electronic equipment. Specialized housing types for the physically disabled and the elderly often use similar equipment or special units from healthcare facilities, such as serving trays or carts for geriatric chairs.

Office Equipment

Office equipment includes items necessary for a business to carry on its daily activities; these items might include computers, video devices, printers, copiers, and mailroom machines. Other equipment found in offices ranges from

FIGURE 17.25 Equipment in retail facilities is designed and made in a variety of ways to store and display merchandise. *Peter Cavanagh / Alamy*

appliances for an employee break room to prefabricated shelving. Audiovisual and lectern equipment, as well as screens and electronic communication equipment, is often specified for conference rooms.

The designer is often asked to plan for a client's space growth and projected equipment needs. Spatial and electrical requirements are projected for new equipment acquisitions in various increments, such as 5 or 10 years.

Healthcare Equipment

Equipment for healthcare facilities comprises a large variety of highly specialized products that generally are specified by the client or user. The interior designer is mostly involved with coordinating the functional and aesthetic needs for the equipment and its placement in the space. For example, a physician might decide what equipment is needed for an operating room and leave the details of lighting, finishes, color, electrical connections, and spatial arrangement to the designer.

Healthcare units include dental, radiology, and hospital operating room equipment. More specifically, these might be autoclaves, examination tables, dental chairs, and x-ray machines. In addition, the interior designer also selects such items as refrigerators and additional equipment for staff rooms and other lounges.

Hospitality Equipment

Equipment for hospitality industries is as varied as the service and accommodations provided. Food service equipment includes units for food storage and preparation, cooking, food dispensing, serving, dishwashing, and cleanup. Ice machines, cash registers, bar equipment, and server stations are also part of this type of equipment.

Equipment for hotels and motels can include computerized check-in/out systems, room key monitoring, and carts for porters and housekeeping staff. Individual room equipment includes bathroom items, televisions, and appliances, such as small refrigerators and microwaves.

Retail Equipment

Retail equipment can include cash registers, display stands, manufactured shelving systems, and display cases (Figure 17.25). Equipment for specialized shops, such as a beauty facility, would include hair dryers, shampoo stations, operators' chairs, and specialized skin care machines.

Institutional Equipment

Special equipment is made for libraries, museums, churches, schools, public facilities, and other institutions. These can include lockers, vending machines, audiovisual equipment, study carrels, and recreational equipment.

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Design Communication

18

Communication involves transmitting, transferring, or making known specific ideas, information, opinions, or decisions. Thoughts, ideas, and plans are created in someone's mind, but to serve a purpose, these ultimately have to be communicated to others through some medium. Musicians use sounds to express their musical ideas, writers translate their ideas into words, and designers express their ideas through visualization and drawings (Figure 18.1). Although people may have many great ideas, these concepts must be communicated or they remain "big ideas" that never translate into reality. If an idea is not effectively communicated, it essentially remains unfulfilled.

Most of the ideas designers have are communicated in visual forms, yet the receiver (generally a client) may not be trained to think visually. For example, a lawyer who deals mostly in verbal and written exchanges may not fully understand architecturally drawn plans, sections, and elevations. Designers should attempt to find the best form of communication to make their ideas clearly understood. As communication is a two-way process, designers must also listen to what a client is saying.

Designers communicate their ideas through a process that can be divided into three phases: design conception, design communication, and design implementation. The diagram in Figure 18.2 illustrates the design phases and communication flow, as well as areas of specifics each phase involves. Although we list these distinct steps, they sometimes blend together as one evolves into the next. For example, the use of building information modeling (BIM) in the design phase often creates three-dimensional models and analysis that can be presented to clients and others early in the design stages.

Design conception assists the designer in thinking through, and visualizing the solution to, a problem. Design communication helps the client to visualize how needs will be met by the designer's ideas, proposals, or solutions. To be effective, the designer should clearly define what needs to be communicated and the best way to do it so the proposal will be most accurately understood.

This dissemination can be diagrammed (Figure 18.3) before and after each presentation to ensure that the client clearly understands the design development. The third phase, design implementation, helps the builder or installer to understand clearly what is to be built.

Although a designer's presentation may be beautiful to look at and perhaps be considered by some a work of art, it is a means of communicating an idea that is to be physically carried out. In other words, design visuals are usually not the end product, but represent the designer's perception, analysis, and synthesis of a particular problem or situation and a proposed solution. Interaction must occur with other individuals to put these concepts into motion. In turn, many initial design decisions and details tend to evolve as the design is explored and communicated.

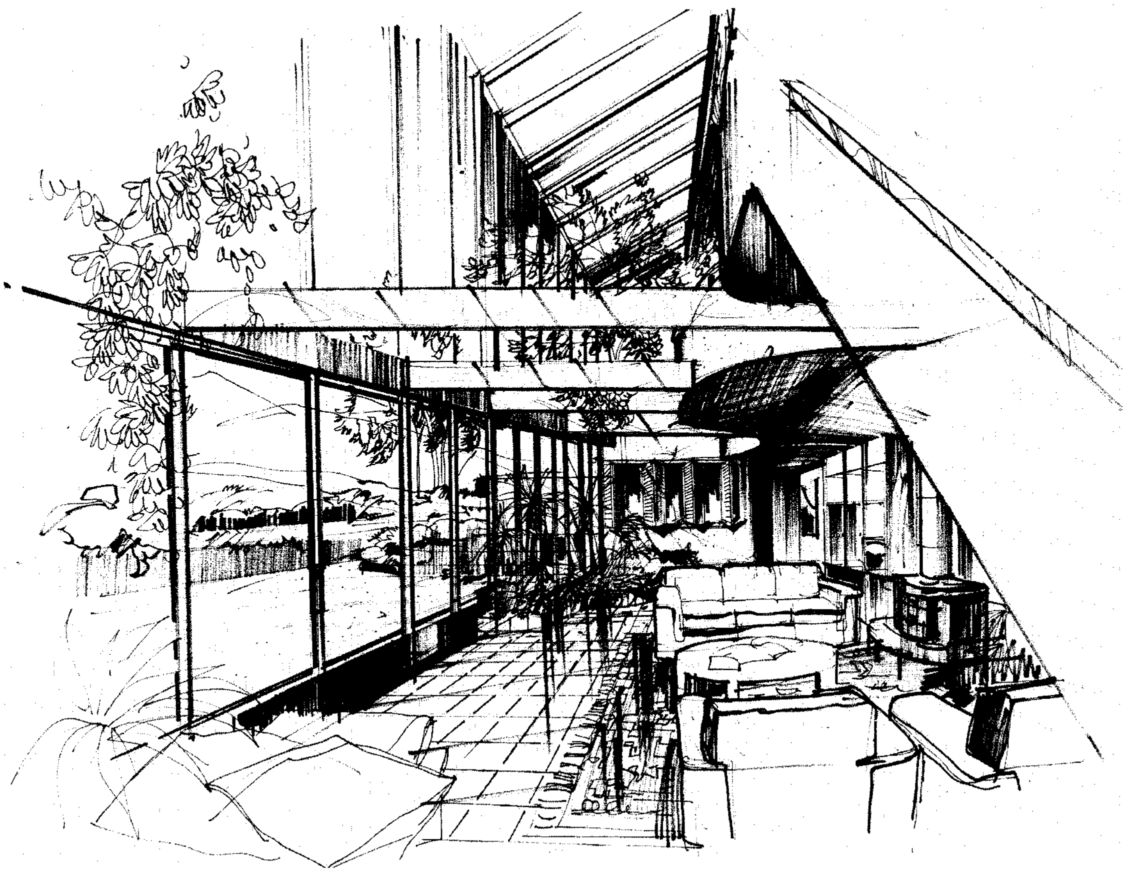


FIGURE 18.1 Designers execute sketches to explain their design ideas to a client, such as this sunroom in a proposed residence.

1 DESIGN CONCEPTION

Problem Identification and Definition
Research and Data Collection
Analysis
Concepts
Idea Generation

2 DESIGN COMMUNICATION

Preliminary Designs/Drawings
Visual/Verbal Presentations
Client Responses
Proposals and Budgets
Design Development

3 DESIGN IMPLEMENTATION

Construction Drawings
Specifications, Samples
Contracts and Business Documents
Construction of the Project
Scheduling and Budget Control
Construction Coordination
Move-In by Client

FIGURE 18.2 Designers use various communication modes and mediums during their involvement in a project.

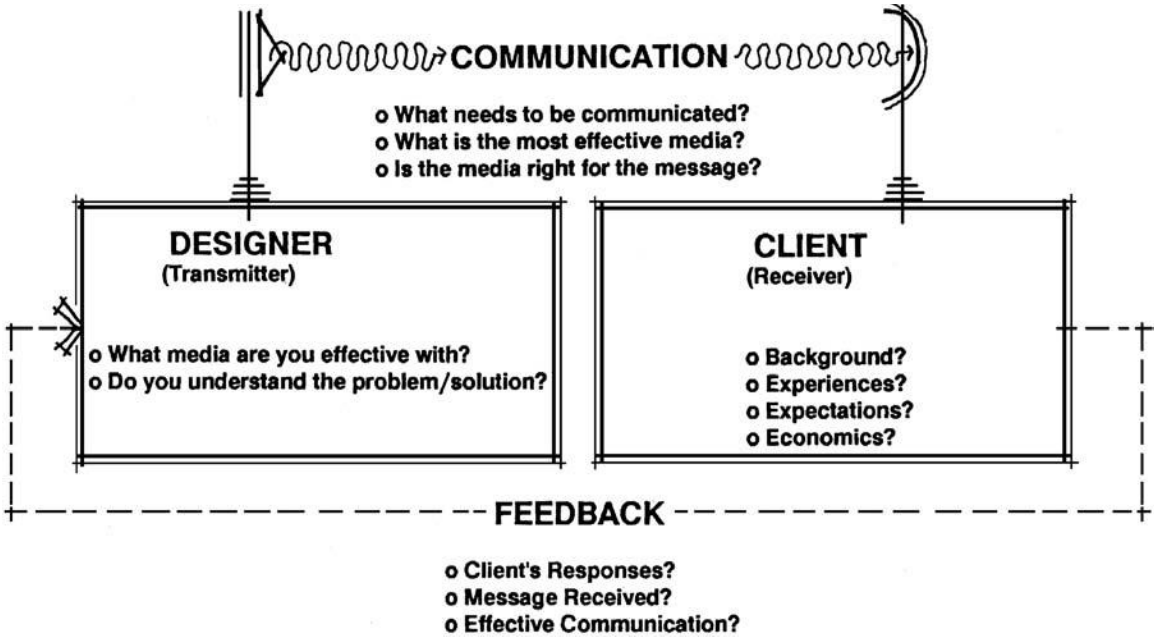


FIGURE 18.3 In this diagram of design dissemination, the designer can also become the receiver as the client becomes the transmitter.

People tend to perceive what they expect or want to see, rather than what is really communicated (Figure 18.4). They can misinterpret information if it is not clearly communicated. The surrounding environment, situation, or cultural differences will often influence people's perceptions of what is being communicated.

The purpose of this chapter is not to teach design students how to draw, but rather how to transmit design ideas most effectively through various mediums and methods of communication.

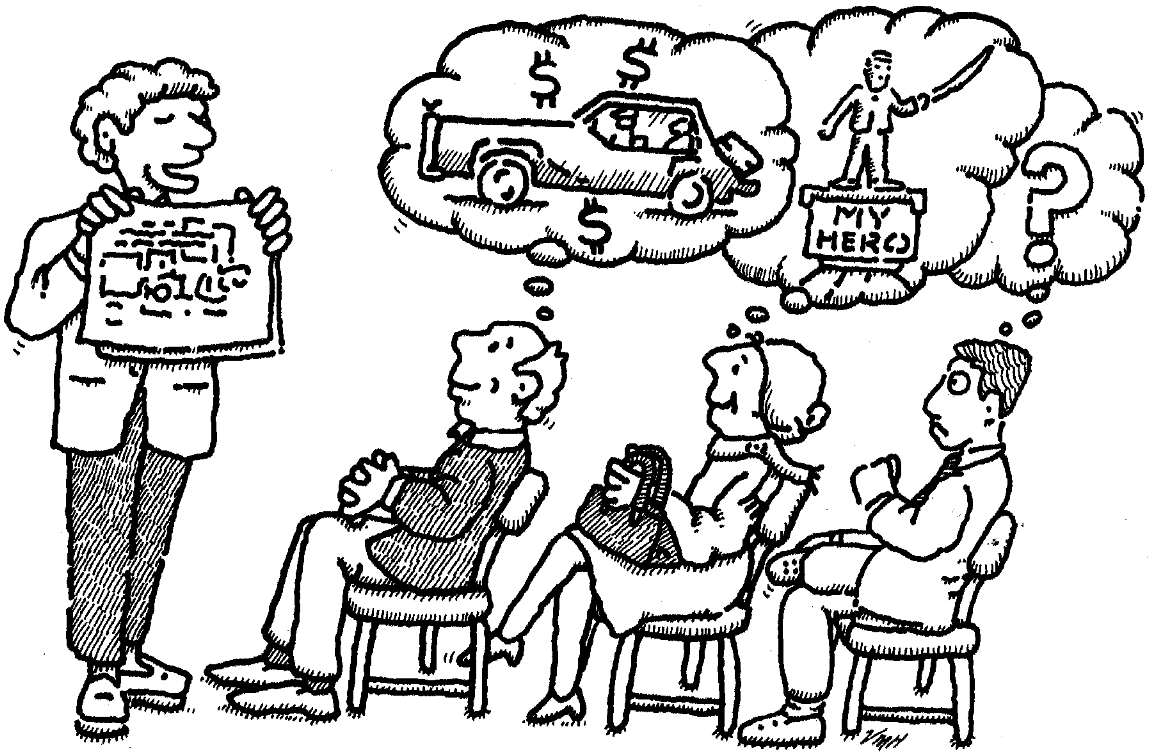


FIGURE 18.4 Individuals tend to perceive and interpret ideas differently. Clear communication is needed to convey specific thoughts, ideas, and solutions.

DRAWING AS DESIGN COMMUNICATION

Designers develop their ideas and communicate them through the visual language commonly referred to as drawing. Throughout the ages, people have been expressing their ideas, experiences, and expectations through drawing. Some drawings are realistic interpretations, and others are abstract. Designers can translate their ideas from abstract drawings to realistic images that can be clearly understood and followed by others who may not be trained in the visual arts. Technology now provides the designer with the tools to create very realistic images for their clients (Figure 18.5).

Drawing is a very powerful tool for the designer and has long been the quickest, most direct, and most effective design communication medium available. However, the line between hand-drawing and digital imaging and manipulation is blurring as computer software and the designer's experience with it make the computer the new pencil or pen. Hand-drawing is a learned skill that must be continuously developed. The only way to become proficient in drawing is to observe and PRACTICE, PRACTICE, PRACTICE.

In his book *Design Drawing*, William Lockard defines drawing in three basic categories: art, design-drawing, and drafting. He compares these forms and illustrates their differences according to their methods, uses, and value systems.

Drawing as *art* places value on self-expression, technique, levels of communication, and choice of subject matter. The drawing actually becomes the finished product as a one-of-a-kind original, such as a sketch by Picasso, and usually increases in value over time. Generally, this form of drawing is not used extensively in the interior design field, although a computer rendering may look very realistic, be a work of art, and be used for marketing purposes.

Design-drawing is a process or means to an end, not necessarily the finished product. It is an exploratory, changing, redefining technique to develop ideas and concepts for communicating to oneself and for others to follow. These drawings serve as a guide for developing and constructing a project (Figure 18.6). At times, however, the beauty of the drawings may place these visuals at the art plateau, and they may indeed become priceless. Design drawings usually are created in the design conception and design communication phases and exhibit different degrees of finish or detail.

Drafting is a form of drawing that consists of formal rules of visual abstraction, such as legends and symbols, or of orthographic projections that are accurate to scale and serve as a pattern for building something. These drawings typically are created in the design implementation phase. The drafting process is an efficient, scaled set of drawing conventions commonly followed by individuals involved in designing, manufacturing, or constructing building, cabinetry, and furniture (Figure 18.7).

FIGURE 18.5 Some interior renderings are very realistic and are used to explain a design concept to a client.
Courtesy of Lisa VanZee

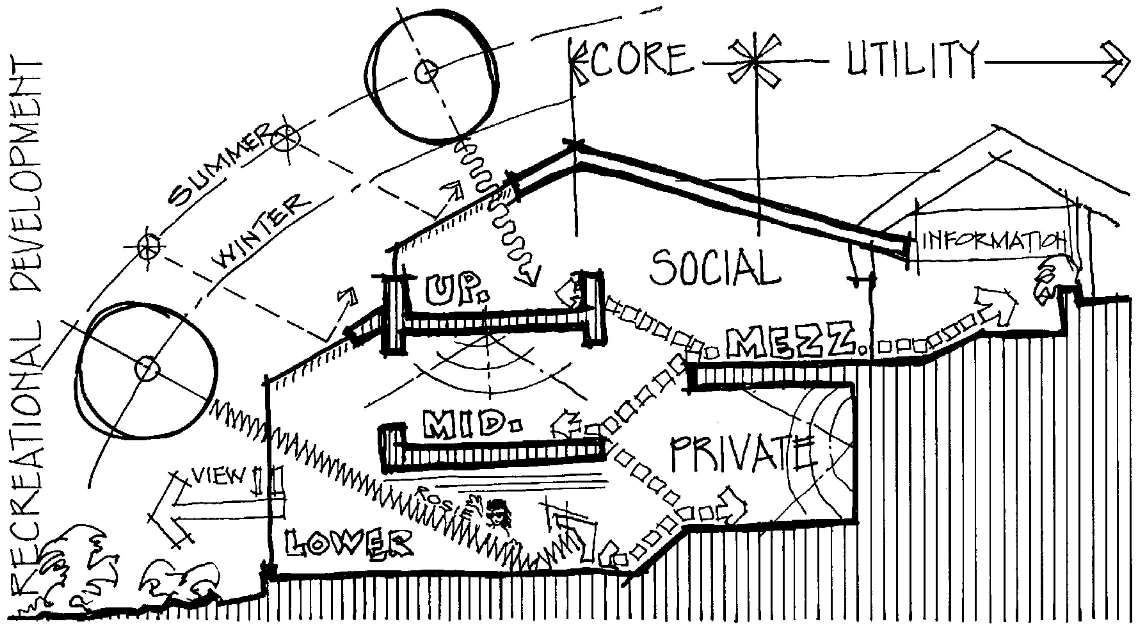


FIGURE 18.6 Design drawings help to develop and refine concepts that can be visually explained to others.

This chapter deals primarily with the design and drafting forms of drawing, not with drawing as an art form. It will discuss when to use drawings and what form of drawing the designer should use to develop concepts and communicate to others.

Although drawing is a very effective means of design communication, a designer should be aware of its limits as a medium. Drawings alone will not always fully explain an idea and will have to be augmented by a verbal presentation, a computer-generated model, or even a three-dimensional scaled model.

Architectural Graphics

One of the first drawing stages in the design conception phase deals with certain symbols or visual abstractions commonly referred to as architectural graphics. These do not necessarily include detailed drawings of floor plans, elevations, or sections, but rather portray basic issues, ideas, concepts, and physical relationships of a particular design.

At this stage, the graphics are fairly abstract and general in nature. The designer sketches and resolves the basic issues of the situation before moving on to details. Concepts are refined in these loose sketches and communicated to the client in a visual, graphic form, often done with computer assistance. The designer works visually through a design process (Figure 6.6) beginning with schematic sketches, then developing bubble diagrams, zoning diagrams, and preliminary designs. Bubble and zoning plans (Figure 18.8) help define spaces and their relationships.

Graphics for interior design can be presented in many different forms, each with its own language or symbols. Graphics for building design can be broken down into two groups of relationships: (1) physical, which are spatial configurations, location in space, and elements, and (2) nonphysical, which are concepts, ideas, events, processes, and time. These graphics might include diagrams, charts, matrices, zoning, plans, circulation, spatial relationships, hierarchy, structure, and scheduling (Figure 18.9).

In most cases, architectural graphics are produced in the design conception and design communication phases. However, they can also be found in the design implementation phase, in the form of a graphic guide for the construction process. Although the construction drawings, or blueprints, for a building are really graphic symbols, we usually refer to them as architectural drawings.

Architectural Drawings

Architectural drawings can be pictorial images of buildings, interiors, or components to be built. These drawings also illustrate materials and methods for constructing objects as drawn by a designer to serve as a guide for others

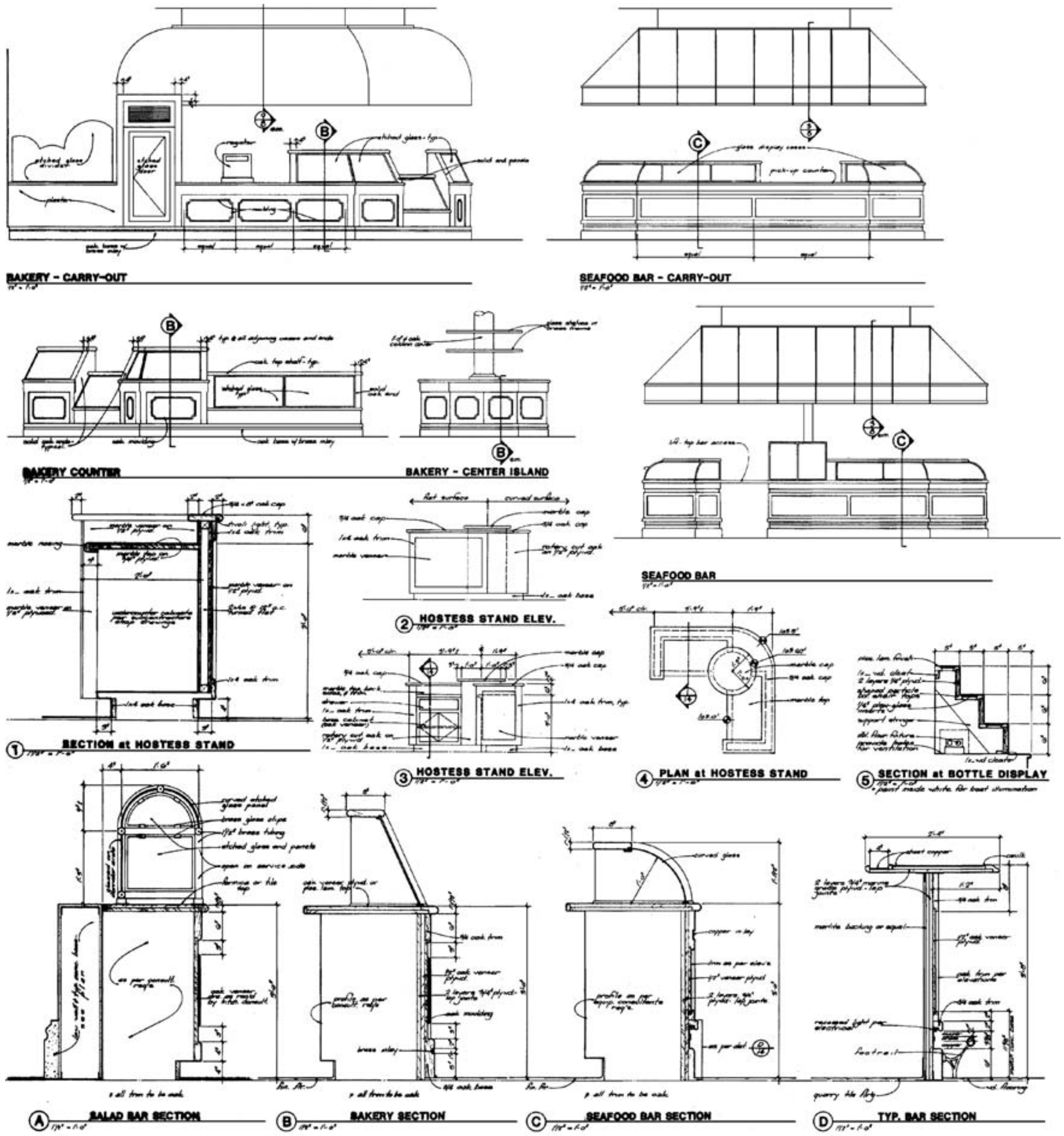


FIGURE 18.7 Example of construction drawings to explain the details needed for construction.

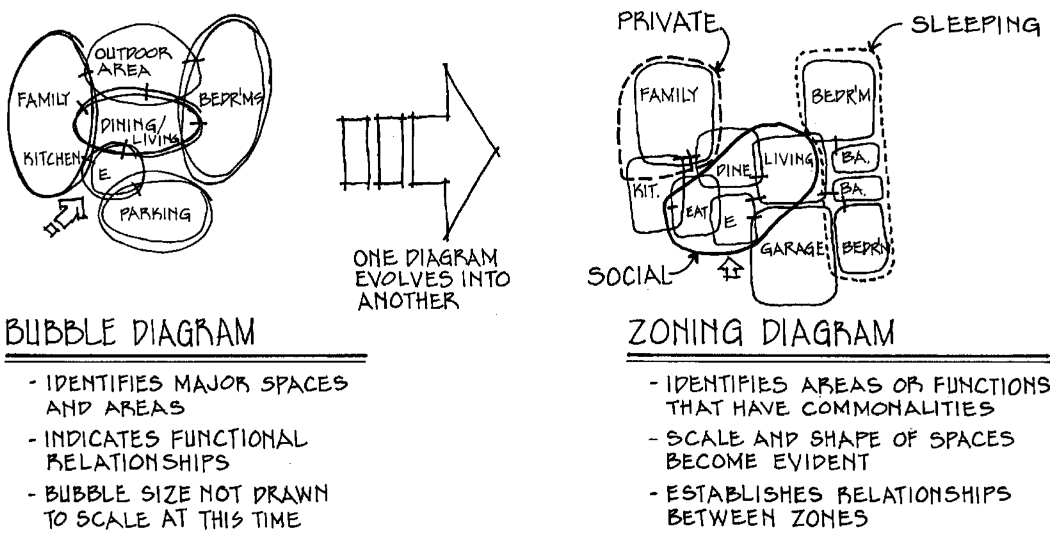


FIGURE 18.8 Bubble diagrams and zoning diagrams are schematic drawings that help to visually establish the relationships of spaces and the needs of the users.

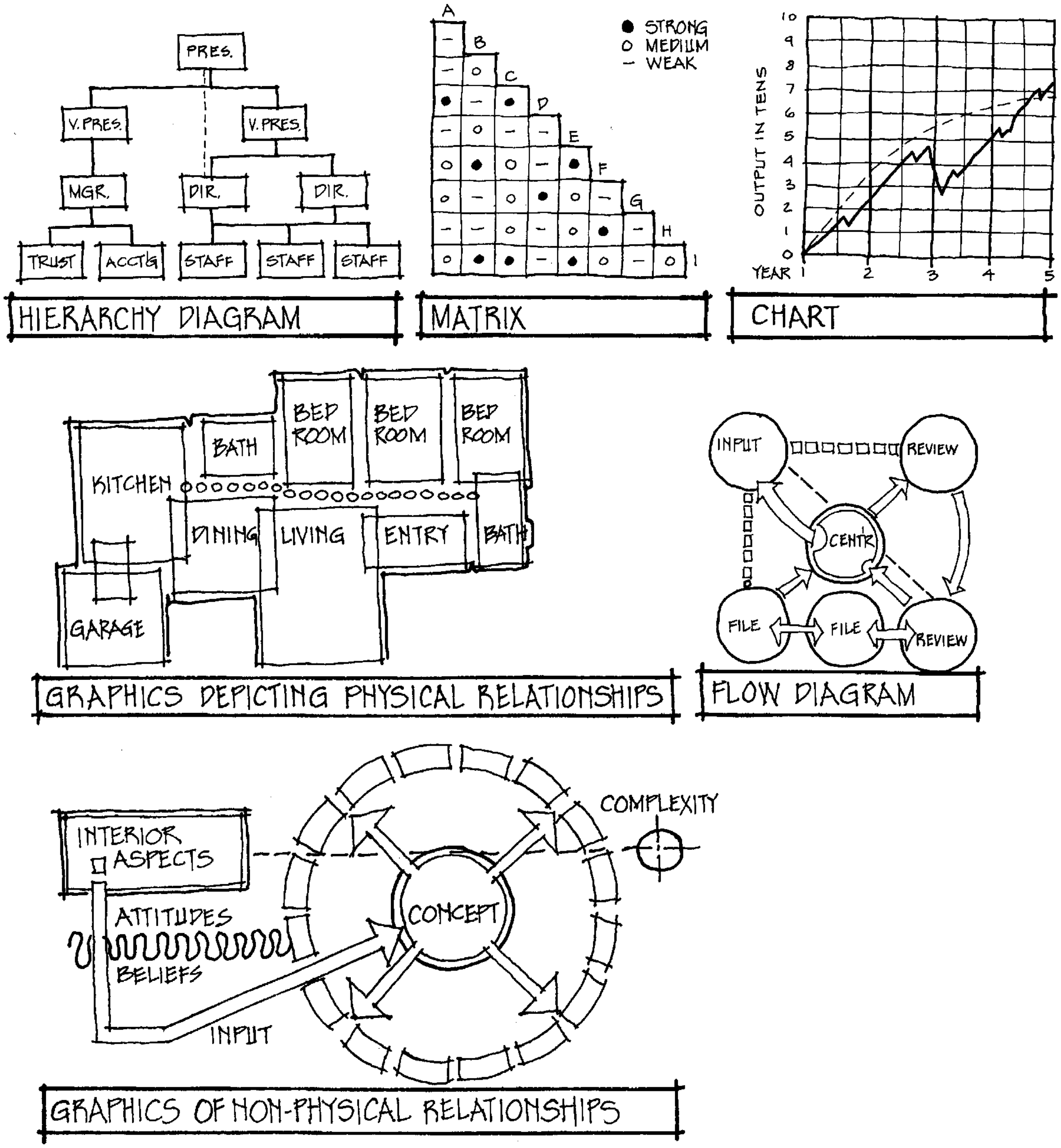


FIGURE 18.9 Graphics for design methodologies

to follow. Architectural drawings differ from schematic and architectural graphics in that they are usually more accurate in scale and detail (Figure 18.10). Architectural drawings for interiors include floor plans, sections, elevations, details, ceiling plans, finish schedules, and electrical plans. However, other kinds of drawings may be necessary before a total project can be constructed and installed. These might include a site plan, foundation plan, structural plan, and mechanical (heating, cooling, ventilation, water, and waste) plans.

Architectural drawings are done as design or presentation drawings and as construction or "working" drawings.

Presentation and Construction Drawings

Presentation drawings (Figure 18.11) are used to convey spatial relationships, elements, materials, color, furniture, furnishings, and equipment. Presentation drawings should be architecturally correct but should also present the space as "psychologically comfortable." This type of drawing should be both pleasing visually and easy to understand. For example, if the designer is using carpeting on the floor, it is often rendered in the drawing with similar color and texture. Or if wood flooring is being used, it is illustrated with wood color and grain (if the floor plan scale is appropriate).

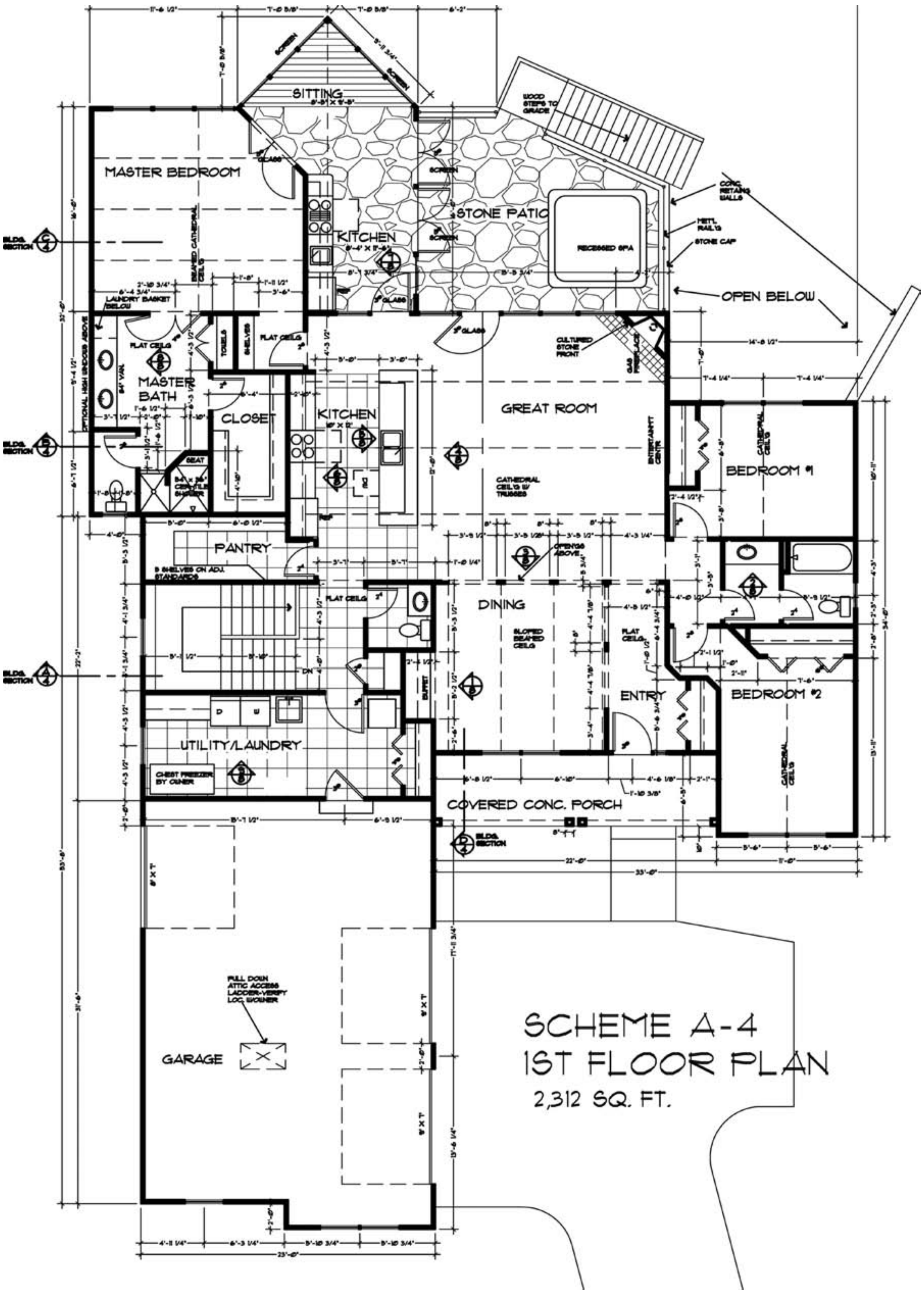


FIGURE 18.10 This floor plan for a new residence is drawn to scale and contains a lot of details, dimensions, and other notes for construction purposes.

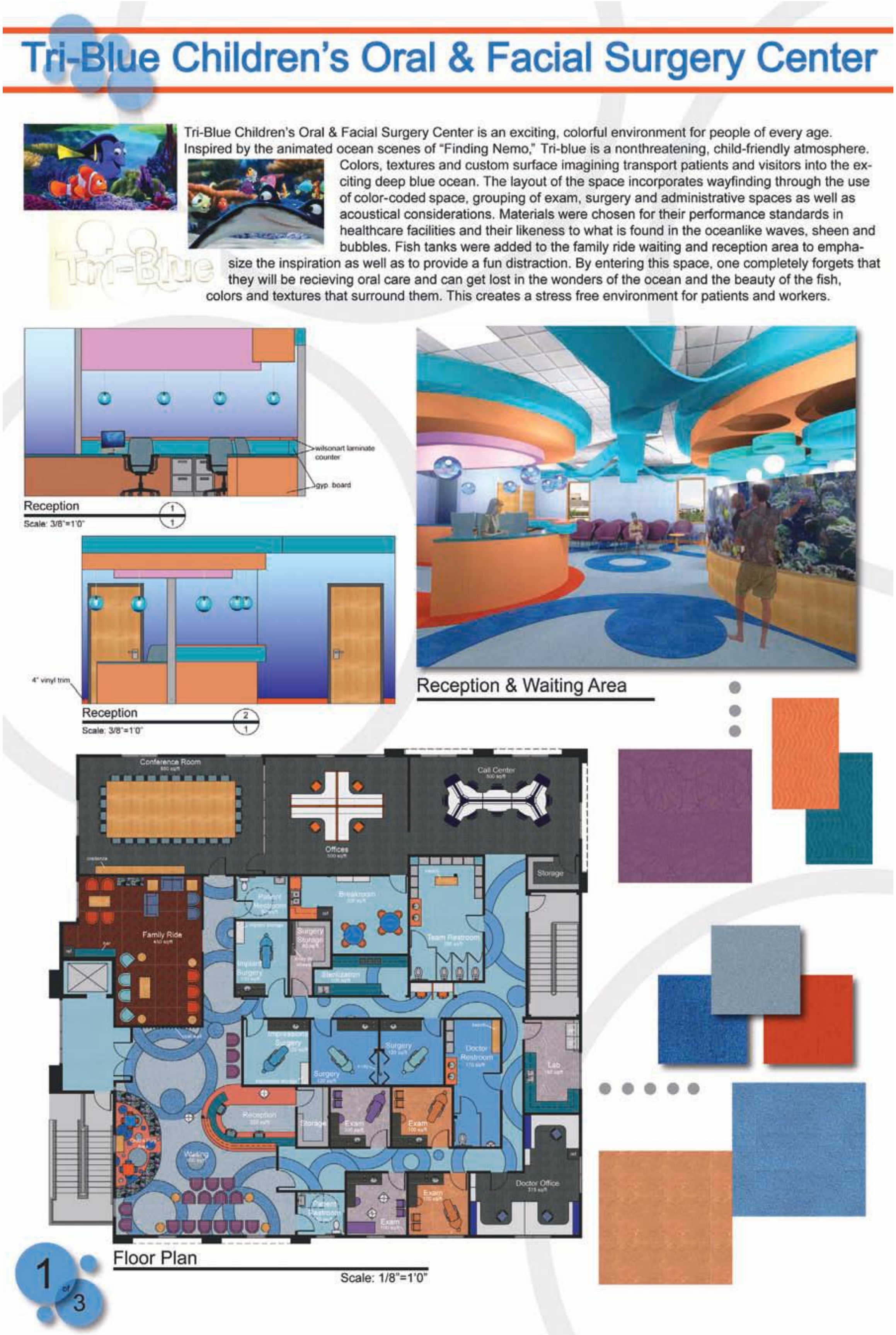


FIGURE 18.11 This presentation board by Brittany Pringle is one in a series depicting a new medical facility in an existing building.
Courtesy of Brittany Pringle

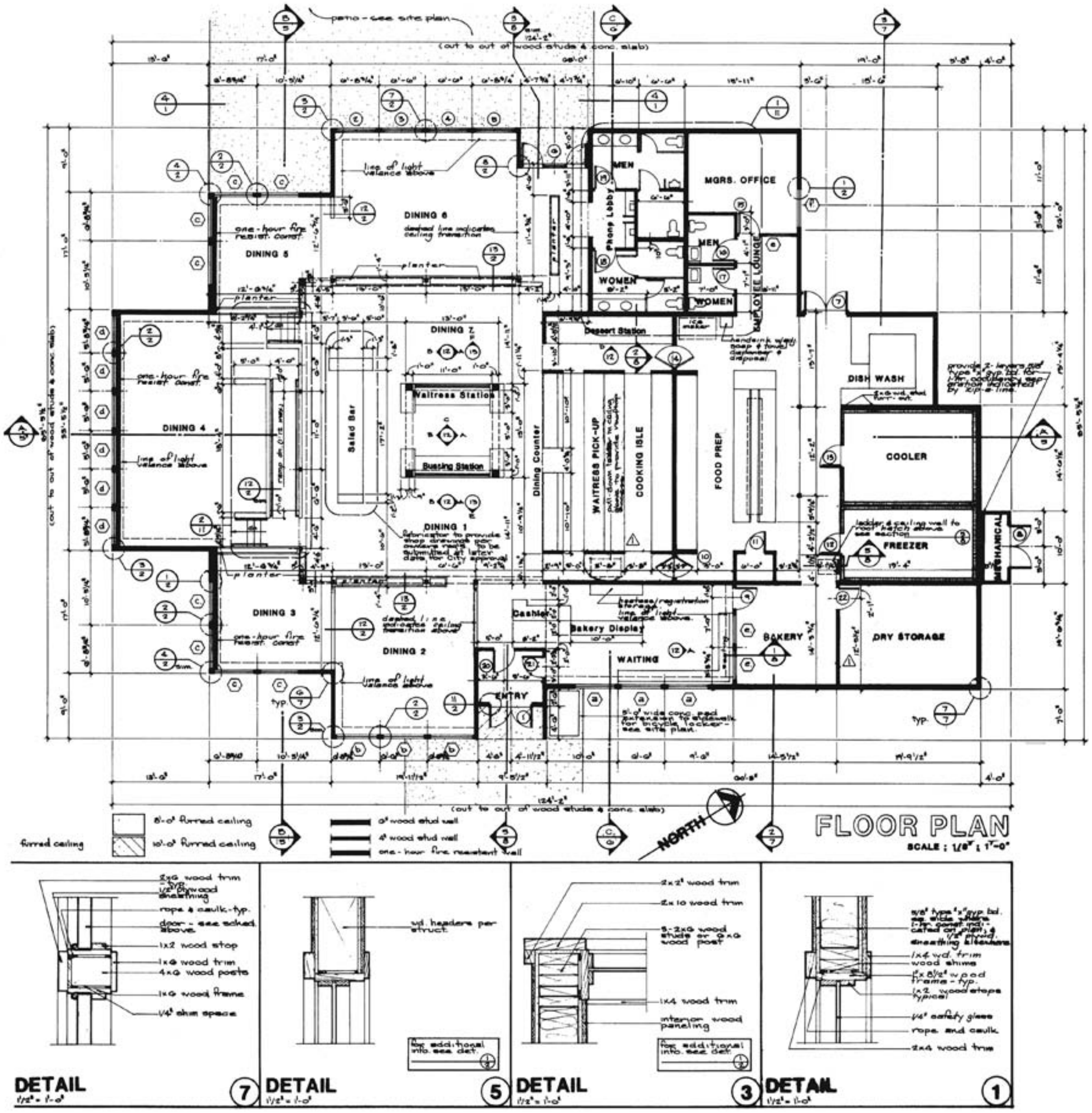


FIGURE 18.12 Floor plan and details from a partial set of construction drawings for a restaurant

Furniture should also show detail, rather than merely indicating the outer edges of the piece. The arms, back, and shape of each piece are indicated where possible. A presentation drawing does not eliminate the need for a construction drawing, since the two are generated at different stages within the overall process.

Construction drawings (Figure 18.12) are graphic representations to communicate how to do the construction, remodeling, or installation of a project. These drawings include room labeling; dimensions; door, window, and fixture locations; materials; notes; and other proposed interior construction details.

Floor Plans

Floor plans are used to illustrate the layout of spaces and elements, such as walls and doors, and to clarify relationships of one space to another. Floor plans are the basic reference point for most design projects and are one of the most important items presented to the client or the builder. They give a bird's-eye view of a floor level of the interiors. Floor plans have an imaginary horizontal cut made through the building walls approximately 4 feet (1,219 mm) above the floor level, and the top of the building is then lifted away (Figure 18.13). Floor plans indicate the size and outline of a building as well as the location of the interior walls, doors, windows, fixtures, and other elements. Floor plans are drawn to scale, and furniture is often added to give a sense

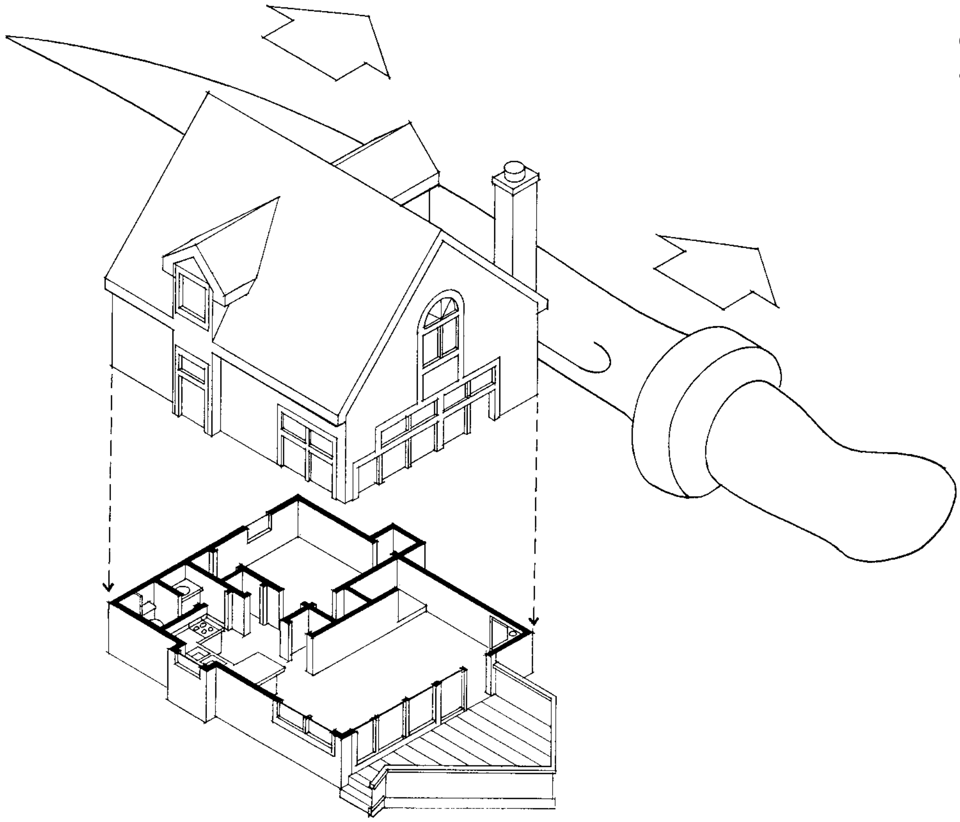


FIGURE 18.13 A floor plan view is created by slicing horizontally through a building.

of scale and help define the use of each area. Labeling of spaces also assists in defining the function of the room, if it is not visually apparent in the drawing. Color and textures of materials can be added to a floor plan to give it the character and spirit of the interior. Floor plans are generally drawn to a scale of ⅛″ = 1′0″ or ¼″ = 1′0″ (1:100 or 1:50 in the metric system); other scales can be used, depending on the size of the actual project.

As the metric system becomes more prevalent in the United States and for international clients, architectural scales will eventually evolve into that system. Plans are often referenced to a compass point of north or to other major geographical or building elements. Figure 18.14 shows a floor plan presented both as a presentation drawing and as a construction drawing.

Sections

Sections are drawings representing a view of an object and its interior after making an imaginary vertical cut through it (Figure 18.15). This view represents what is drawn for the cross section. Sections show heights and vertical relationships between spaces, floors, and ceilings, as well as clarify certain building elements and details, such as stairs, walls, and beams. Sections can also give detailed information—such as the size of structural elements, type of foundation, and type of interior flooring construction/materials—that is not clearly shown in other drawings.

Building cross sections show most of the important aspects of an interior; smaller cross sections (drawn at a larger scale) show details of individual portions of a building, space, or object. The designer provides as many cross sections as necessary to convey the information needed about the space/building.

Sections should ideally be cut in a straight, continuous line, using jogs in the cutting plane only when absolutely necessary. A section indicator is needed on the floor plan to show where the floor is cut and to indicate the direction of the section view. Building sections are usually drawn at ⅛″ = 1′0″ or ¼″ = 1′0″ scale (1:100 or 1:50 metric). Large scales, such as ⅜″ = 1′0″ (1:35 metric), are usually used for detailed design sections. For large buildings and complexes, the scale might be reduced to 1/16″ = 1′0″ (1:200 metric) or smaller.

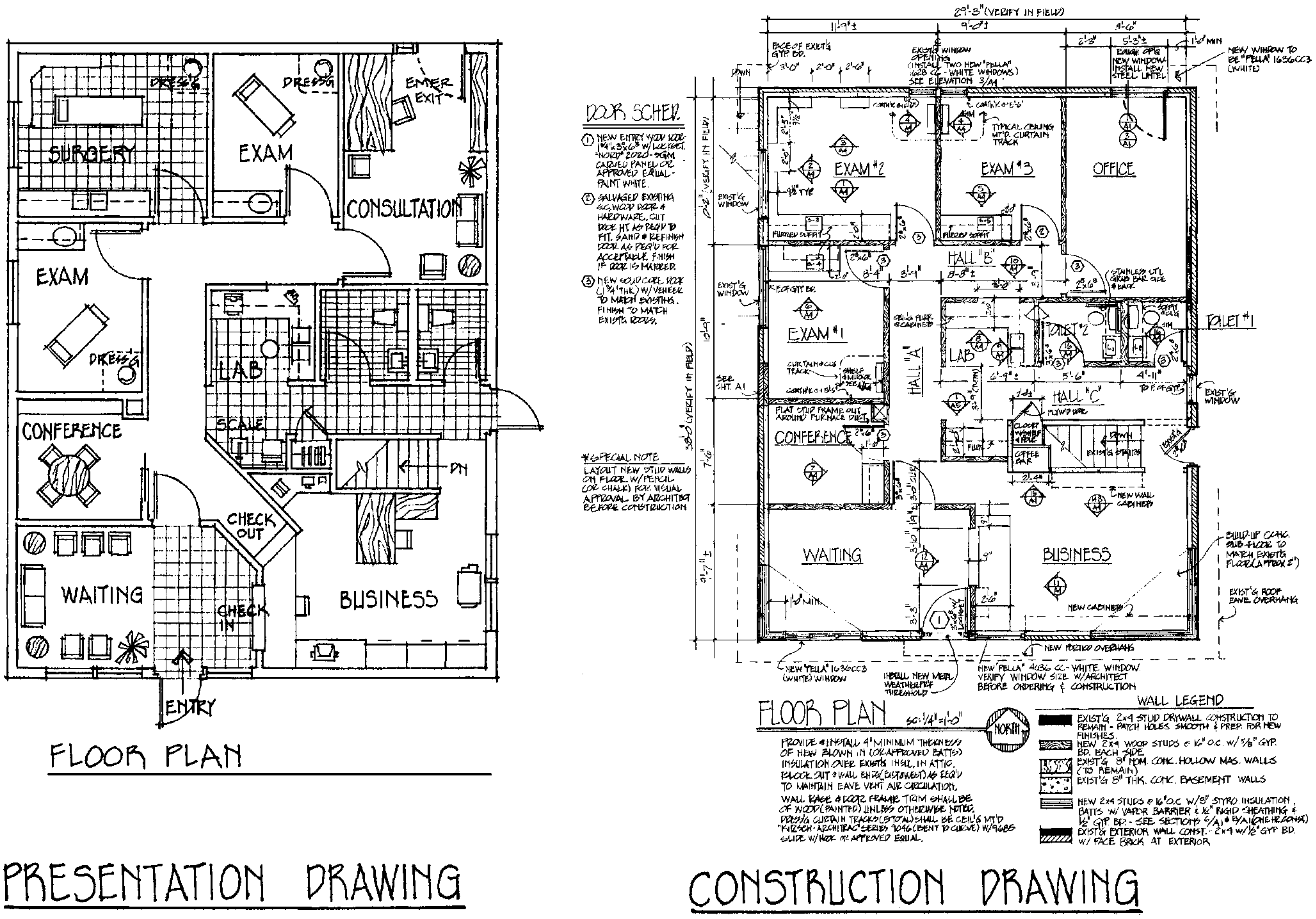


FIGURE 18.14 Examples of a presentation and a construction drawing

It is often a good practice, when possible, to include people in design sections to give a sense of human scale to the spaces. Figure 18.16 shows a building section as a presentation drawing and as a construction drawing.

Elevations

Elevations are straight-on views of specific exterior or interior walls, or of related elements, such as cabinetry. They convey a structure's form, door and window openings, materials, and texture. An elevation drawing shows no depth but does show height, width, and materials.

Interior elevations (Figure 18.17) are vertical projections of the inside walls used to indicate ceiling heights and placement, type, and size of built-in cabinetry and accessories. These elevations might also show other special features attached to the walls, wall finishing, and other details appropriate for a particular space.

Exterior elevations (Figure 18.18) depict the roof, doors, wall finish, window style, and other elements from the outside. Exterior elevations illustrate how the structure is enclosed, that is, the external surfaces; these elevations are usually labeled according to the direction they face and are referenced to the floor plan.

Elevations used in design drawings and construction drawings can look similar. The major differences are that in design or presentation drawings, shade, shadows, and texture are often used to portray relationships and the character or form of a building (or interior).

Details

Details are enlarged scale drawings of particular exterior or interior elements that need specific attention or further explanation, such as cabinets, window frames, built-in furniture, stairs, fireplaces, or even a skylight (Figure 18.19).

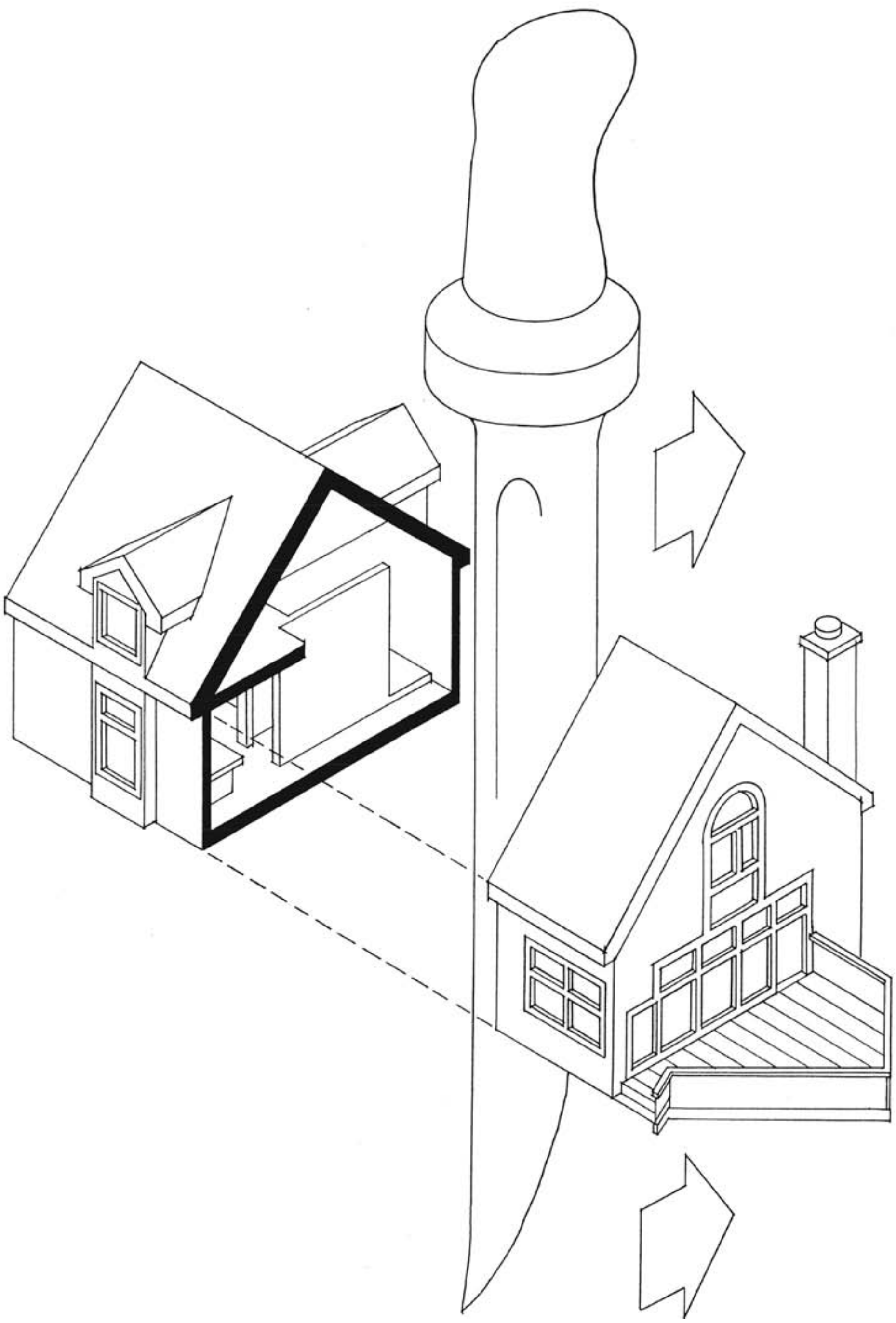


FIGURE 18.15 Section view can be imagined by slicing vertically through a building, as illustrated.

The number of detail drawings depends on the complexity of the designs and construction materials/techniques needed. Detail drawings give exact materials; indicate dimensions, such as height, width, depth, and location; and are referenced to the other drawings.

Reflected Ceiling, Lighting, and Electrical Plans

A ceiling plan is usually drawn as if the viewer were looking down through a transparent ceiling at the floor plan. This image of the ceiling is referred to as a reflected ceiling plan and is drawn so that it has the same orientation as the floor plan (Figure 18.20). It is not reversed like a true mirror image.

The reflected ceiling plan involves a horizontal cut through the building; it is used to indicate information such as ceiling material and layout (acoustical tile panels), lighting fixtures (type, location, and sometimes switching),

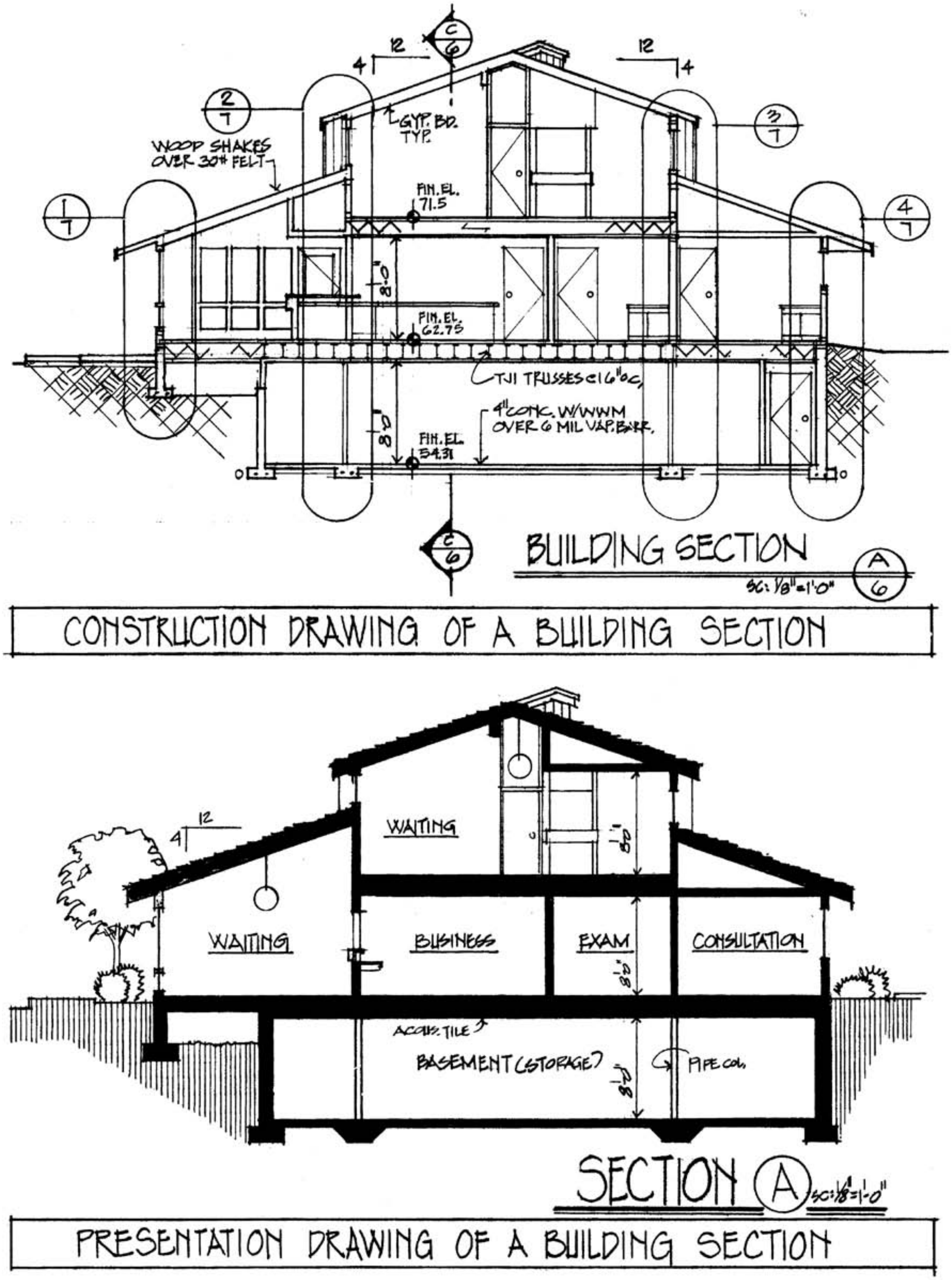


FIGURE 18.16 Example of building section drawings

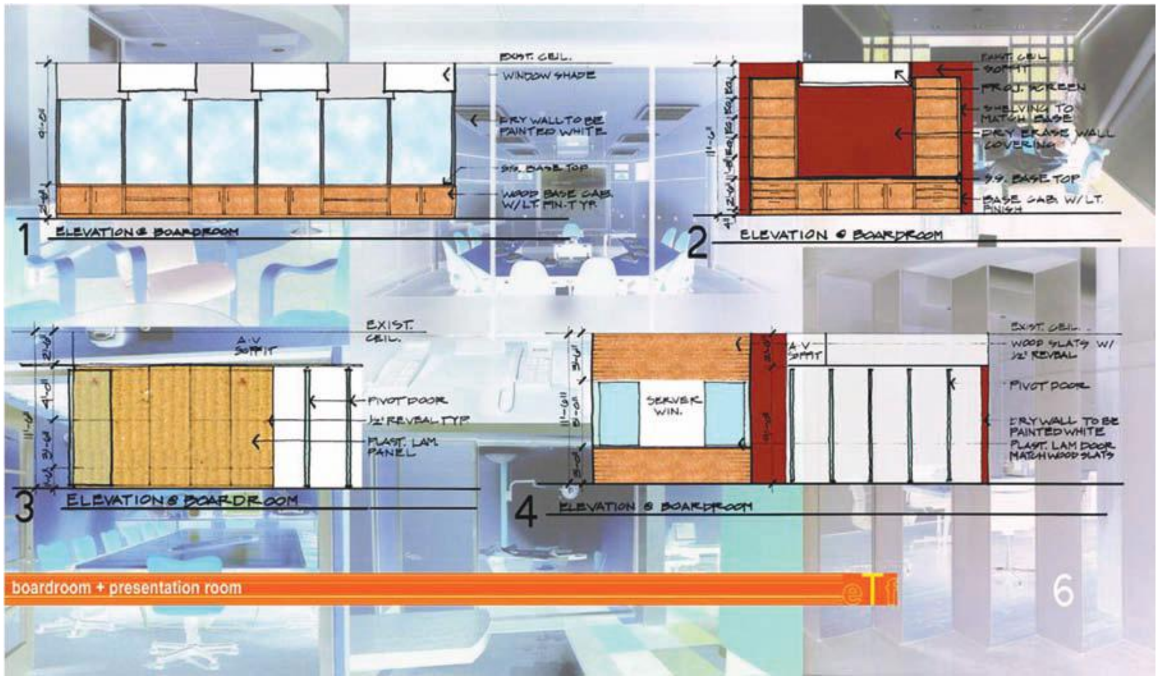


FIGURE 18.17 Interior elevations in this presentation drawing are straight-on views of a room wall and/or individual elements. Depth is not apparent in these drawings.

Courtesy of Jeff Johnston

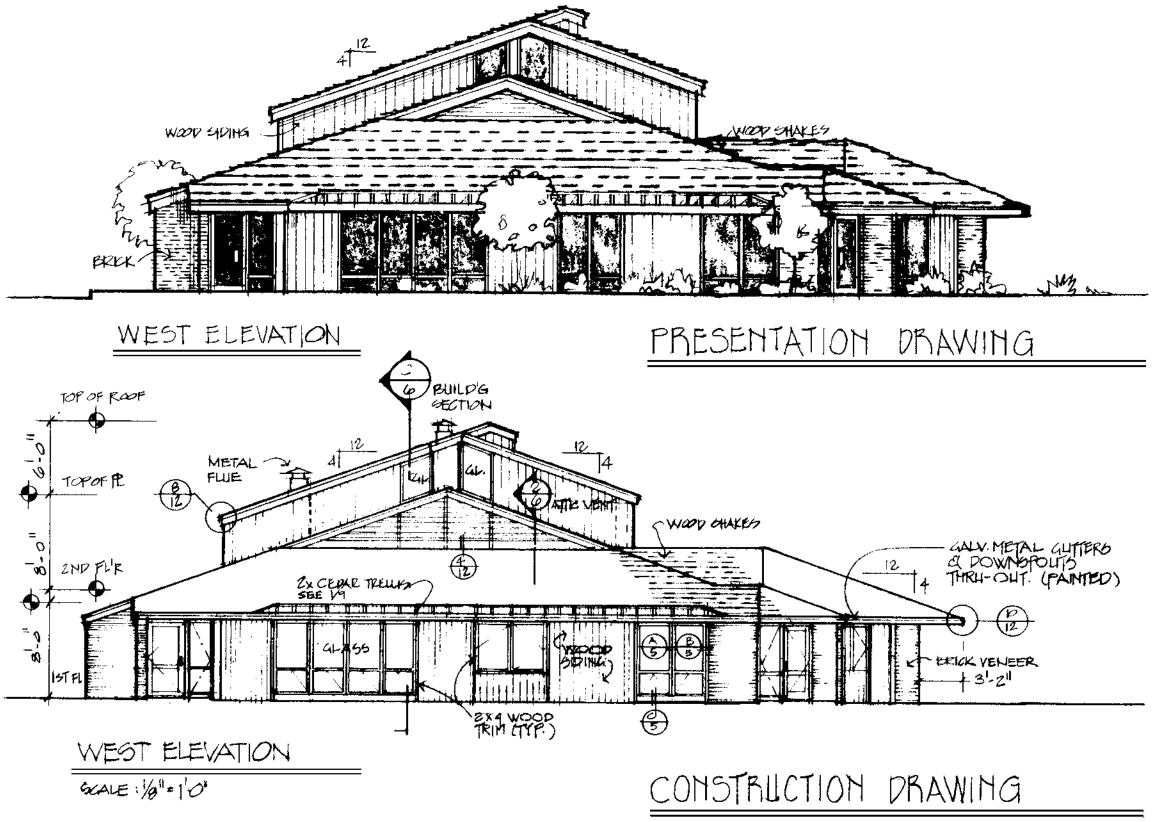


FIGURE 18.18 Elevations can be drawn as a presentation drawing or a construction drawing.

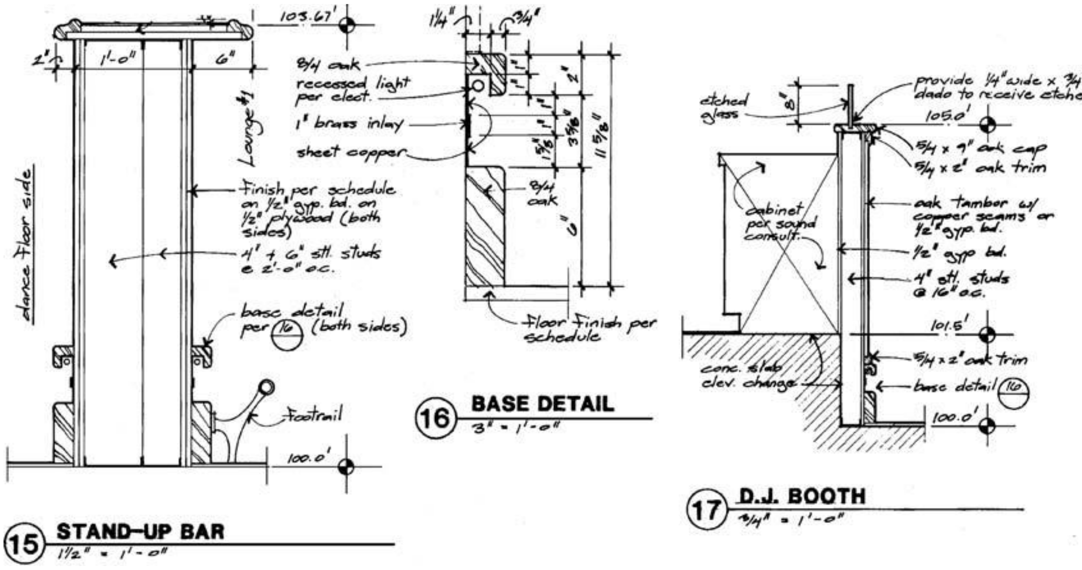


FIGURE 18.19 Example of detail drawings

exposed structural members, custom ceiling treatments, heating/air-conditioning diffusers, and many other details.

In a lighting plan (often drawn as a reflected ceiling plan), two common methods are used to indicate the location of the switches for a particular light fixture (Figure 18.21). One method uses an appropriate line to connect each luminaire and its switch or dimmer. In this system, a single line symbolizes the fixture connection within a single circuit. The electrical contractor or the electrical engineer will determine the actual number and size of the wires, as well as their exact physical location. The other method, used in large spaces, places a lowercase letter or number

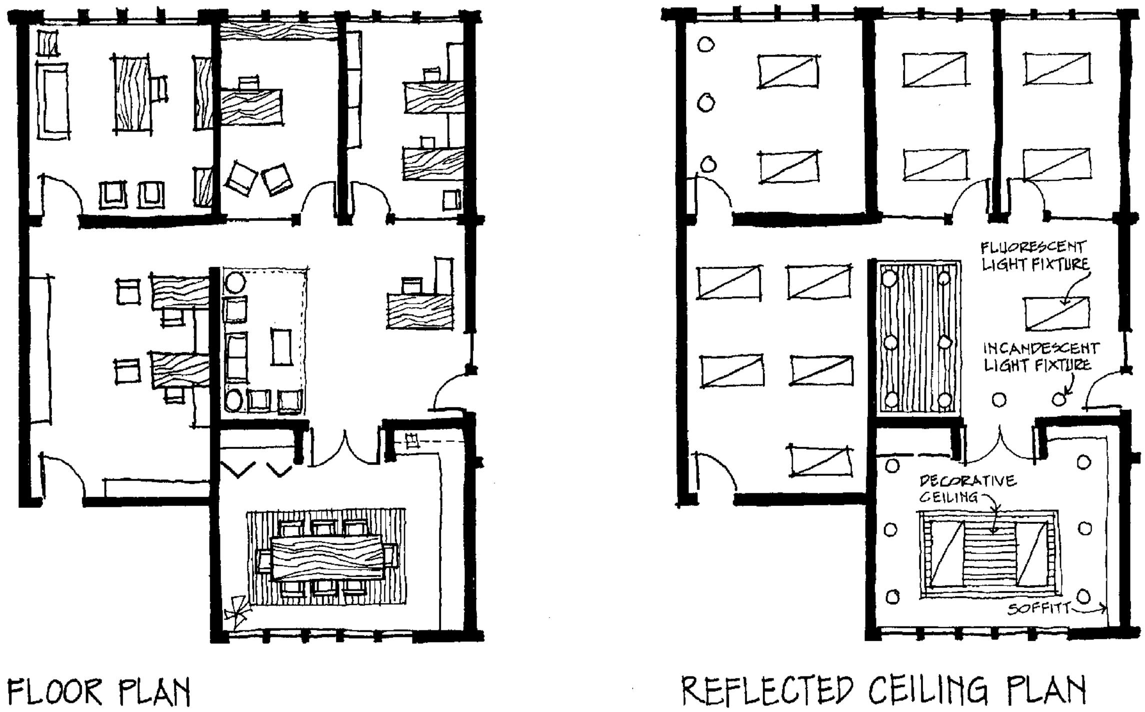


FIGURE 18.20 A reflected ceiling plan must be oriented to the floor plan view.

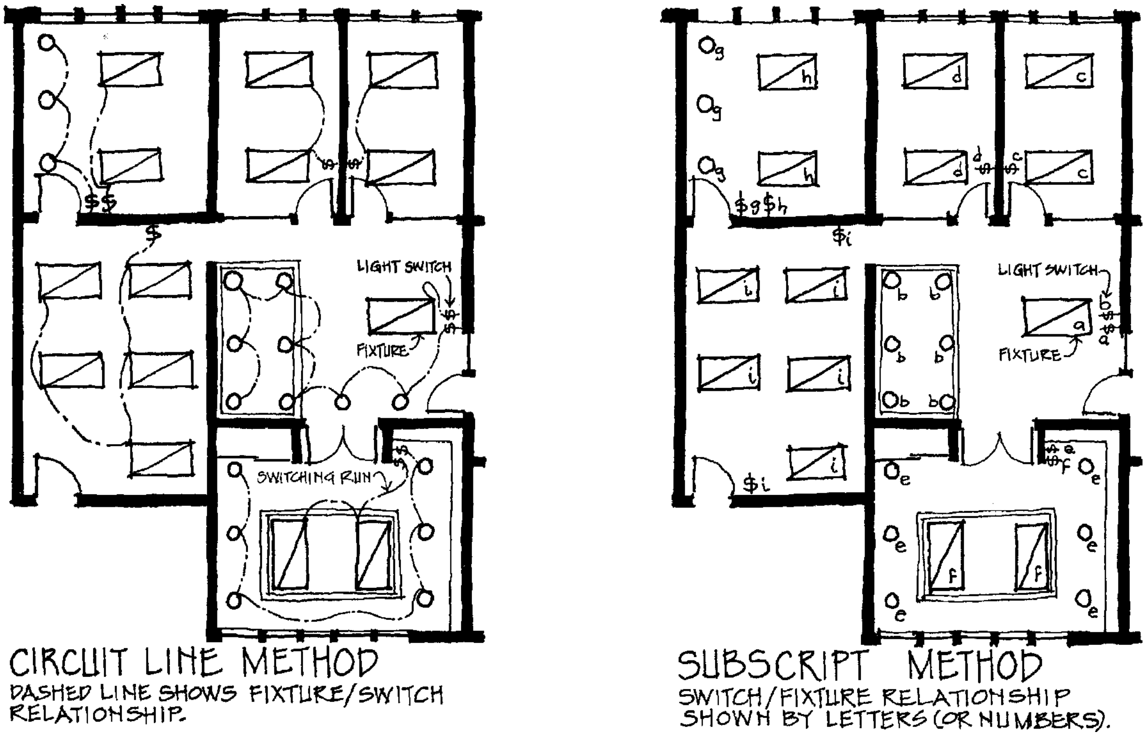


FIGURE 18.21 Two different drawing methods can be used for indicating the switching controls for a lighting system.

by each luminaire symbol, and that letter or number refers to a corresponding control, such as a wall switch, with the same lowercase letter or number.

A lighting schedule indicating all luminaires by type, description, wattage, lamp, manufacturer, and finishes is included with the reflected ceiling plan for easy reference.

Electrical plans are drawn as floor plans and generally indicate the location of wall or floor convenience electrical outlets. Electrical plans sometimes show the actual wiring circuit runs to the electrical panel. Other systems, such as telephone, computer, or special equipment, also are often indicated on the electrical plan. In small projects or residential construction, the lighting plan and electrical plan are often combined into one drawing or incorporated into the floor plan (Figure 18.22).

Schedules

Schedules list elements important to a building or space and are usually made for doors, windows, furniture, room finishes, colors, and any other project components needing detailed clarification. Several schedules are usually required. For example, one schedule may show all the doors within a building or space, indicating their style, size, location, manufacturer, finish, and hardware (Figure 18.23), and a different schedule might do the same for windows.

Room finish schedules can be done in chart or plan view form (Figure 18.24). The chart schedule is keyed to a floor plan; the schedule includes the room name (or number) and sets up finish categories for the floors, wall bases, walls, ceilings, and miscellaneous trims. Vertical columns are established below headings that indicate types of room materials, such as vinyl, carpet, tile, wood, plaster, paint, or other finish.

A specialized finish plan in which materials are keyed directly on the plan is another way to indicate room finishes. An accompanying key indicates the type and location of the finish.

Since the format providing the information for one project may not be adequate in another situation, there are many ways to design schedules. Schedules should be clear and easy to read in order to avoid confusion or mistakes.

Installation Plans

Installation plans are a part of the construction drawings and communicate the location of built-in or movable items, such as furniture, furnishings, or equipment. One of the most common installation plans is the furniture plan (Figure 18.25), which is often keyed to a furniture schedule or specifications. The plan indicates exactly the

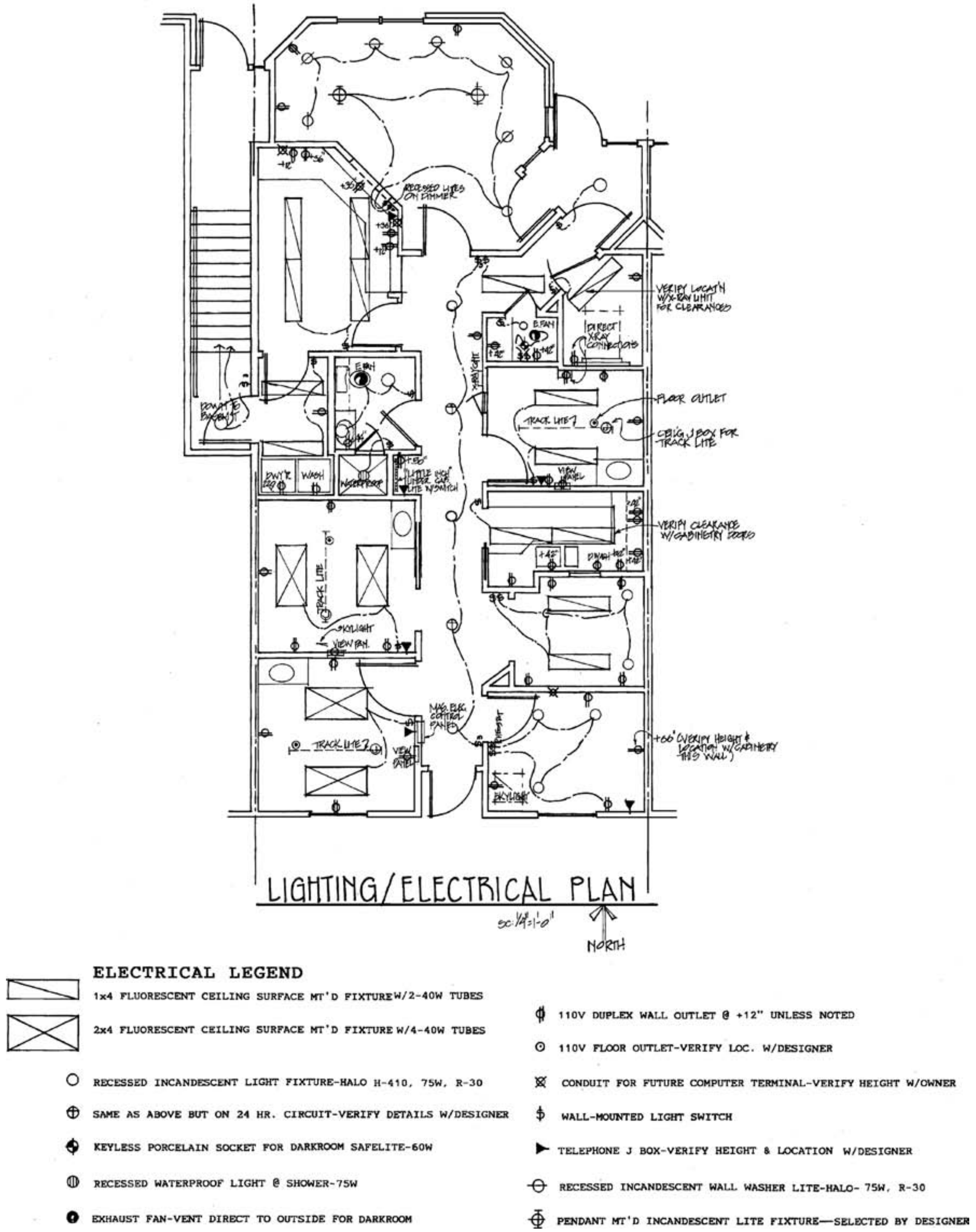


FIGURE 18.22 In small projects, the lighting and electrical plan can be combined for simplicity.

unit to be positioned, its orientation, and possibly its alignment with electrical or communication systems. Other installation plans might include window treatments, electronic equipment lamps, cabinetry, appliances, and other items that require directives for proper placement.

Three-Dimensional Drawings

The visuals discussed to this point are two-dimensional; that is, they illustrate space and elements in a flat view. For example, the floor plan usually shows the length and width of everything within a space. An elevation or

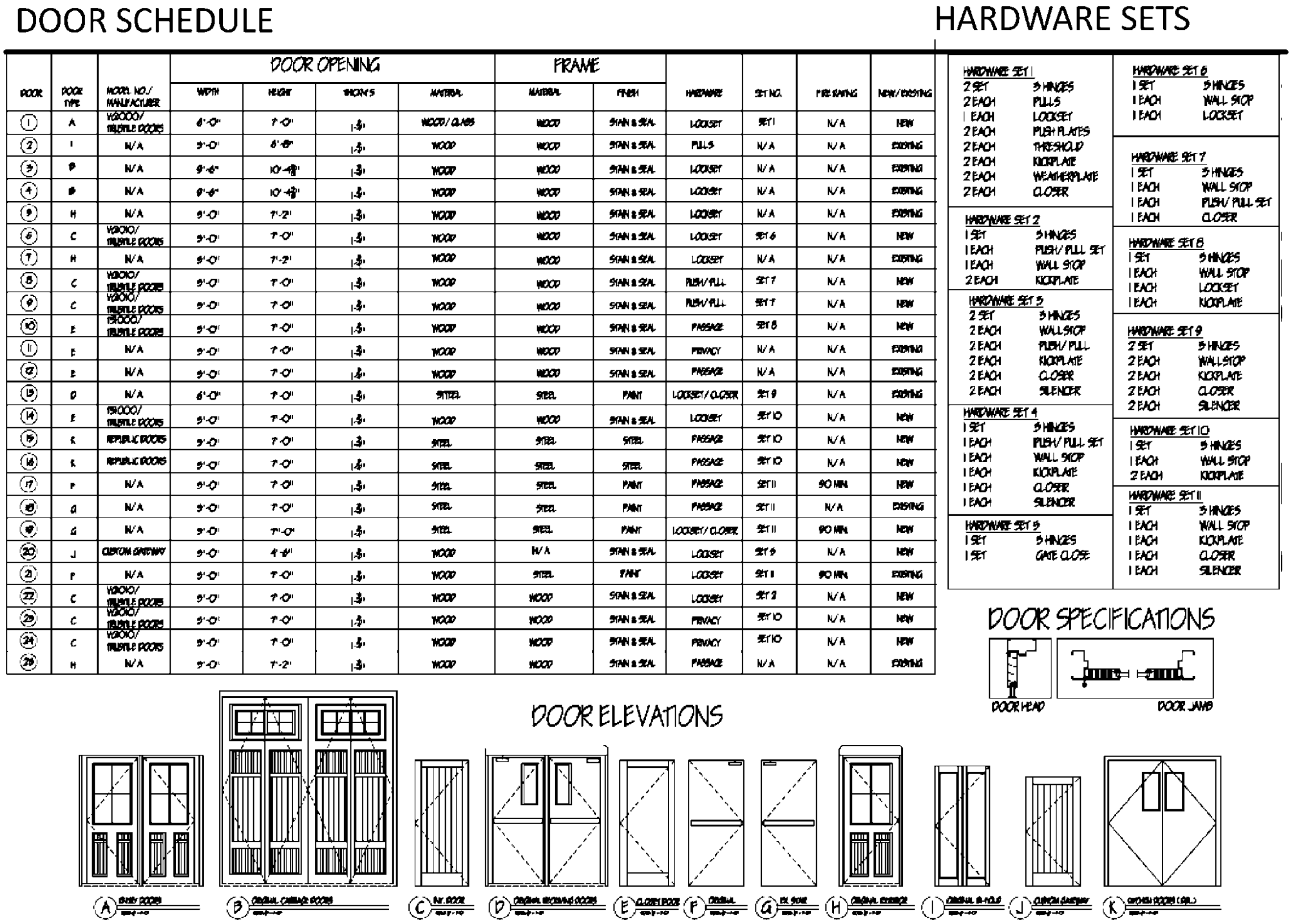


FIGURE 18.23 Door schedules spell out the specific details of every door and are keyed to the floor plan.

section is then needed to illustrate height, but no third dimension or true depth is visually indicated. For this information, the designer creates a series of multiviews, called orthographic drawings (Figure 18.26), which depict reality through a group of related views.

However, a single-view drawing can portray all three dimensions of form simultaneously and illustrate the relationships of space, objects, and materials in a more realistic or photographic manner. The two major types of single-view drawings are paraline drawings and perspective drawings. In paraline drawings, the parallel lines remain parallel, but they converge to vanishing points in perspectives.

Paraline Drawings

Paraline drawings are categorized according to the axonometric and oblique methods of projection used to develop them. Some designers commonly refer to paraline as axonometric drawings; however, axonometric drawings include the isometric, diametric, and trimetric. Oblique drawings include the transoblique and the general oblique. The two most common types of paraline drawings used in interiors and architecture are the isometric and the oblique. Paralines are generally easier and faster to construct by hand-drawing than perspectives, which makes paralines useful for quickly illustrating three-dimensional ideas, especially in the early stages of the design. However, most of these axonometric drawings can be quickly generated with various computer software.

ISOMETRIC DRAWINGS Isometric drawings (derived from the Greek words meaning "equal measure") are based on 30° angles; their three principal axes of measurement are two ground-plan axes and a vertical axis for height (Figure 18.27). These three axes collectively define the three edges of a basic isometric cube. Both ground-plan axes tilt 30° above the horizontal plane line in an isometric drawing, and the height axis is a vertical line measuring true height.

FIGURE 18.24 Finishes in a project can be specified in a chart/schedule form (a) or drawn as a finish plan (b).

ROOM FINISH SCHEDULE

ROOM	FLOOR			BASE			WALLS			CEILING			NOTES
	CARPET	HARDWOOD	CERAMIC TILE	WOOD	VINYL	CERAMIC TILE	WALLPAPER	PAINT	CERAMIC TILE	PTD. GYP. BD.	WOOD	ACOUS. TILE	
FOYER		●		●			●				●		COFFERED CEILING
LIVING ROOM		●		●			●			●			
DINING ROOM		●		●			●			●			
KITCHEN			●			●		●		●			
BREAKFAST NOOK			●			●		●		●			
GREAT ROOM	●			●				●		●			
OFFICE	●			●				●				●	
LAUNDRY/ MUD ROOM			●		●			●		●			
MASTER BEDROOM	●			●			●			●			
MASTER BATH			●			●		●		●			
POWDER ROOM			●			●	●		●	●			CERAMIC TILE WAINSCOT
BEDROOM 1	●			●			●			●			
BEDROOM 2	●			●				●		●			
BATHROOM (2ND FLR.)			●			●		●		●			
BONUS ROOM	●			●				●		●			

The major pictorial defect of an isometric drawing is the visual distortion caused by parallel lines not appearing to converge at a point as they recede into the "distance." Isometric drawings are effective as a scaled tool to depict single objects, such as furniture, and whole interior spaces.

OBLIQUE DRAWINGS Oblique drawings can be categorized into plan obliques and elevation obliques. Oblique drawings consist of 90° angles between two adjacent planes or walls. Plan obliques are projected from the plan view of a building or space in which the objects retain their true size and shape (Figure 18.28). The advantage of an oblique drawing is that a building floor plan or elevation can be used directly to construct this type of paraline, whereas an isometric cannot use the plan or elevation directly. The plan is usually tilted at an angle, and height lines are drawn as verticals at true or proportional scales. Plan obliques are usually drawn at two 45° angles or at 30°/60° angles.

Elevation obliques present the building or spaces in their true size and shape, which permits oblique paralines to be constructed directly from elevation views. Receding lines are generally drawn at 30°, 45°, or 60° angles to the elevation, and depths are measured along these receding lines. Oblique paralines are generally more effective when utilized for entire environments rather than for single objects.

Perspective Drawings

Perspectives are one of the most realistic types of representational design drawings used in architectural and interior graphics. They are a popular method of illustrating a three-dimensional space on a two-dimensional plane (Figure 18.29). A perspective, like a paraline drawing, is a single-view drawing; however, the perspective drawing can eliminate the optical distortion caused by lines drawn parallel. The perspective is a more realistic view since it represents the reality of form in three dimensions, as we see it with our eyes.

Architects and interior designers frequently use perspectives both as design exploration sketches and as design presentation tools. Quick, freehand sketches or computer modeling can help to anticipate the essence or

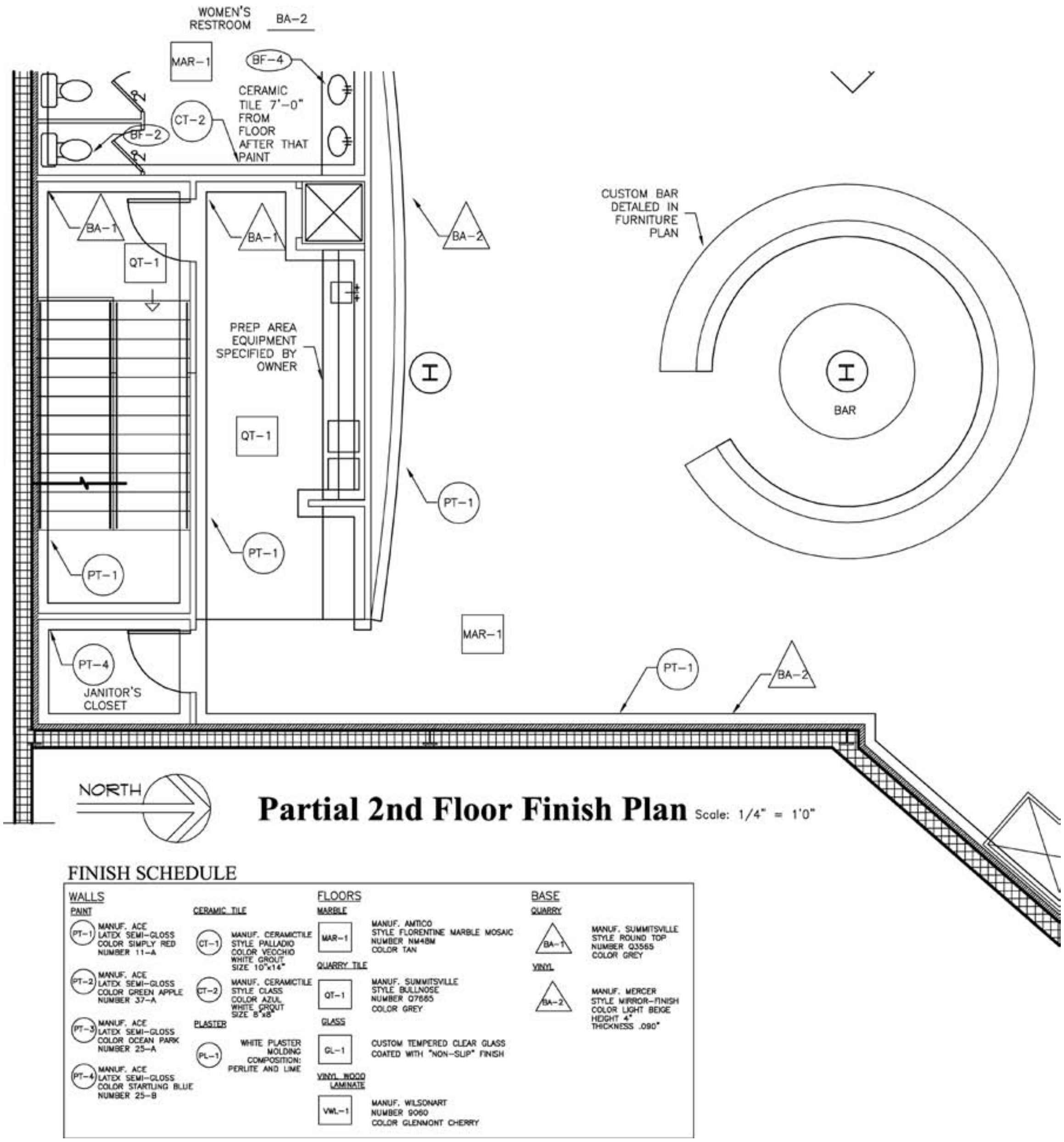


FIGURE 18.24 (Continued)

character of a space—that is, its form, scale, light, patterns, and textural qualities. For a presentation through computer visualization, perspectives are more precisely constructed and rendered to depict the structure and its environment as realistically as possible. A perspective often includes people, vegetation, furniture, textures, and accessories. It is important to make the image believable and representative of the way a space will actually appear.

Architectural and interior designers utilize three basic types of perspectives: one-point, two-point, and three-point. The difference depends on the observer's point of view and the orientation of the object or space being seen.

ONE-POINT PERSPECTIVE One-point perspective (Figure 18.30) involves drawing a line three ways: vertically, horizontally (always parallel to the ground line), and in perspective (converging to one point). In interiors, one-point perspectives usually illustrate three walls of a space. If done by hand, they are relatively easy to construct but can result in dull and static views, if not composed properly.

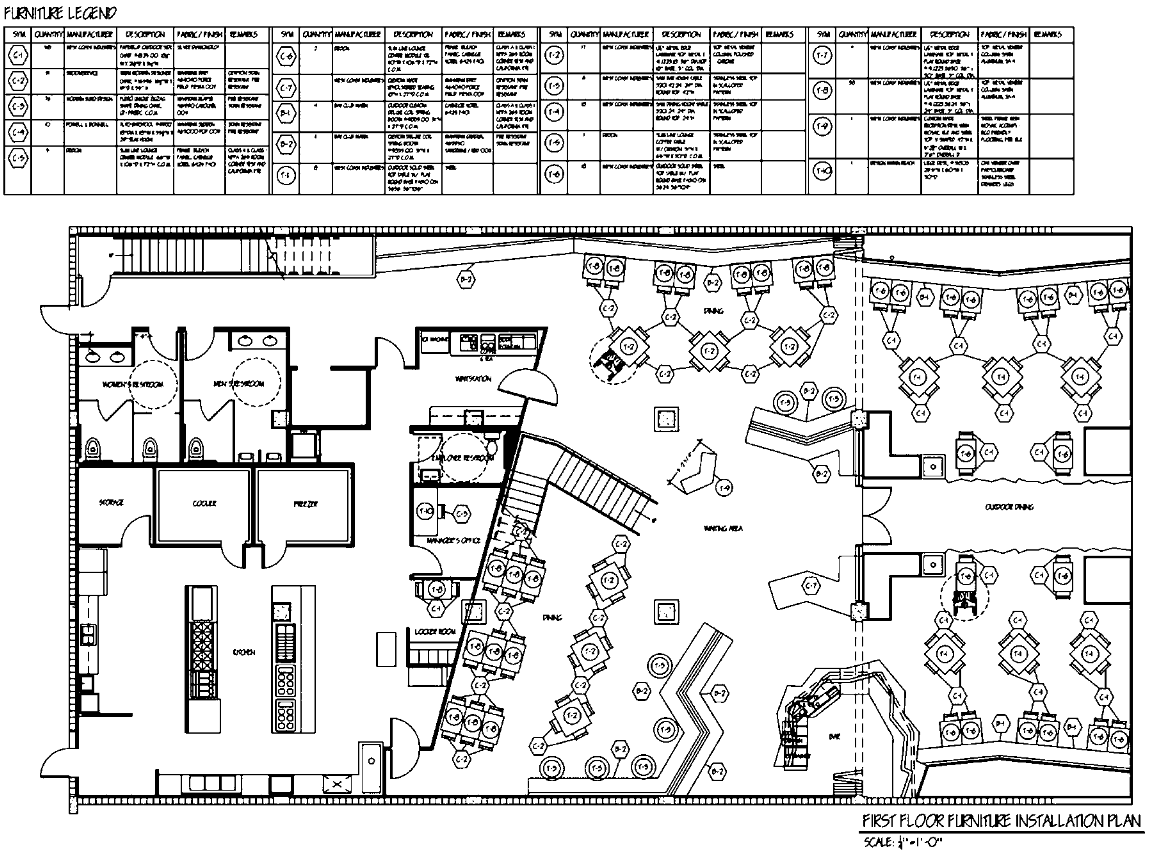


FIGURE 18.25 A furniture installation plan and schedule indicate where specific items will be placed.

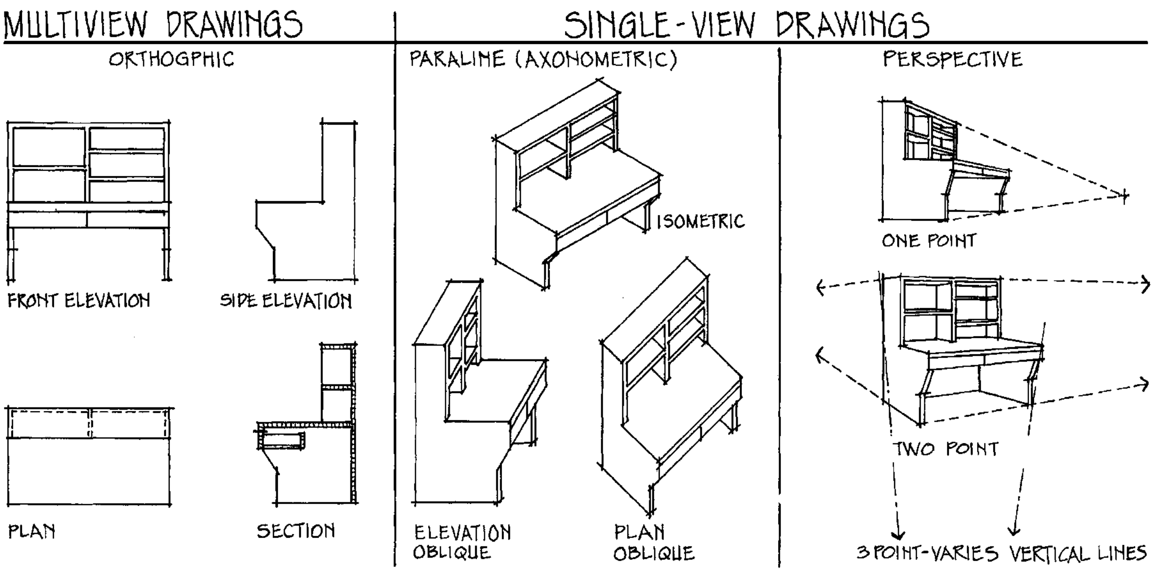


FIGURE 18.26 Examples of single-view and multiview drawings

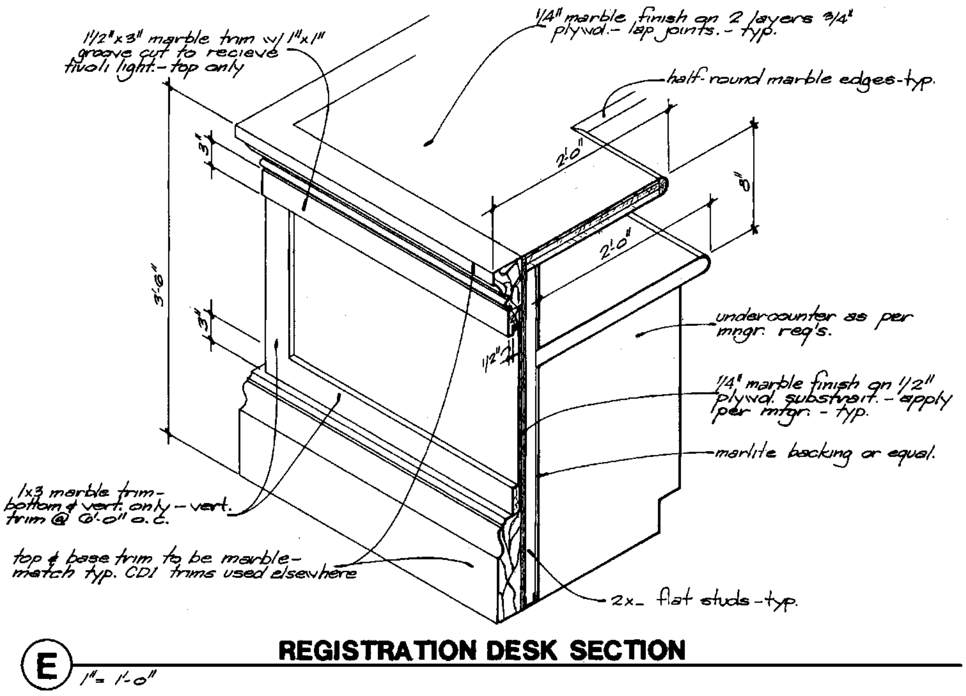


FIGURE 18.27 This registration desk section is drawn as an isometric to help explain some of the materials and construction details.

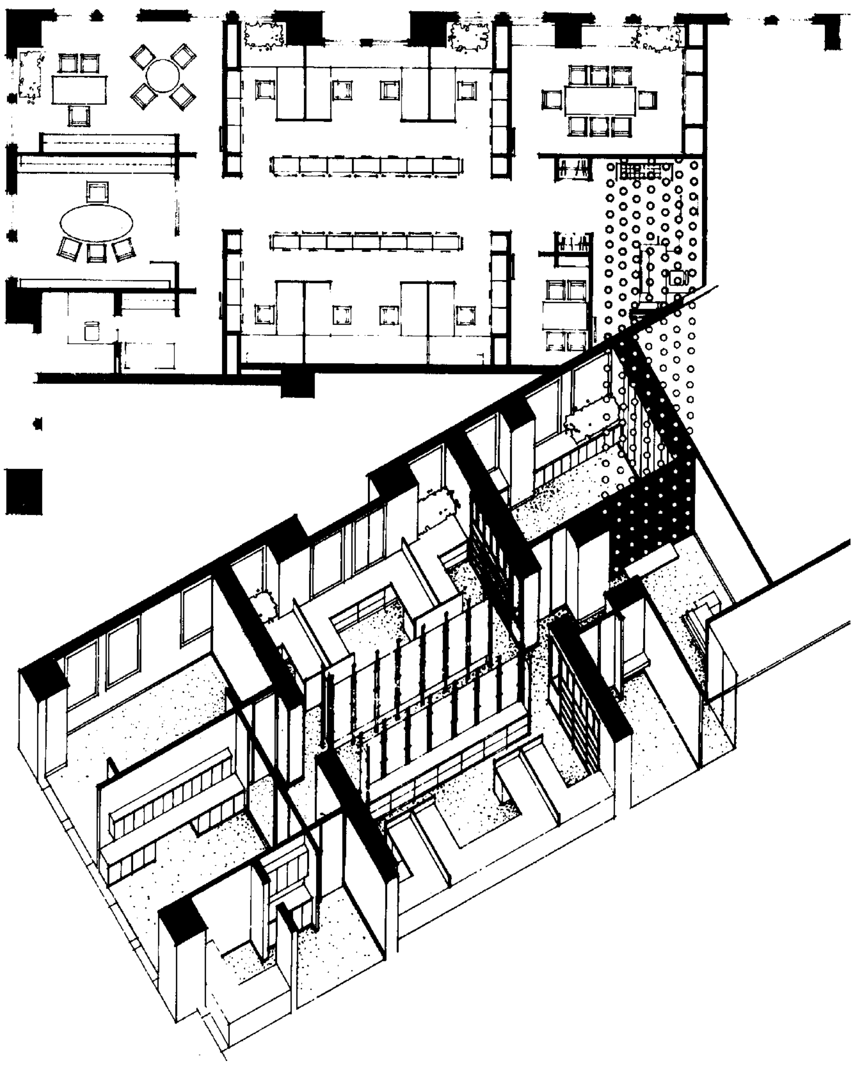


FIGURE 18.28 A plan oblique drawing retains the true size and shape of the floor plan. Here it is rotated to a 30/60° angle and heights are projected vertically.

FIGURE 18.29 This perspective rendering by Gary Saxton was done by hand with a felt-tip marker.

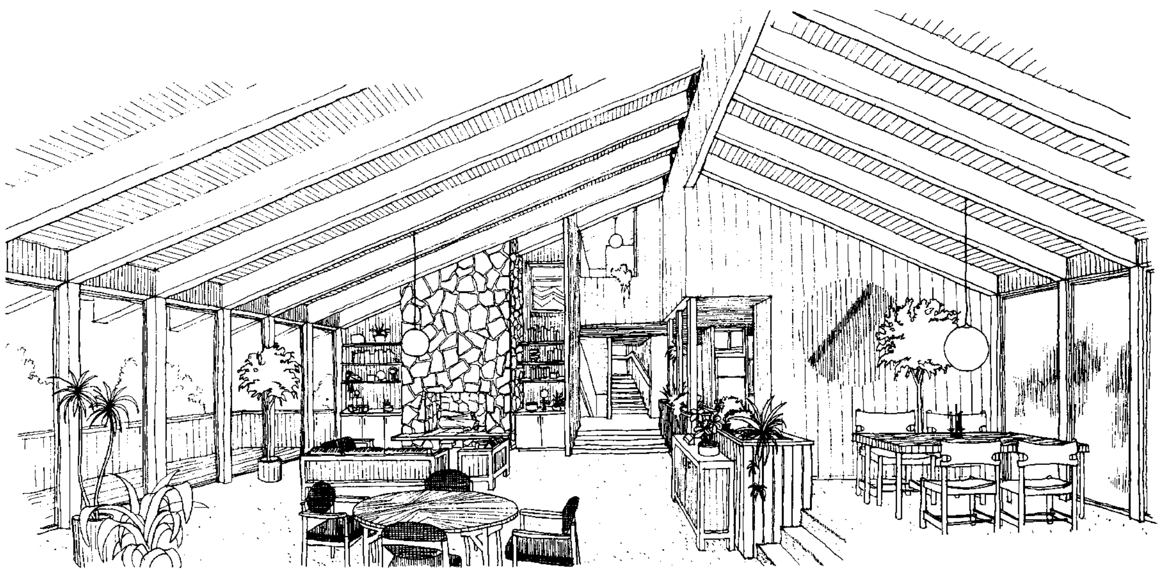


FIGURE 18.30 In a one-point perspective, lines depicting depth converge to one common vanishing point.

FIGURE 18.31 These computer renderings are presented in a two-point perspective, drawn with two vanishing points.
Courtesy of Jeff Johnston

TWO-POINT PERSPECTIVE Two-point perspective (Figure 18.31) involves two kinds of lines: vertical lines and perspective lines that converge at two different vanishing points. Both vanishing paints are located on the same horizon line, and all vertical lines are parallel. A two-point perspective tends to present more dynamic illustrations than a one-point, since the two-point portrays a more natural view for the observer. Two-point perspective is a good way to illustrate a corner of a space or the relationship between two walls or planes.

THREE-POINT PERSPECTIVE Three-point perspectives have three major vanishing points, and all lines converge at these paints. These perspectives are similar to two-point perspectives, except that in the three-point the vertical lines are not parallel but, rather, converge at the third vanishing point. Three-point perspectives are generally used to illustrate exterior views of tall buildings or objects where the eye sees things vanishing to three points. In interior design, three-point perspective is effective in illustrating tall vertical spaces, such as multistory atriums.

The designer constructs perspectives utilizing plan perspective theories to build the view, and rendering line by line. Through practice and computer- generated base drawings, the designer begins to rely more on the eye than on systematic, and often time-consuming, perspective construction. These factors allow the designer to make better use of time and money, spending them on design and communication instead of on drawing.

Shortcuts in preparing renderings can be taken to create effective drawings in a minimum amount of time. The designer might use commercially available perspective chart systems for quick sketching, or computer layouts that can be adjusted for particular viewpoints. Computers create effective rendered perspectives from any view the designer chooses, and these can be shown as a presentation drawing to the client. They can also be animated for a live “walk-through” viewing.

DIGITAL MEDIA FOR DESIGN COMMUNICATION

The Renaissance period saw the development of systematic perspective systems that enabled draftspersons to create realistic pictures. Further scientific exploration led to the development of the camera and photography as we know them today. Almost every interior and/or architectural firm has a camera or other digital media devices that are indispensable as design communication tools.

Photography

Photography has many applications in interior design. The digital camera can be used for documenting existing spaces, furniture, or equipment during the design and construction processes. The camera, along with digital scanners and other electronic software, can also be used for presentations, shortcuts in preparing renderings, and recording design presentations or finished projects.

Photography has long been combined with the printing and electronic industries into office machines such as the photocopier and facsimile (fax) machine. These machines not only instantly copy words and pictures but can enlarge, reduce, print, transmit, and receive them in color. Designers still use some of these machines in their communications, but more are produced and transmitted by digital scanners, e-mail, and other Internet file storage offerings.

Design communication often takes the form of a presentation using various software programs, such as Microsoft's PowerPoint. There is a sense of theatricality about digital presentations—a darkened room, stage center (the "slides" and narrator), and a sense of a planned "show." This type of presentation shows the client what the designer envisions. The slide show enables the designer to combine many mediums and communication techniques to explain proposals. He or she can choreograph photos of models, written words, architectural drawings, charts, spoken words, realistic pictures, video walk-through, or anything else that can help explain the design concepts to the client—and he or she can use a dash of professional showmanship in doing so.

The designer should design the presentation, not just show a series of pictures, because the best slide visuals can be weakened by poor preparation and delivery. One technique for assisting in planning and organizing a presentation was the storyboard—developed and used for years by the movie and television industries (Figure 7.22). Now, presentations are created and organized by using PowerPoint or other software.

As the designer becomes proficient with digital presentation software and equipment, more sophisticated techniques can be added to the presentation. However, visual effects that are too extravagant might distract from the actual design proposals and overshadow the designer's professional concepts and expertise. Unexpected equipment failure could also cause some communication problems and drastically affect the presentation.

Videos

Digital video cameras and projection systems are convenient for recording existing conditions in a project, presenting proposals, or making presentations. Computer-generated images can be saved to various digital devices to create a convincing "walk" through a space or show other multiple time images in a convincing sequence.

In some cases, the designer might hire a professional video production consultant for a high-quality video.

MODELS AS DESIGN COMMUNICATION

An effective way of communicating design ideas is to generate a digital three-dimensional model or build a scaled model of a proposed project. Clients can clearly see what the designer has in mind with regard to spatial configurations, sequential spaces, objects, and scale. Color, materials, finishes, and furniture proposals can also be included. Unlike two-dimensional drawings, a model shows the client what is happening in all dimensions of the project. As the client moves around the model, he or she can see the relationship of the parts, whereas it would take a series of drawings to explain all these various features. A client does not need a background of visual training to understand a model, since most of the important features can be shown in a realistic manner.

Design models have been constructed since early civilizations to serve as a guide for developing or explaining ideas. Today, the aircraft, automobile, industrial design, and space industries construct miniature or full-size models as testing vehicles or for presentation purposes. The sophistication of these models has progressed over the years to include actual working models with moving parts and electronic circuitry. Now, with 3-D printing, some very detailed models can be quickly produced directly from digital inputs.

Architects and interior designers build models of their proposed ideas to study their designs or present ideas to their clients. Models are used for various purposes and are constructed as conceptual models, study models, and presentation models.

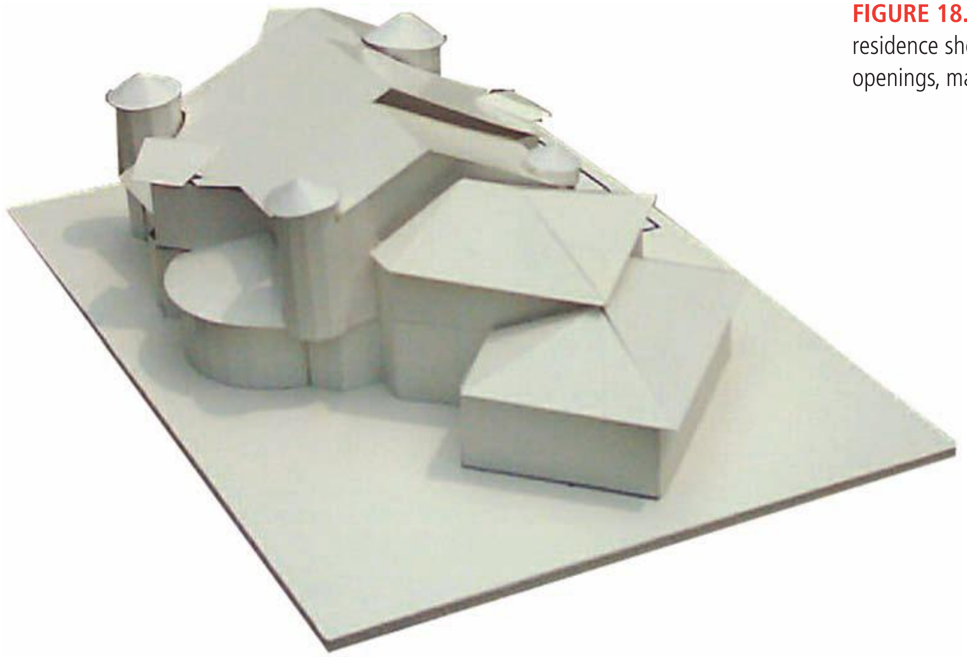


FIGURE 18.32 This conceptual model of a new residence shows massing of forms. Glazed openings, materials, and details are not included.

Conceptual Models

After the design drawings are executed (or, sometimes, during their preparation), a rough or conceptual model (Figure 18.32) might be constructed to aid the designer in studying the physical relationships of ideas about mass, space, scale, and arrangement. The model might never be shown to the client.

The conceptual model, sometimes called a mass model, is usually simple in materials and construction and is void of detail. It may not even show building openings, such as doors and windows. Such a model might be built of clay, wood, cardboard, heavy paper, or foam-core board and glued or taped together. A conceptual model can also be used to study various stages of construction or can be modified to become a finished model. This working model is rough, simple, and flexible for possible reconstructing as a key.

Study Models

The study model is a refinement of the conceptual model. It is used for more accurate representation of scaled detail or other physical elements, such as building openings and perhaps color. This model is usually crafted more precisely than the rough model and may be used in presentations to the client (Figure 18.33).

Presentation Models

A presentation, or finished, model is a realistic, scaled representation of the completed project. It accurately portrays the designs through scale, materials, detail, and spatial and structural elements. These models might be done in all white, or in color (Figure 18.34). The model is carefully crafted to show the client as nearly as possible what the final design solution will look like. Much time and money are put into these models; often they are encased in protective clear plastic.

Building the Model

A designer should consider what is being communicated and the extent of realism and detail needed to convey the ideas. These decisions dictate whether to build a conceptual, study, or presentation model. Then the designer decides whether to construct the model or hire a professional model builder. Important factors to consider are the amount of time needed for construction and the monetary budget to build the model.

Scale and Materials of the Model

Choosing the scale and materials of a model is dependent on the size of the actual project and the resulting finished size of the model. The scale should be appropriate to show what is necessary to the client and should be

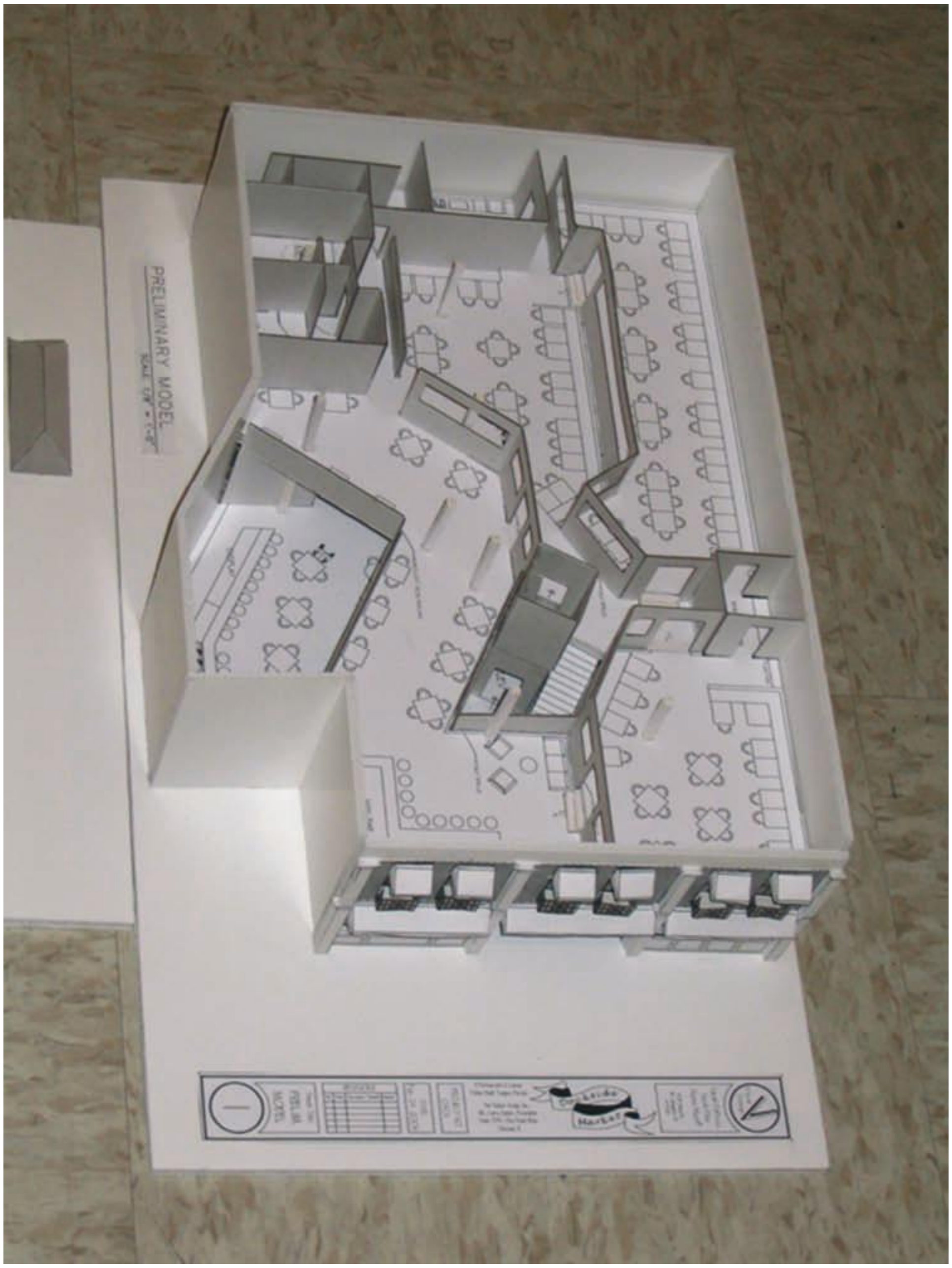


FIGURE 18.33 In this "study model" for a new restaurant in an old warehouse, a floor plan is printed at a small scale, and walls are erected in cardboard.

conducive to using available model materials. The scale should have a convenient relationship to other design drawings; time can be saved if plans, elevations, and sections do not have to be converted to the model's special scale. Materials used to build scaled models are often simulated. For example, real carpet has too large a scaled texture to be convincing in a model; substitutions of felt or colored sandpaper are more in scale for a model's carpet.

Special Models

Sometimes a designer needs to demonstrate a particular feature in the designs that may not be possible to show in the aforementioned three types of models. For instance, the designer's lighting proposal may have included both natural and artificial light sources (Figure 18.35). A special lighting model could be constructed that shows the client how natural light enters the space, illuminates the proper areas, and is augmented by artificial light. Other special models might include a full-size furniture mock-up for the client to experience.

Categories of model types are not clear-cut niches that encompass specific models. The categories often overlap; what began as a conceptual study model may be added to and further refined into a full presentation model.

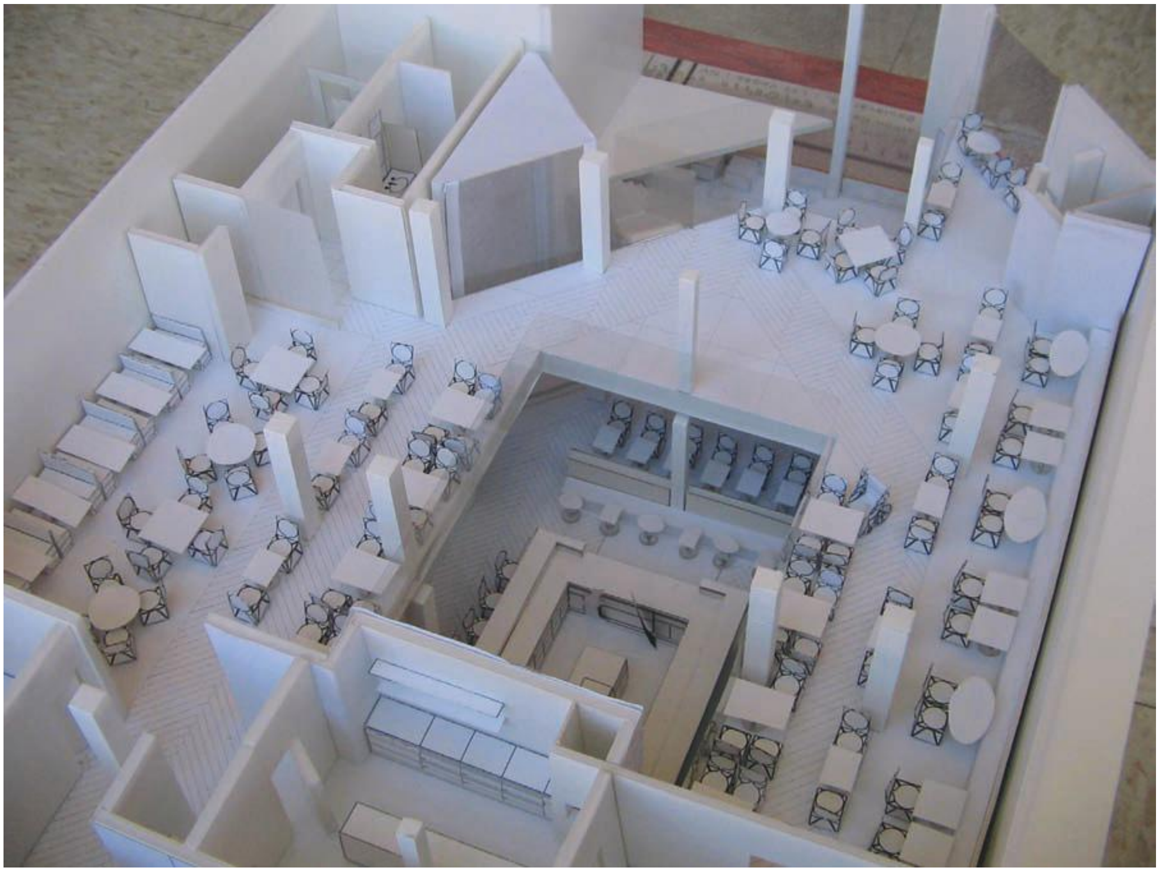


FIGURE 18.34 This "presentation model" of a new restaurant in a shopping mall depicts scale and realistic forms such as furniture and architectural elements.

FIGURE 18.35 This scaled model presents the designer's natural and artificial lighting techniques for this new beach restaurant.

MATERIALS, TECHNIQUES, AND REPRODUCTION

The interior designer employs a number of materials, techniques, and reproduction methods. These range from quick sketches using felt-tip markers on tracing paper to computerized drawings.

Drawing Papers and Boards

A variety of papers are used for hand-drawing and range from rolled transparent tracing paper (called bumwad, yellow trace, flimsy, canary, tissue, and other names) to more expensive rag paper, vellum, and plastic sheets. The flimsy papers are used for quick sketches and rapid development of ideas through creating a series of overlays and exploring with pencil or pen. As ideas are refined by hand, better papers can be used that take more erasures and provide a better tooth for drawing with various mediums. Many types of cardboard, also called boards, are used in interior design as a presentation medium, as mat framing for drawings, and for model building. Simple chipboard is effectively used for models and as a cutting surface. More expensive and colored cardboards are used for design presentations and detailed models. Drawings are also mounted on these or cut into windows for highlighting. An alternative to the cardboards is foam-core board, which is made in several thicknesses and consists of plasticized or kraft paper faces over a polystyrene foam center. Digital images can be glued to these for presentation purposes. Foam core is also used for simple study models and for mounting drawings or manufacturers' samples.

Drawing and Lettering Aids

Plastic drawing templates are available that make quick work of hand-drawing common or repetitive objects in plan or elevation. Templates are made for furniture, equipment doors, geometric shapes, plants, stairs, and so forth. Many of these are available from various manufacturers specifically for their products.

Although much of the lettering executed on drawings is hand-done, many alternatives are available to the designer. Technology has also produced various forms of electronic lettering that can save time, offering hundreds of font styles.

Blueprints and Photographic Reproduction

Copies of drawings used to be made by what was called the blueprint process. This terminology originated long ago for a light-sensitive paper that produced a copy of a drawing as white lines on a blue background. Then the diazo process replaced the old method, but the name still often remains. The diazo process used a transparent original that was placed over a chemically active paper, exposed to light, and run through a developer to bring out dark lines on a white background. Today, this process has been replaced with scanners and electronic printing.

ORAL AND WRITTEN COMMUNICATION

Oral Dialogue

Oral dialogue between the designer and the client is perhaps the most common and basic form of design communication. Oral language is used to augment forms of visual presentations. When the visual mediums are not completely effective for translating ideas, or the client is having difficulty in understanding the designer's concepts, dialogue between the parties is of immense help. It also allows immediate response and is often the only direct feedback from the client.

A good relationship between the designer and the client is the basic premise of effective dialogue. The two should try to understand one another's viewpoints, be considerate of any differences, and, above all, keep an open line of communication and strong rapport. Therefore, it is suggested that the aspiring interior designer should at some time take coursework in speech and communication skills, as well as practicing good verbal presentations.

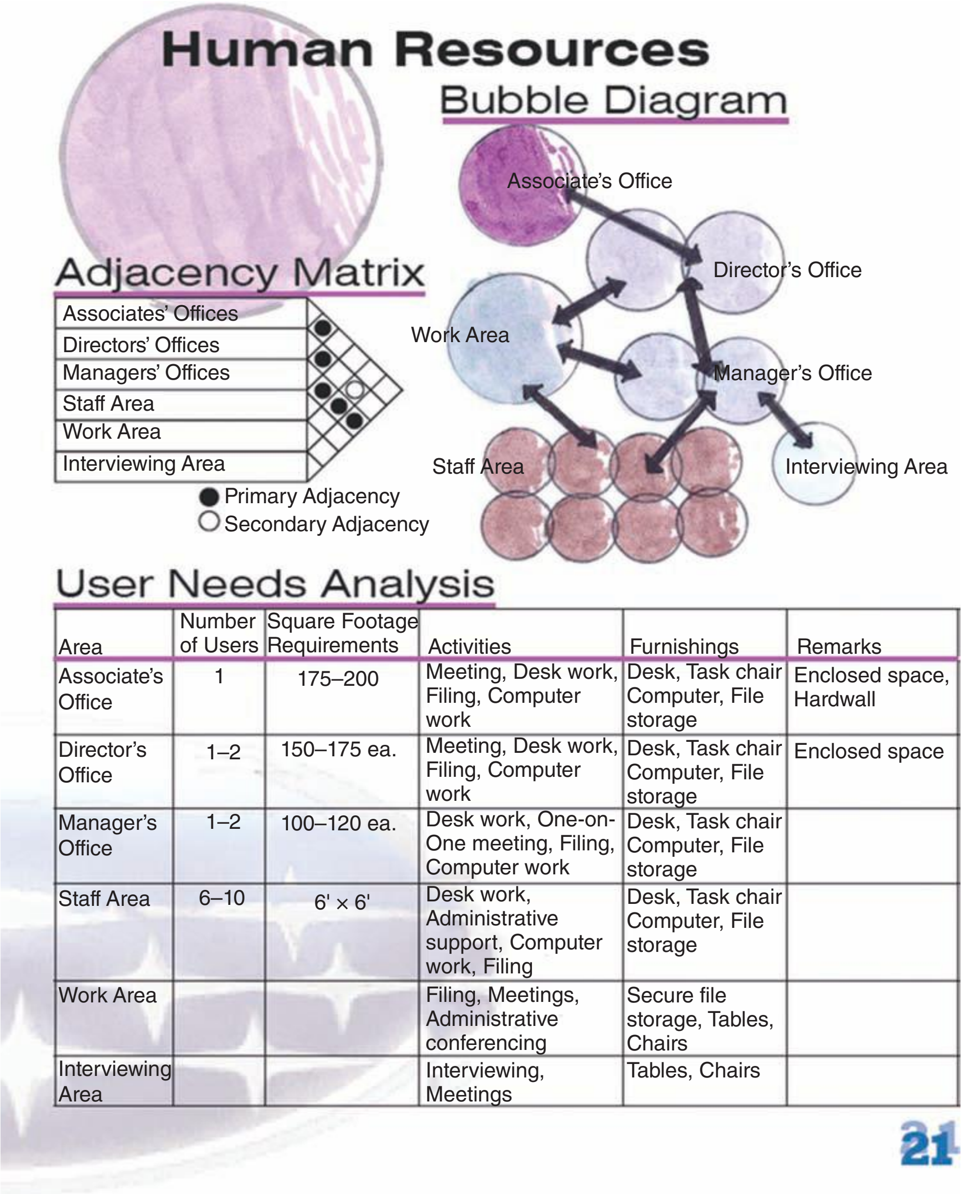
Oral presentations demand a sense of professionalism, along with an awareness of the client's expectations. The designer should be enthusiastic about the project and responsive to the client's questions. Humor and candidness can prevent a presentation from becoming boring, but the approach must still be professional. Before the presentation, the designer should outline what he or she wants to say and should make written or mental notes. The designer should plan the sequence of what is to be presented and determine what oral descriptions are needed. The oral presentation should begin with the overall concept, or theme, of the project and continue to explain why something was done, keeping the client's needs in mind.

The designer should not just present information but should also ask for questions and responses from the client, since most clients feel the need to be involved in the presentation. The designer should be distinct and specific about the points he or she wishes to impress on the client. Talks should neither be too long nor give the impression that the presentation is an inflexible speech. The designer should be responsive and allow comments to vary from the planned outline if the client needs further discussion on a certain point. It is then the designer's responsibility to skillfully guide the presentation back to his or her control without offending the client. Each oral presentation is unique because of the two-way nature of communication, but the designer should ultimately control the sequence and direction.

Written Communication

The written word is a powerful and effective means of communication in design. Designers are often faced with the problem of sifting through, analyzing, and organizing staggering amounts of information from the client. To achieve clear communication among all those involved in a design situation, the designer collects all the input data, documents them, and carefully organizes those facts into an appropriate format, such as a program (see Chapter 7). The material is usually presented in written and graphic form for the client to review. These documents might be sent electronically, or printed for distribution. This procedure enables the designer and the client to have a clear understanding of the entire design proposal in both written and graphic form. Programs are communication tools for recording client needs and expectations and ensuring that these parameters are met before construction of the project begins.

Many design firms prepare and design their own programs or reports in a brochure format, utilizing written information and graphics to convey concepts (Figure 18.36). The documents are sometimes produced in multiples



Area	Number of Users	Square Footage Requirements	Activities	Furnishings	Remarks
Associate's Office	1	175–200	Meeting, Desk work, Filing, Computer work	Desk, Task chair Computer, File storage	Enclosed space, Hardwall
Director's Office	1–2	150–175 ea.	Meeting, Desk work, Filing, Computer work	Desk, Task chair Computer, File storage	Enclosed space
Manager's Office	1–2	100–120 ea.	Desk work, One-on-One meeting, Filing, Computer work	Desk, Task chair Computer, File storage	
Staff Area	6–10	6' × 6'	Desk work, Administrative support, Computer work, Filing	Desk, Task chair Computer, File storage	
Work Area			Filing, Meetings, Administrative conferencing	Secure file storage, Tables, Chairs	
Interviewing Area			Interviewing, Meetings	Tables, Chairs	

FIGURE 18.36 Example of a page from a written/graphical program

(printed or electronically sent) and supplied to concerned parties who may share some responsibility for the project. Many programs/brochures are very sophisticated in their makeup and are often prepared by several of the design staff; in large firms, a few designers may be involved only in this area on all the firm's projects.

Other forms of written communication are budgets, specifications, and purchase orders (see Chapter 19). Added to this list might be letters of transmittal, letters of agreement, work orders, contracts, and other legal documents. These forms are specialized documents that can be commercially printed, then used by the designer to communicate with the various parties throughout the project.

One of the prime written communication devices the designer might use during design and construction is the letter. A letter should be composed with a sense of organization and composition and a clear understanding of what is being communicated.

COMPUTERS IN INTERIOR DESIGN

Computer technology in interior design offices has created exciting aids in design, drafting, accounting, word processing, and other uses. Great strides are being made in using computers and electronics in our everyday life and these developments will continue to impact the design profession as well.

Computer hardware (machines) and software (programs) are constantly becoming more sophisticated, smaller, and less expensive. The designer does not even need to own such equipment; access is readily available through various worldwide Internet networks, telephones, satellite linkages, and personal digital devices.

Manufacturers are beginning to offer more computer aids directly to the design profession to assist in specifying products for interior projects. As computer technology advances, costs will come down, software will become more user friendly, and more design firms will become more electronics based. Gone are the large drafting and drawing studios, with spaces designed for emphasis on teaming and conferencing.

Computer Digital Manipulation

Innovations in computer technology have had significant impact on interior design practice. Programs for these operations can produce simple line drawings; complex, three-dimensional colored renderings; and videos. As the designer becomes more proficient at working with software, he or she can generate more sophisticated drawings and explorations of spatial concepts at a quicker pace, saving both time and money for the client and the designer.

Many interior and architectural firms utilize computers to produce design drawings, renderings, and construction/installation drawings for communication to their clients. Information and designs are placed on video displays to work out and present ideas for the projects. The computers generate plans, elevations, sections, and perspectives of proposed interior spaces and components (Figure 18.37). Stored data, such as furniture, finishes, and line-by-line budget items, can be instantly called up while designing. Sophisticated computer-aided drawing of interiors can present a very effective three-dimensional view of a space that is immediately displayed from any fixed or moving point of view. The operator can quickly move objects about in the space, select the view, and produce a digital output of that sequence.

More and more of the drawings and written documents the interior designer prepares are not being placed on paper, but instead are electronically transmitted. At the same time, they might be transmitted to a contractor for instant pricing and to an engineer's module for verifying environmental support systems needed. The transmission to and feedback from others are becoming more of a world connection, with the various parties instantly communicating with the others. Face-to-face business communication may eventually be replaced by the electronic mediums of the future, but despite this technological wizardry, we will still have the basic human need for personal contact with other human beings.

Databases and Spreadsheets

Software programs of databases and spreadsheets store, organize, and retrieve groups of information (data) in a variety of ways. These files can include such information as every client's name and address for information gathering or mailing labels. Databases can manage and track budget estimates, inventory furniture, estimate fees, project costs and square footage comparisons, and disseminate manufacturers' product information.

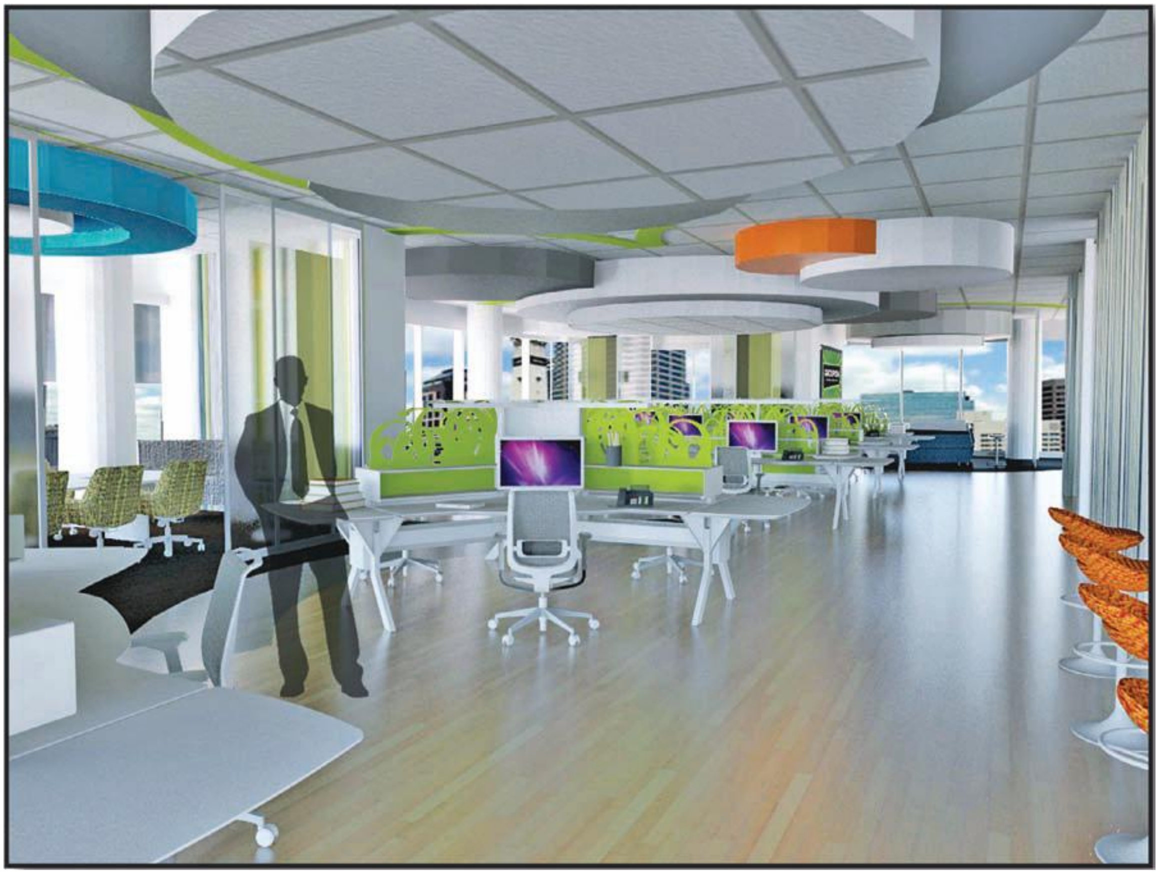


FIGURE 18.37 An example of a computer-generated rendering for a proposed office
Courtesy of Kelsey Venekamp

Word Processing

Word processing has become very flexible for composing and writing. Changes and additions can easily be made to correspondence, reports, documents, contracts, purchase orders, and specifications. Word-processing software stores large amounts of information, does spelling checks, and prints out multiple copies. Software merging graphics and text on the same page (called desktop publishing) can be used to produce high-quality brochures, reports, newsletters, press releases, and other documents that were formerly prepared only by using outside printing firms.

PUTTING THE PRESENTATION TOGETHER

Design communication takes place in a presentation in which the designer is giving, showing, or presenting ideas, information, and proposals to a client. The designer might be trying to persuade a potential client to select his or her firm to do a project, or might be presenting design ideas to a client for approval. The first instance usually involves a portfolio or website of the designer's past works, whereas the latter is a presentation of new ideas to be carried out. The format, mediums, and elaborateness of the designer's presentation can be similar in each case or can vary greatly according to the type of communication selected. There are no rules, since the types of presentations, elaborateness, and costs vary not only from project to project, but also among the presentation procedures established by a particular design firm.

Some designers have access to complex audiovisual presentation rooms for impressive, theatrical formats, and others show just a pencil sketch while sitting in the client's office, or manipulate images and information on personal digital devices. Presentations can be categorized as formal or informal, depending on each situation. Experience, the working relationship with a client, and design judgment dictate the form and content of the presentation. Design presentations often vary according to what mediums are currently popular. Interior designers and architects have shifted several times in past years from carefully inked, delineated drawings and elaborate, time-consuming presentation formats to quick-sketch and computerized techniques and informal presentations. No doubt, these trends will shift again, following current design movements in the profession and in schools of design.

Presentations should always convey a sense of honesty about what is being proposed, not "sell" the client an inappropriate solution. The designer should not use elaborate, beautiful presentations to hide weak or poor design work.

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The Professional Practice of Interior Design—Business and Management

19

INTERIOR DESIGN AS A BUSINESS

The practice of interior design is an art, a science, a career, a lifestyle, and, above all, a business. It is an exciting profession involving the use of creative ideas to solve problems effectively for real-world situations. The profession entails using other people's money and having them trust in the services and/or goods the interior designer provides. The practice of design is similar in its business aspect to that of other professions, such as medicine, law, dentistry, and architecture. All of these provide a service and operate as a business entity.

One of the primary reasons a business exists is to make a profit. However, a successful business also serves a need in society and for the individual. Business entities, whether individuals, small firms, or large corporations, all have responsibilities—personnel, facilities, and supplies that must be managed to keep the businesses functioning. Effective business procedures and management are vital to a firm's well-being; that is, it must permit its staff members to have time to do their jobs; in the case of design, this means permitting the designer to solve problems creatively by generating exciting solutions to problems.

This chapter is divided into three parts: The first introduces interior design as a business, the second illustrates how a design business operates, and the third deals with the management and scheduling of projects within a professional firm.

Residential and Nonresidential Practice

Interior design is a service-oriented profession that involves different types of expertise in working with facilities within the built environment. The practice of interior design is commonly divided into residential or nonresidential (contract or commercial) design. Although a designer can do both kinds of work, there seems to be a tendency to specialize in one of these areas. This specialization can occur because of the type of projects the designer enjoys or his or her business conduct, expertise, working habits, or profit motives. Designer-client working relationships are different in these two general categories and ultimately reflect the designer's own desires and aspirations. Residential work does not generally require the stringent written rules and protocol demanded in commercial work, but both categories call for strong personality and communication skills for client contacts.

Specialization

The strong tendency toward specialization in the field of interior design will probably continue as technology and society become more complex, demanding more knowledge and expertise from designers. The specialist seeks projects involving specific types of interiors, such as hospitality or healthcare. The generalist works with a variety of project types, sometimes including both residential and commercial work. The specialist believes that a client gets the benefit of more expertise, efficiency, and in-depth services when the designer has refined and improved his or her knowledge of a particular type of interior. Since the scope of work and services required to solve a problem in a specialized area is similar in most cases, the specialist designer tends to be able to build a knowledge base and become more task efficient. Some of the most noted designers and well-publicized projects are a result of specialization. However, specialization may lead to a decrease in creativity, because a designer may tend to solve all projects in a similar manner—which may not be the best and most personalized solution for each client. A designer must guard against creating a typical solution to any problem, because each project and each client is different. (See Chapter 8 for a list of specializations within the field of interior design.)

Types of Services Offered

The designer can offer many different kinds of services, depending on the project and the client's needs. These services might range from drawing preliminary sketches for a client's furniture arrangement to designing, specifying, inspecting, and coordinating all elements for the design of a new facility. Traditionally, there are several ways the designer offers services: design/specify, design/merchandising, and contracting. However, these services can be combined or modified depending on the client's needs.

Design/Specify

When the designer provides consultation without buying or reselling products, this is commonly called design, space planning, or specifying services. The designer might select furniture or equipment by specifying in detail the type or required performance of products. In some cases, the designer might prepare the purchase order for the owner but not get involved in the actual outlay of money for purchasing. Many interior design firms primarily involved in commercial work operate this way. The designer is paid on a fee basis, by the hour, or by a percentage of the project cost.

Design/Merchandising

When the designer becomes involved in the buying and selling of products for the client, the services are recognized as merchandising; if the designer also provides design services, this is known as design/merchandising. The designer actually becomes a merchant who procures products at a discount, places a markup on them, and resells them to the client. The designer might also charge on an hourly basis for time spent. In the design/merchandising arrangement, the designer often must obtain a resale license from a state jurisdiction, and he or she can become responsible and liable for the product sold. In many small communities there may be no source of the needed products, so the designer fulfills the necessary role of one by personally obtaining the proper products.

The designer might be employed by a retail store offering both design expertise and products. In this situation, the designer might receive both a salary and a commission from the store. Generally, the client does not pay a fee for the designer's services if purchasing products from the store; however, the store may charge a fee in addition to the retail sales, depending upon the services offered, the structure of the establishment, and its location.

The majority of interior designers charge a design fee for their services, rather than merchandise goods for a profit.

Contracting

At times, a designer might act as a contractor and hire subcontractors for construction, painting, hanging drapery, or installing wallpapers. Or, a designer might operate a workroom for upholstery or window treatments, if he or she has developed a specialty operation, or these services are not readily available in the community. In this capacity, the designer becomes directly involved with and responsible for the materials, labor, and results of the construction. In either case, payment is made to the designer for materials and labor, just as most other contractors receive their money. Some states require the designer to obtain a contractor's license in this type of operation.

Entering the Business World

With a degree in design, a resume of skills and experience, and a portfolio of design projects, the new designer is ready to get on with the business aspect of his or her education and enter the working world. Interior design involves a commitment to hard work and creativity and a passion for the profession. Let's look at several ways a designer can enter the business world, move up in it, and possibly start a business.

Employee

The typical graduate enters the design field as an entry-level employee of a design firm. The employee is paid an hourly rate, a salary, a commission if products are sold, or a combination of these. In addition, the company might include paid holidays, vacation, and other fringe benefits, such as health insurance, overtime pay, retirement benefits, and even profit-sharing bonuses. As the employee gains experience and becomes a more valuable asset to the company, rewards come in the form of raises and other special compensations. Eventually, with hard work, the employee moves up, gaining seniority and administrative responsibilities. He or she might eventually become an associate, officer, partner, or part owner in the firm.

Associate/Officer

Associate status in a firm is different from being an employee; in some cases, an associate is part owner of the firm. The associate perhaps is involved in management decisions and direction of the firm's goals, and usually shares in profits he or she helps to generate. Associate status varies with the size, type, and operation of the firm. It is a great learning experience to participate in running a business without being saddled with the liabilities of complete ownership.

Oftentimes, an associate is identified as an officer in a firm, such as vice president, denoting title and status. Benefits vary according to the firm, but most officers have a say in the operations and usually have their names visible on the firm's business letterheads or other signage.

Partnerships and Other Ventures

After a period of hard work and teamwork, an employee or associate might advance to the point of joining an existing design partnership or becoming part of a corporation. This advancement allows the designer to participate more fully in the firm's operations and often means a bigger share of the profits. However, along with these benefits come some of the responsibilities of keeping a firm running smoothly. In most cases, the new partner must buy into the existing partnership or corporation. Some companies will allow this required investment to be paid over a period of years to offset large upfront sums.

Buying a Business

It can be advantageous to buy an existing business with an established clientele and reputation. This opportunity sometimes occurs with the death, retirement, or relocation of the original owner(s). There are, however, some disadvantages to be taken into account. For instance, if the former management, employees, or facilities are not operating efficiently, it can take a considerable amount of time and money to get the business back on the right profit-making track.

Starting a Business

Many new businesses are started every year, and many of these become successful. However, some fail, which can cause immense financial and psychological stress to the owner(s). Starting a business can be an exciting venture, but regular paychecks, vacations, set hours, and the luxury of leaving the job at the office at the end of each day are often no longer guaranteed. A designer must be strongly committed to making the business work. A considerable amount of personal time will be absorbed by the management process, rather than by designing. Nevertheless, the profit incentives and freedom to decide how the firm is to operate and grow are worth the effort to many designers.

BUSINESS OPERATIONS

Types of Business Organizations

In starting a new business, the designer must consider a number of issues. One of the first is the type of operation—the sole proprietorship, the partnership, or the corporation. Each of these involves a different kind of legal ownership.

Sole Proprietorship

The simplest business formation for the small design firm is that of sole proprietorship. All profits and responsibilities belong to the sole owner. The owner is the entity and often the name of the company is that of the owner, which does not necessarily mean that only one individual makes up the company; some employees might be given titles for operational functions, such as vice president of production.

The sole proprietorship is perhaps the least expensive business to start and the easiest to run. The owner has complete control over everything, and all profits are the owner's. On the other hand, the owner is responsible for the taxes, liabilities, debts, and any other problems. The owner must meet the company's debts with personal assets and is responsible for employee errors or omissions.

Partnership

A partnership is made up of two or more persons (co-owners) who operate a business enterprise for profit, sharing both the risks and the financial rewards. These associations are usually made up of individuals who complement one another and support the idea of sharing creativity as well as risk. The partners assume joint liability for debts and obligations.

Various states have specific guidelines that govern partnerships and often require a legal agreement between the parties. Even if this formal document is not required, it is vital to have it prepared in order to protect the rights and wishes of the partners for times when differences might arise.

Partnerships can be established as general or limited associations. In the general type, all partners have equal responsibility for debts and liabilities, whereas in the limited arrangement, the limited partners are liable primarily only for their investments. General partners might have more of a voice in management decisions and receive a greater share of profits than do limited partners.

Corporation

The third type of business organization is a corporation established as a legally distinct entity. It exists apart from the principal people constituting it. A corporation can offer some tax advantages and protect the individuals who own or run it from personal liabilities and debts. The owners' personal assets can be protected from debtors, and the corporation can continue to exist if members die or sell their shares. However, corporations are subject to governmental scrutiny and can be complicated to run because of the many regulations and tax requirements.

Operational Goals and Objectives

To be successful in a new or existing business, a person must set goals, objectives, and commitments. Goals are ideals or what one aspires to achieve, whereas objectives serve as the methods or stepping stones to achieve those goals. Commitment involves a dedication to adhere to the plan and make changes as necessary to move in an orderly fashion to realize the results desired.

Personal Goals

An individual can establish personal goals by taking stock of where he or she is and looking to the future. These goals might need to be set in increments of 1, 5, 10, or more years to be realistically attainable. Goals should be written and organized into specific achievements, including lifestyle, profession, and relationships to others. These personal goals should be reviewed periodically to see if they have changed or need revision.

Business Goals

Although a business must make a profit, there are other considerations. The designer must ascertain what kind of work he or she wants to do and enjoys doing, and what his or her contribution to society will be. The designer must establish business plans and list steps to achieve goals effectively. A business must be developed and analyzed according to its strengths, weaknesses, and future projections. Some of the methods used to research and establish business goals are considered in the following sections.

Market Analysis

The success of a business depends on the market from which it derives its profits. Design offices are established to seek and foster clients, in order to keep the business running, execute good work, and make a profit. It is important to do an analysis of the market in which the business operates. The client profile, the number of potential clients, competition from other designers, location of the design office, and other factors can greatly affect the success of the business. These must be carefully analyzed to see if the projected business can successfully operate in a particular business community.

POTENTIAL CLIENT PROFILE Potential clients must be analyzed by number, profile, and type. For example, in some communities, the population profile might indicate that the local inhabitants are not really interested in investing money in the design of their surroundings, and that they are happy without change. A design business would probably fail if the population did not really want the services, or if there were not enough potential clients to justify starting a new interior design practice in the area.

COMPETITION AND SERVICES OFFERED A business must size up its competition: How many competitors are there, and what kind of services do they offer? Perhaps a new business can offer services that the current competition cannot. However, if there is too much competition for the size of the client base or community, enough work may not be available for all the design firms to operate successfully. Also, fees for services must be in line with what other firms are charging, since most clients will not pay substantially higher costs for one firm than for another.

Location of Offices

The location of offices performing interior design is as varied as the type of individual or firm. Location can be very important to clients and staff in terms of accessibility, convenience, and professional image; however, in some cases, the location is not critical. For example, if clients do not normally come to the office, it often is not necessary to locate in their immediate area.

Interior design firms usually select a home, a retail store, or a professional office building for their business location. Each has advantages and disadvantages.

RESIDENTIAL STUDIO Perhaps the simplest and most economical location for establishing an interior design business is the residential studio or home office (Figure 19.1). This can be a room in the house that is segregated as a distinct office with its own entry and identity. Many designers, particularly those starting out, choose this type for its economy—both in monetary outlay and in personal travel time. As computers and electronic media advance, we may see an increase in this type of office location, since it is becoming less important to commute to a central office location for the day's work.

However, offices located as residential studios can have some disadvantages. Disruptions from the business—such as after-hours phone calls, deliveries, and salespeople—can upset the home routine. In turn, daily home distractions, such as noisy children and neighbors who come to visit, can affect the business operations and professional image.

RETAIL STORE A second location for an interiors operation can be in a retail or manufacturing establishment, such as a furniture showroom, home furnishings store, or even part of a large department store. In all of these, the retail aspect of the operation is generally the prime profit-making motive, and design services are secondary. The services and expertise of interior designers can vary greatly from store to store, depending on what the retail establishment expects in terms of sales volume. Some retail stores hire outside designers; others have a full staff of professionally trained designers.

PROFESSIONAL OFFICE The third type of location is the professional office set up exclusively to offer design services (Figure 19.2). The professional office might be an independent interior design firm or operate within an architectural firm that has an interior design department. In a full-service organization, architects, engineers, planners, and graphic designers might also be housed in the office.

The location, size, and image of the design office will vary according to the community size and client base. Some firms will locate in a central business district and cater primarily to downtown clients who seek office spaces or other centralized facilities. Other firms will locate in suburban areas, office parks, or manufacturers' showroom districts. The latter have the advantage of saving the designer and client time by providing quick access to showrooms for selections of furniture and other goods.

OTHER LOCATIONS In addition to these three common locations, there are other sites for the practice of interior design. Facility management operations of large companies and institutions might have their own design staff. Some developers, realtors, and leasing agents for high-rise office space also have a small staff of interior designers or architects for space planning functions and tenant development.

Small and Large Offices

Interior design is practiced by individuals working alone, by small firms, and by large organizations. Offices vary in physical size, staff organization, and type of services offered. Generally speaking, small design firms restrict their work to small projects that do not require a large staff. These firms can offer the benefit of having one or two

FIGURE 19.1 This home studio is divided into two areas, with the work area located in a loft that overlooks the entry and meeting areas.

designers do all the work on a project; therefore, the designer or designers gain experience in all areas, encompassing client contact, designing, budgeting, producing construction documents, supervising, and so forth. In a large design firm, the designer may not be involved in all aspects of a project. The project might be so large that one person cannot do the whole job and needs to concentrate on only a part of it. Collaboration and teamwork are very important in completing a large project.

Design firms are often divided into two or three groups of staff functions: administrative and production (Figure 19.3) or administrative, design, and production. The administrative arm is responsible for areas such as personnel, financial management, legal, and other general functions of maintaining the business operations. These duties might be performed by business specialists or the principals of the firm.

FIGURE 19.2 This conference room provides collaborative space within a professional design firm.
Image Courtesy of Herman Miller, Inc.

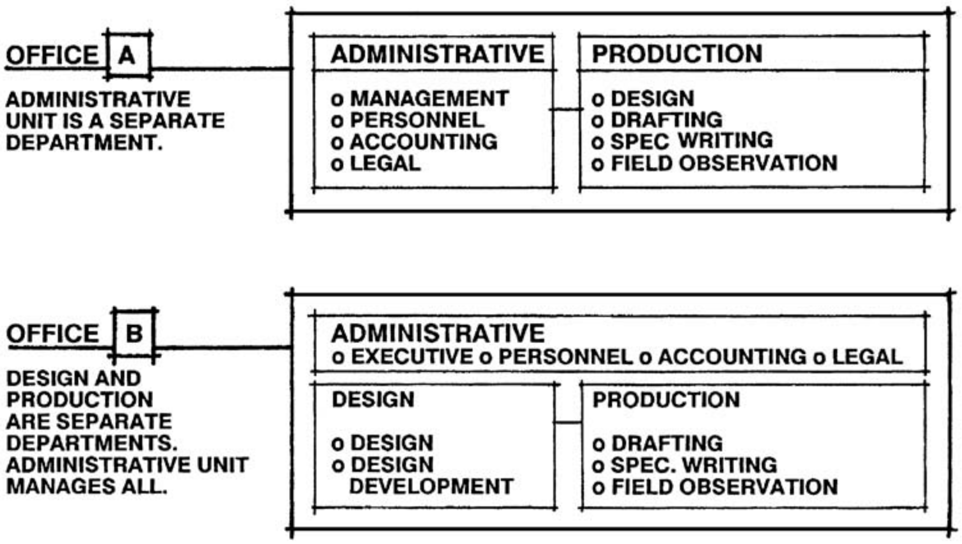

FIGURE 19.3 Design firms can be organized and managed according to the expertise of the personnel, the scope of services offered, and the decision-making process within the firm.

The design and production departments of a design office render services such as feasibility studies, design sketches, construction drawings, and the coordination of duties during construction. Design and production can be combined in one department or split into two departments with distinct functions and responsibilities.

Design firms are organized so that each staff member is assigned work in relation to his or her experience, capability, and potential to carry out those responsibilities efficiently. These employees are often organized into teams and assigned to a particular project. In turn, each individual or team is assigned to a senior person or project director to ensure that all the work meshes. Because most firms handle many projects at a time, this designated project director guides several jobs at once, coordinating the work of each project. In turn, project directors report to the owner or partners.

Marketing, Public Relations, Ethics

Marketing

Marketing is an important part of a design firm's operations because it keeps the firm in business by seeking potential contacts to secure the kind of work the firm is capable of doing. All successful design firms have a sound business development program that augments their creative and production endeavors. Marketing consists of identifying clients and their needs. Firms use various techniques, such as business call forms, work sheets, and follow-up memos, to pursue leads for commissions. Successful firms know how to market their services aggressively rather than waiting for the telephone to ring or a client to walk through the front door. These firms develop marketing tools such as brochures and portfolios to provide prospective clients with information about the services and skills of the firm.

Public Relations

Public relations for an interior designer are an image-building process. Wide exposure is a key factor in creating public recognition of who designers are, what services they offer, and the benefit they contribute to society through their work. Getting completed projects and information published in newspapers, magazines, and other media helps a company to gain exposure. Designers should join local civic organizations or serve in volunteer organizations for additional community exposure. Although the prime motive for community involvement should be for the good of the citizenry, it can also lead to contacts with those who might later need the services of a designer.

Ethics

As physicians, attorneys, and architects have a code of ethics, so do interior designers. Professional societies, such as the American Society of Interior Designers (ASID) and the International Interior Design Association (IIDA), have a written code of ethics that their members pledge to uphold. These codes set a minimum standard for the designer and address conduct, competency, integrity, and responsibilities. Members who violate these rules can be subject to disciplinary action by the judicial boards of the organization. For designers who might not belong to professional societies, unwritten ethics standards serve to promote the image of interior designers as professional, capable, and responsible practitioners, to their clients, each other, and society.

Business Consultants

The complexity of rules, regulations, and technological advances can create a mountain of knowledge for the interior designer to keep abreast of. At times, it seems impossible to know every detail and requirement a project entails. Consultants and other sources can assist in getting the job done. These team players augment the designer's resources by offering more services and expertise to respond to clients' needs.

Attorneys, Bankers, Accountants, Insurance Agents

Other consultants, such as attorneys, bankers, accountants, and insurance agents, are of vital importance to the interior designer's business operations.

Attorneys help in the firm's legal matters, such as assisting in setting up the initial structure of the business and offering advice for contract preparation or interpretation. Attorneys can also be an asset in a contract dispute or a lawsuit.

Bankers can provide monetary support when the designer is starting up a business or can provide help when the financial operations need additional cash or a loan to buy a building or equipment or, occasionally, to meet payroll demands.

Accountants handle matters such as finances, taxes, credit arrangements, and the fiscal operations of accounts receivable and payable. They can assist the firm in determining the actual profits made and project how to continue the business as a profit-making entity.

Insurance agents provide a multitude of types of coverage for the designer and the business, including medical and life insurance for the staff and protection of the building and equipment. There is also omissions and errors insurance for the firm that covers designers' services and is similar to the malpractice insurance that doctors carry.

Fees and Compensation

Methods for charging for interior design services vary. No set fees will apply for every designer or project—each can be its own unique arrangement. In estimating what to charge for his or her services, the designer must define the scope of the work in terms of staff needs and time required to do the work. The designer should know both what the competition is charging and what the client expects. The designer can utilize several methods of fee structuring. Those presented in the following sections are the most typical, but they can be altered or combined by the designer to better suit the services provided, the client's needs, and the scope of the project.

Hourly Fee

The designer can charge a set rate for each hour actually spent on the project. This rate is generally marked up to include overhead, profit, and operating costs.

Fixed, Flat, or Stipulated Fee

When the designer agrees to do the work for a specified amount of money, this is called a fixed, flat, or stipulated fee. Although this method of charging might appear simple, the designer must accurately estimate time and overhead for a project, which can be difficult if the scope of work is not clearly defined, or if unexpected events (such as clients changing their minds) occur throughout the project. However, this method can be profitable if the designer has done many similar jobs.

Percentage of a Project Cost

A designer can charge a fee as a percentage of the project cost, which can include the materials used and the labor expended by others. The percentage fee varies in proportion to the size and cost of the project and the designer's time expended. The percentage is usually higher for small projects than for larger projects. This type of fee can be advantageous when the project has changes that result in higher costs and complexity, since the designer's fees increase proportionately to the amount of time needed to do the work.

Fee Plus Expenses or Percentage

On small jobs, or when the scope of the designer's services is not clearly defined, the fee can be based on a set fee plus expenses, or even a set fee plus a percentage of the project costs. Project costs can be determined from construction, furniture, and/or furnishings costs.

Cost Plus Fee

The cost plus fee involves buying furniture and other merchandise at the designer's cost, then reselling them to the client at a marked-up fee. The profit a designer makes is the difference between what the designer charges the client for the merchandise and what the designer pays a manufacturer or wholesaler for the merchandise. A designer can usually make more profits this way than on a fee basis. For example, to select a client's new sofa may take the designer three hours and be billed at $70 per hour, for a total of $210. On the other hand, if a markup of 20 percent is added to a $2,000 sofa, the designer's profit is $400. However, a designer may feel that the markup method puts more emphasis on selling merchandise than on designing.

Area or Per Square Foot Fee

The area or per square foot fee is used on a specialized basis when the designer has considerable experience and knows the competition's fees very well in the same type of market. The area or per square foot fee is used in the specialized field of tenant development—planning spaces in office buildings. The fee can range from 50 cents a square foot up.

Contractual Agreements

Contractual agreements are needed between various parties involved with interior design projects to indicate each party's responsibilities. Agreements can be oral or written, but it is preferable and more professional to put everything in writing to prevent possible disagreements later. A contract serves as a legal agreement between two or more parties and is recognized as a binding relationship for those who enter into it. In interior design, the three most common contracts are client/designer, owner/contractor (also called installer, supplier, or manufacturer), and designer/consultant.

Client/Designer Contracts

Written contracts between the client and the designer protect both parties and confirm each party's rights and obligations in their relationship. Although some designers work without a written contract, it is professional practice to clearly define the responsibilities and anticipated performance of both the client and the designer. These documents can be simple work orders (Figure 19.4), letters of agreement, or preprinted contracts provided by various professional design societies, such as ASID, which produces several copyrighted documents for interior designers to use (Figure 19.5). They all encompass some of the essential parts listed in the following sections.

WORK ORDER Number ________

Date ________________

(Your firm) ____________________________

(Your address) ____________________________

(Your phone no.) ____________________________

Client ____

Address ____

Phone ______________ Date Job Completion Requested ______________

Services Requested ____

☐ A. Fixed Fee of: $ ________ ☐ With partial billings monthly commensurate with job progress.

☐ To be billed at completion of job.

☐ B. Services to be billed monthly at current hourly charge rates per hour; plus expenses for the individuals working on the project (i.e., blueprints, copying, long-distance phone calls.)

Remarks ____

PLEASE READ, SIGN, AND RETURN ONE COPY TO DESIGNER AT ABOVE ADDRESS.
Payment will be due and payable by the end of the month in which the work is billed. 1½% per month will be charged on the unpaid balance on accounts after 30 days. The above order for work is hereby approved. If it is necessary to retain an attorney to enforce collection, the undersigned agrees to pay reasonable attorney fees and court costs in addition to the aforesaid interest.

☐ Work will not commence or be scheduled until signed copy is returned.
☐ Work will begin without signed work order being returned, but may be terminated without notice if signed copy is not returned within 10 days.

By: ______________________________ By: ______________________________
Designer Date (Person responsible for payment) Date

FIGURE 19.4 Example of a simple work order form for design services

AMERICAN SOCIETY OF
INTERIOR DESIGNERS, INC.

ASID DOCUMENT 301 · 2008

AGREEMENT BETWEEN DESIGNER AND CLIENT FOR DESIGN SERVICES

Small/Medium Commercial Contract 2008

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FIGURE 19.5 A preprinted contract produced by ASID for design services
Courtesy of ASID

SCOPE OF SERVICES The scope of services defines what services the designer is likely to provide to solve the client's problem, including programming, schematic design, design development, contract document preparation (including specifications), contract administration, move-in, and follow-up evaluation if necessary.

PROJECT DESCRIPTION Project description defines the location and particulars of what is to be designed, built, or installed. It lists the location, approximate size, and limits of the areas the designer is to address.

IDENTIFICATION OF THE PARTIES The parties entering into the contract are clearly defined using the legal name(s), titles, and addresses of the client and the designer. The contract specifies who is responsible for signing (if the client is a company) and paying the designer's fees, and identifies the client's representative if it is a large corporation or has more than one partner.

TERMS AND CONDITIONS The terms and conditions of the contractual agreement are detailed so that both parties have a clear understanding of their responsibilities and of what is expected of each. The contract also defines any additional requirements, exceptions, and other parts of the total contract. For example, the contract might require that the client furnish temporary electrical power in a renovation, but not insurance for the workers.

FEES AND COMPENSATION The fees and compensation are set out in the contract, which also specifies when payments are due to the designer. Clauses are usually added to cover reimbursable expenses, penalties for late payments, and retainers. A retainer is a sum of money (usually 10 percent of the total fees) sometimes given to the designer at the beginning of the project. Retainers are required if the client and the designer are working together for the first time or if the designer is supplying merchandise. The retainer represents good faith on the part of the client.

DATE AND SIGNATURES Dates and signatures are added to the contract to show that all parties have read it and agree to its conditions. Each party keeps a copy of the contract, which then serves as a legal document.

Client/Contractor Contracts

The client (owner) and the contractor enter into a legal written contract similar to the client/designer agreement, although the client/contractor contract is often more specific. This contract itemizes in detail the work to be done and the cost. It usually specifies the length of time in which the work is to be completed. The designer's drawings and specifications are made a part of the contract to clearly delineate the scope of the project and the quality of workmanship expected. The professional societies have all prepared standardized documents for these owner/contractor agreements.

Designer/Consultant And Other Related Contracts

Other related contracts are entered into by various parties in order to complete a project. These are of a specialized nature and are designed to specify the details of the transaction between two or more people. The most common types are designer/consultant agreements, purchase orders, and owner/subcontractor agreements.

Bookkeeping and Accounting

For an interior design business to be run effectively and efficiently, either an in-house or an independent accountant must maintain cost control of the firm's operations. Various forms and books of the firm's accounts receivable and payable are established and maintained on a regular basis. These can range from simple ledger books in smaller organizations to complicated computer analyses in large firms (Figure 19.6). Another method of accounting is to use employee time sheets (Figure 19.7) for computing billable time on a project.

PROJECT MANAGEMENT

The managing of designers' projects is crucial to the successful operation of the business and to future work. Projects must be efficiently handled to meet the client's needs in a timely manner, bring recognition to the designer, and keep the business operating by generating a profit. Whether an individual designer or a group is to accomplish the work, there must be a clear understanding of the project, the required design services to solve the situation, and the sequence of steps necessary to get the project accomplished.

PROFIT OR LOSS STATEMENT
WILD ROSE INTERIORS
PERIOD ENDING JULY 31, 201X

Gross Income			
From Fees		$38,685	
From Sale of Goods	$26,500		
Freight-in	1,855		
Delivery	2,279		
		$30,634	
Gross Income		$69,319	
Other Revenue			
Interest		400	
Total Gross Income		$69,719	$69,719
Cost of Goods			
From Sale of Goods:			
Cost of Products Sold	$17,500		
Freight-in	875		
Delivery	1,400		
From Fees:			
Direct Labor	27,080		
Supplies	985		
Reproduction Expense	395		
Telephone	205		
Total Cost of Sales & Fees		$48,440	
Gross Profit			$21,279
Operating Expenses			
Advertising & Promotion	$ 200		
Auto Expense	750		
Dues and Subscriptions	160		
Furniture—Depreciation Expense	225		
Insurance	175		
Legal/Professional Services	150		
Salaries	12,500		
Payroll Taxes	1,875		
Group Insurance	105		
Rent	800		
Utilities	300		
Telephone	150		
Travel Reimbursements	150		
Supplies and Postage	325		
Professional Consultant Fees	250		
Printing	75		
Interest Expense	225		
Total Operating Expenses			$18,415
Net Profit			$ 2,864

FIGURE 19.6 Example of an accounting document for a small interior design firm

FIGURE 19.7 Example of an employee time sheet

TIME SHEET Name:________________ Week Ending ____________

BILLABLE HOURS		Time in hours							
Client Name	Project Number	Sun. Sat.	Mon.	Tues.	Wed.	Thur.	Fri.	Total Hrs.	Comments

NON-BILLABLE HOURS		Time in hours							
Name	Project Number	Sun. Sat.	Mon.	Tues.	Wed.	Thur	Fri.	Total Hrs.	Comments

SUMMARY	Time in hours						Total	Comments
Total Billable Hours								
Total Non-Billable Hours								
Grand Total								

Design Teams and Staff Organization

The trend toward working in teams is increasingly common in the design fields. Designers acting as teams can more efficiently offer services by combining expertise either within a firm or in association with other firms or consultants.

When a project is brought into an office, the staff is organized to work with the client, consultants, contractors, and others to bring the finished product to fruition. Generally, design firms use two basic approaches to organizing their staffs: vertical or horizontal (Figure 19.8). These arrangements are set up in such a way that each person is assigned work in relation to his or her experience, capability, work load, and potential to get the job done efficiently.

The vertical organization, or studio approach, is used if the firm consists of a group of generalists rather than specialists. In this arrangement, each person is involved in all phases of the project. On large projects, a design team is set up with specific leaders to assist less experienced staff in gaining knowledge and skills. This arrangement has the advantage of training staff in all levels and experiences of a project.

The horizontal organizational method consists of a series of the firm's specialists or departments working on only one or two aspects of a project as it moves through the firm—like an assembly line. This specialization increases the efficiency of the firm's output and is helpful on large projects. However, staff may not get exposure to all parts

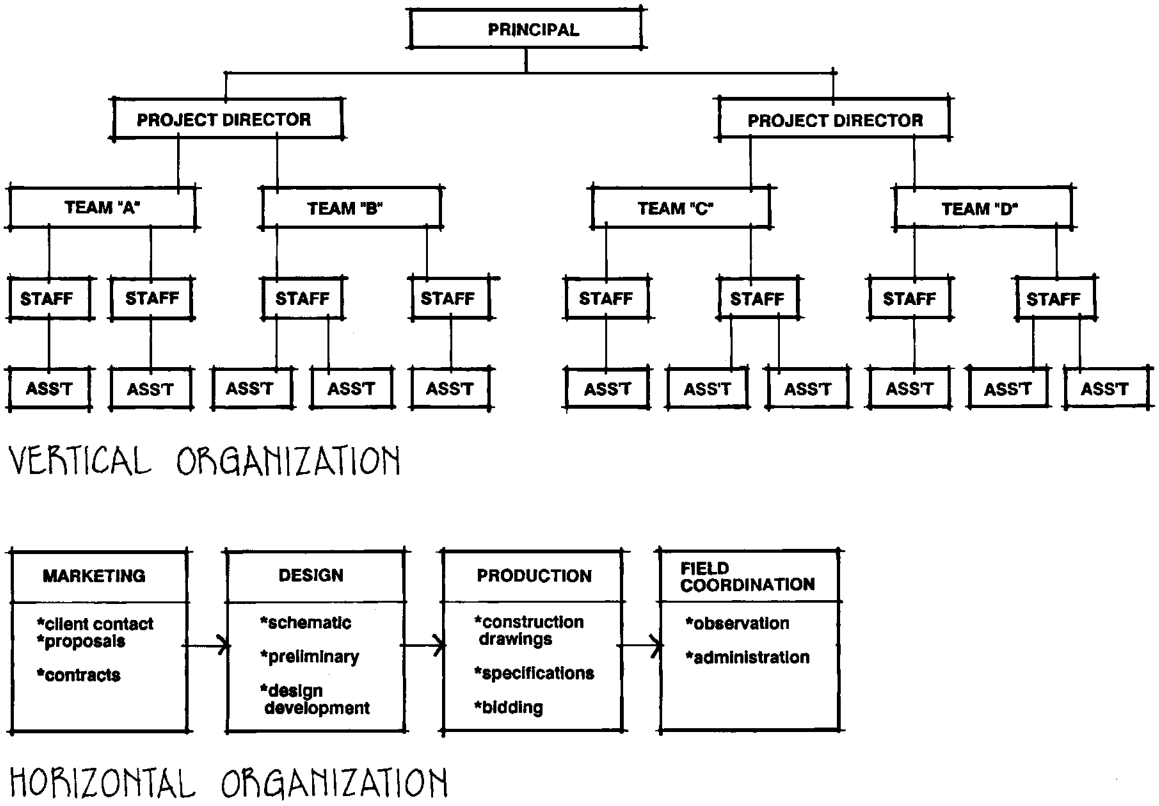

FIGURE 19.8 Vertical and horizontal approaches to organizing a design firm's staff for efficient workflow

of a project and may get pigeonholed in one area. Sometimes design firms use both of these approaches, depending on the size and scope of a project.

Project Consultants and Resources

Architects, Engineers, and Other Consultants

Architects and engineers are professionals who can be very much a part of the designer's team, since they have the expertise to offer unique services to the designer. The architect has been educated, trained, and licensed to give not only technical advice but also suggestions on matters of aesthetics and problem solutions in a project. Whether it is the interior designer retaining the architect or vice versa, it is the teamwork between these individuals that can make for a truly successful project. In great buildings and interiors, it is hard to distinguish the work of the interior designer from that of the architect.

Engineers undergo lengthy professional preparation and are qualified to offer technical assistance to the designer. There are many specialized areas within the field of engineering, such as electrical, structural, mechanical, acoustical, and lighting.

Other consultants the interior designer might work with are landscape architects, industrial designers, and graphic designers.

Manufacturers and Trade Sources

A good resource for the designer is the manufacturer or members of the trade source. These include individuals and companies, such as manufacturers' representatives, dealers, wholesalers, craftsmen, suppliers, and contractors, providing materials, assemblies, and installation of interior products, including furniture, light fixtures, floor coverings, and finishes.

These sources not only provide products but can assist in specifying how the product is to be installed and what standards it should meet. For example, a manufacturer of ceramic tile publishes detailed information about how its product will perform under varying conditions and specifies how the subsurface is to be prepared to ensure this performance. Instructions are also included for installing the tile in a workmanlike manner. A carpet manufacturer can assist a designer by recommending which of its products will best serve the designer's specific needs on a project.

The Client's Budget and Costs

The client's budget is as great a concern to the designer as is creating the project solutions. The designer should not avoid discussing budget constraints with clients. Proposed concepts and designs can be *very* beautiful, but if they exceed the client's budget, the project probably will not be completed, or the designs will have to be redone to bring the costs down. Very few clients will leave the budget open. The designer must estimate project costs and adhere to them throughout the job.

Establishing and Controlling Budgets

The budget for a project might either be established by the client or be submitted by the designer, based on his or her experience with a similar project. In either case, the budget becomes the limit for the designer. If design solutions cannot be met within the established amount, the designer should discuss revisions of the project with the client. Sometimes a designer must redo the project designs to bring down costs—without being paid by the client to do this. The designer who constantly overruns on projects will have a damaged reputation.

Estimating budgets for projects can be difficult for the inexperienced designer. The designer without years of experience in budget estimating can consult other professionals, such as architects, contractors, or estimators. Since the complexity of economics can cause price fluctuations in materials and labor, a designer should never promise that a project or item will not exceed the budget.

Working within a budget can be difficult. The designs, materials, and labor for the project must be carefully monitored to ensure that the job stays within projected costs. At the beginning of the job and throughout the subsequent phases, comparisons of preliminary cost estimates and actual expenditures must be made on a regular basis and presented to the client. In this manner, cost overruns and any hidden expenses can be avoided.

Project Scheduling

At any given time, a design firm might be working on more than one project in varying stages of development. Careful scheduling moves a single project through its stages, yet allows the staff to be involved in more than one project at a time. Each job must be given individual attention and must fit the firm's overall work schedule.

Although the actual construction of a project is usually scheduled by the contractor, the designer attempts to establish overall schedules of design and drawing time, as well as anticipated construction times, to assist the client and execute his or her own services at the proper times required for coordination (Figure 19.9). The principal or a senior partner oversees all scheduling and tracks all projects to ensure that the work flows well in all phases of production.

Projects are typically phased in relation to the design services and the amount of construction required. Although the individual stages of interiors presented here may vary from project to project, most scheduling will progress through the following distinct steps.

Feasibility Studies and Programming

The initial phase in most projects consists of the feasibility study and programming (Figure 19.10). A feasibility study represents preliminary investigations and the assessment of the validity of a project, to ascertain what the client needs and to what extent design services are required. Discussions and preliminary research take place with the client and others to define the scope of the problem.

Programming is a more formal method of researching, documenting, and defining specific goals of the client and project (see Chapter 7). It establishes current and projected requirements needed for space, people, construction, costs, and other items of the project under study. A probable cost estimate or project budget is established for the amount the client will need to spend for the construction and installation of the project. This preliminary estimate is adhered to or modified in later phases, depending on changes required by the client. A letter of agreement or contract is also drawn up between the client and the designer for the required services and fees for this and subsequent phases.

Schematic and Preliminary Designs

Using the program that was developed earlier, rough conceptual sketches or schematics are created to depict physical and nonphysical relationships of the project. These might be in the form of rough architectural drawings

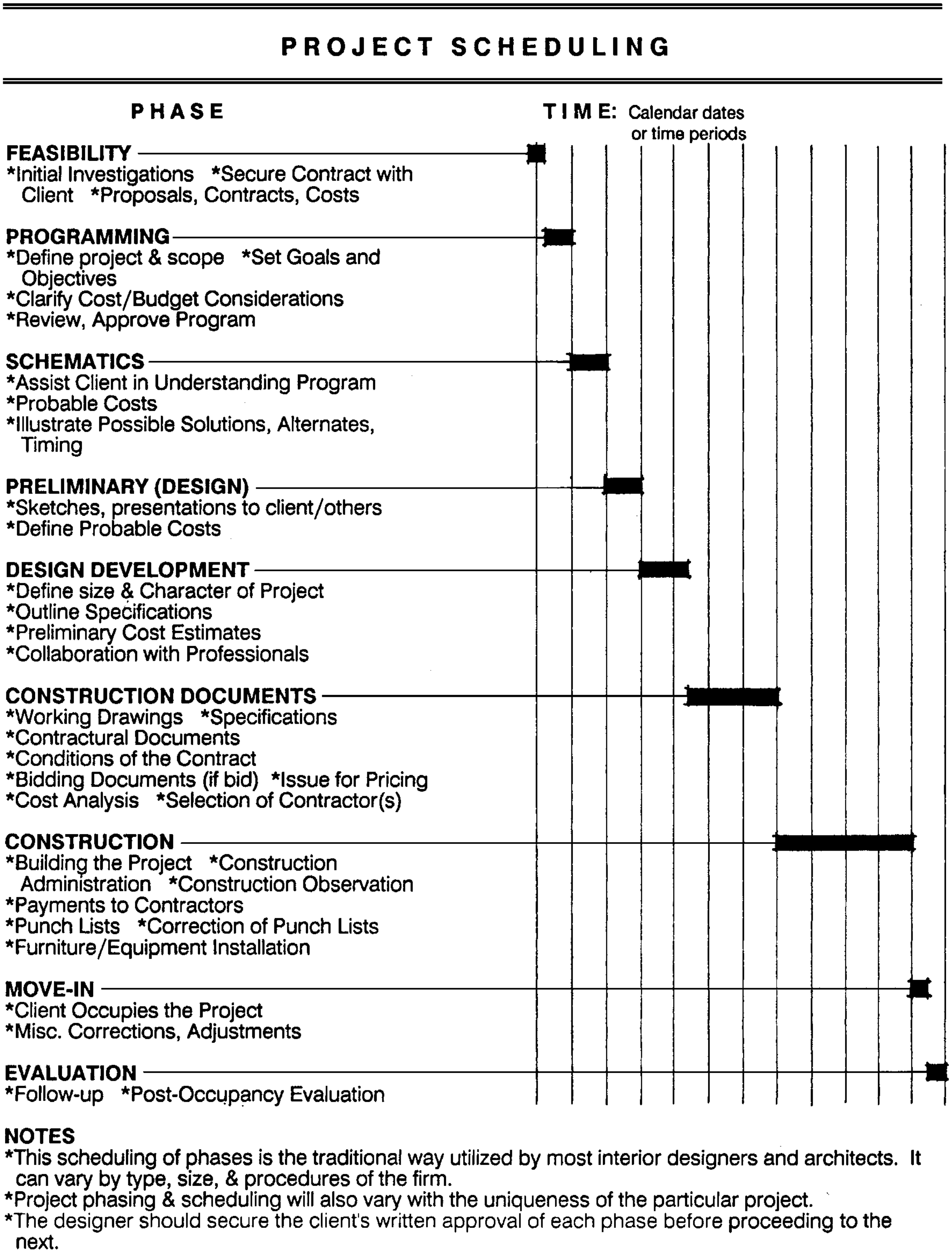

FIGURE 19.9 Careful scheduling moves a project through the stages in an organized manner.

or graphic sketches to test concepts and get feedback from the client. During this phase, the designer might utilize input from consultants to help define basic premises and requirements about the project.

From the schematics, preliminary designs are developed to present operational, functional, and conceptual relationships of the project. These, along with a more refined budget estimate, are presented to the client for input and approval before moving to the next phase. The designer is paid for services either at the end of this phase or monthly if it is a lengthy project.

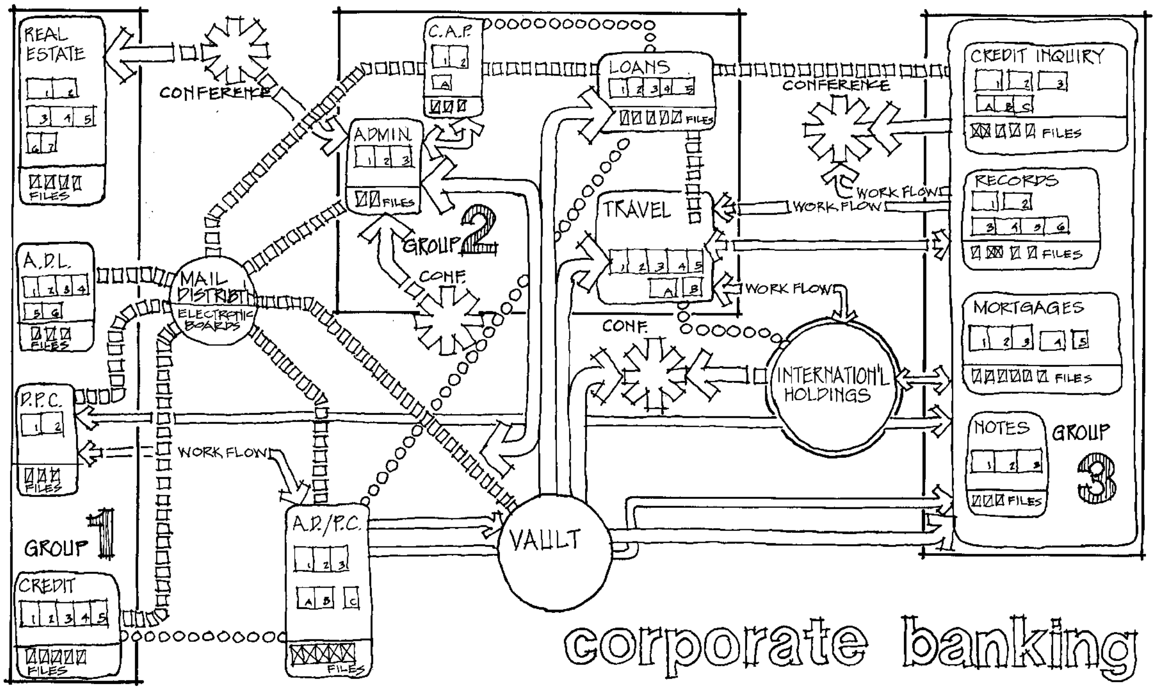

FIGURE 19.10 Feasibility and programming can be presented in a graphic manner to visually explain concepts.

Design Development and Presentation

After the client approves the preliminary design concepts, the project moves into the design development phase, in which drawings and material selections become more specific, to determine the character, size, and details of the entire project. Appropriate finishes, furniture, and furnishings are studied and coordinated in the design concept. Then these elements are drafted and assembled with careful craftsmanship since the designer is presenting his or her best effort for the project.

The designer's ideas and solutions are presented to the client in what is called a presentation format (Figure 19.11). Each designer or firm has a different presentation style and format. Some are very formal with a theatrical flair,

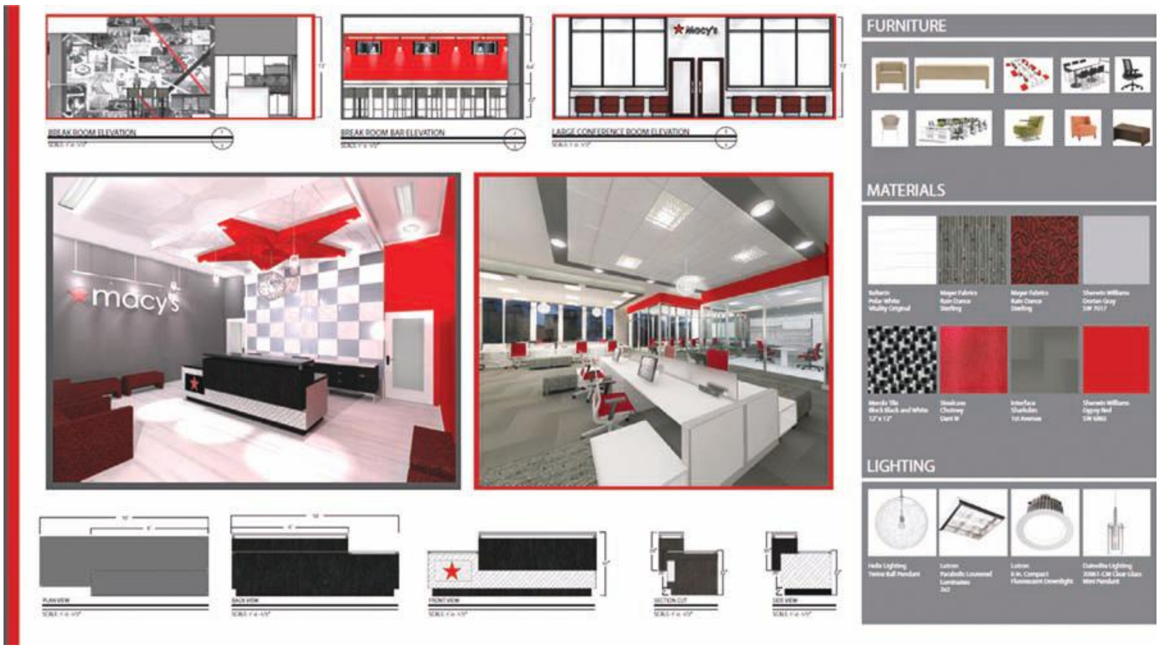

FIGURE 19.11 Example of a presentation board for a new office headquarters in an existing building

and others are more informal. Budget modifications are made as required, and the designer bills for services rendered.

Construction Documents

Once the design is complete and approved by the client, the designer is ready for the construction documents phase, which details what is to be constructed and installed, and how and where that will occur. Construction documents are composed of the construction drawings (working drawings), the specifications, and the various contracts needed to legally bind the client, the contractor, and other parties. These documents are first used by contractors to obtain final cost figures and then become a guide to the execution of the actual construction of the project. The drawings (Figure 19.12) note specifics, such as construction details, exact finishes, cabinetry, all materials, and other items needed to build what the designer envisioned. The specifications (Figure 19.13) are written descriptions of materials, methods, and level of acceptable workmanship. The designer's services for this phase generally represent the largest part of his or her fees because it can take a considerable amount of time to prepare these documents accurately.

Selection of Contractors

The selection of contractors can be seen as a distinct phase, particularly on a large project or when several contractors want the job. Either contractors bid competitively for construction work or the designer assigns one after negotiating a fair price for the work.

In competitive bidding, the designer might assist or represent the client in finding the lowest price to do the project, on the basis of the contract documents. All the contractors are following the same drawings, so their prices can be compared. The client usually reserves the right to select any bidder, since the lowest bidder might produce substandard work.

In negotiating with only one contractor, the client seeks a fixed and reasonable cost or might allow the contractor to do the work on a time (labor) and materials basis. If the latter approach is taken, the contractor bills the client for the work and includes a fee for profit. Negotiation instead of competitive bidding is appropriate if the contractor has a good reputation, charges fair prices, and allows an adequate time frame in which to complete the project.

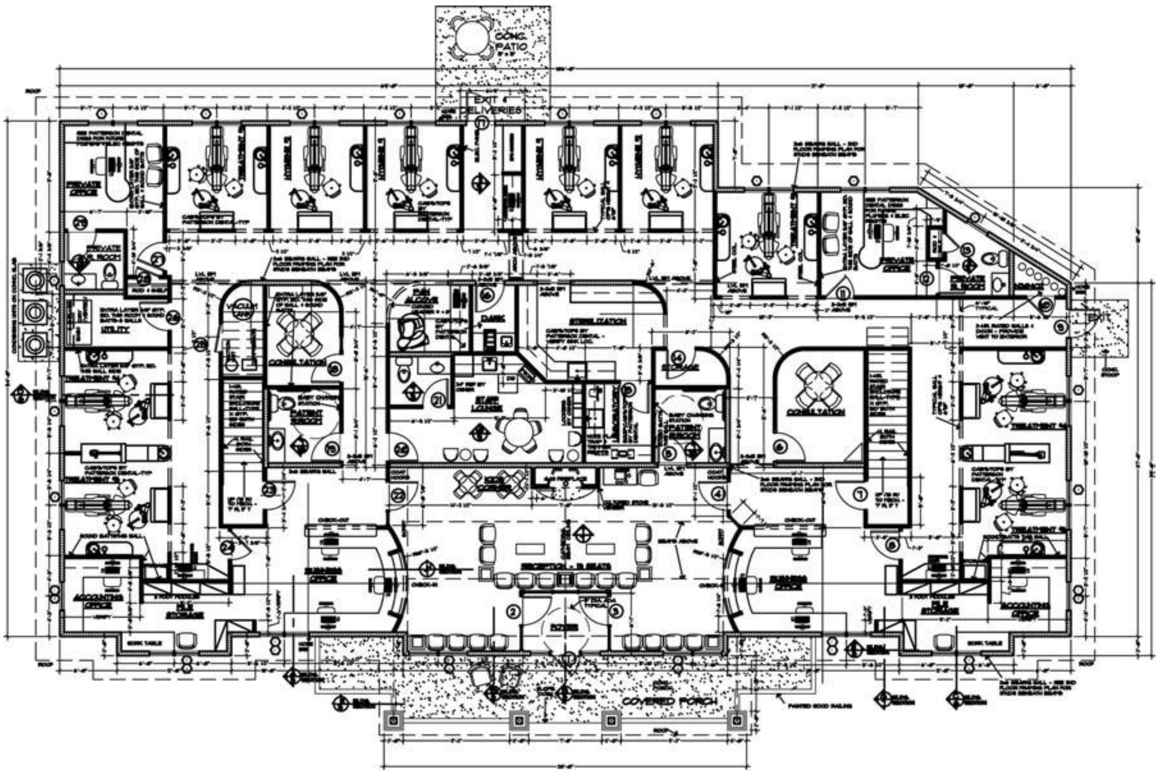

FIGURE 19.12 Construction drawings detail the exact size and other particulars of a project to be built.

SECTION 09680: CARPETING

PART 1—GENERAL

1.1 DESCRIPTION

A. Work included: Provide carpeting and carpet accessories where shown on the Drawings, as specified herein, and as needed for a complete and proper carpet-and-pad installation.

B. Related works

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 1 of these Specifications.

1.2 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.3 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product data: Within 5 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:

1. Materials list of items proposed to be provided under this Section:
2. Manufacturer's specifications and other data needed to prove compliance with the specified requirement:
3. Shop Drawings showing location of seams and locations and types of carpet metal and accessories.
4. Samples of the full range of colors and patterns of carpet and of exposed accessories available from the proposed manufacturers in the specified qualities.
5. Manufacturer's recommended installation procedures which, when approved by the designer will become the basis for accepting or rejecting actual installation procedures used on the Work.

1.4 PRODUCT HANDLING

A. Comply with pertinent provisions of Section 01640.

PART 2—PRODUCTS

2.1 CARPET

A. Provide seam adhesive recommended for the purpose by the manufacturer of the proposed carpet.

B. Provide carpet adhesive recommended for the purpose by the manufacturer of the proposed carpet for the direct glue installation of carpets.

C. Provide other materials not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Designer.

PART 3—EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 SURFACE PREPARATION

A. Make substrata level and free from irregularities. Assure one constant floor height after carpet is installed, filling low spots and grinding high spots as required.

3.3 INSTALLATION

A. General:

1. Glue directly to the floor, using no pads and no foam.
2. Scribe the carpet accurately to vertical surfaces.
3. Align the lines of carpet, as woven, using no fill strips less than 6" wide, laying all carpet in the same direction unless specifically directed otherwise by the Architect.

B. Seams:

1. Locate seams only where shown on the approved Shop Drawings, or where specifically otherwise approved by the Designer.
2. Locate seams to the maximum extent practicable out of the way of traffic.
3. Fabricate seams by the compression method, using a butt joint, and properly bead and seal and/or hotmelt tape.
4. Make seams as inconspicuous as possible, flat, unpuckered, and completely free from glue on the exposed surfaces.
5. Do not stretch seams.
6. Corners on 90° borders to be seamed with a 45° mitered seam.

C. In addition to the cleaning requirements stated elsewhere, thoroughly clean carpet and adjacent surfaces prior to final acceptance of the carpeted areas by the Owner.

3.4 PROTECTION

A. Provide a heavy non-staining paper or plastic walkway as required over carpeting in direction of traffic, maintaining intact until carpeted space . . .

FIGURE 19.13 Example of a partial carpet specification. Specifications are composed of three basic areas: general directions, products to be used, and execution needed for proper installation.

Construction and Contract Administration

The construction and contract administration begins when the contracts are awarded to the various contractors and suppliers. In large projects, many people will work together as the project moves through this phase. It is important for the designer to follow the project closely in order for work to progress smoothly to the end. During construction and installation, the designer acts as the agent for the client by visiting the building site, keeping abreast of the work, and reporting to the client on the quality and progress of the work. The designer reviews the project and the progress of the work in accordance with the contract documents.

Construction of a project must proceed in a timely manner and in a logical sequence. For example, the carpenters must first install floors and walls before the electricians and plumbers can rough in their materials.

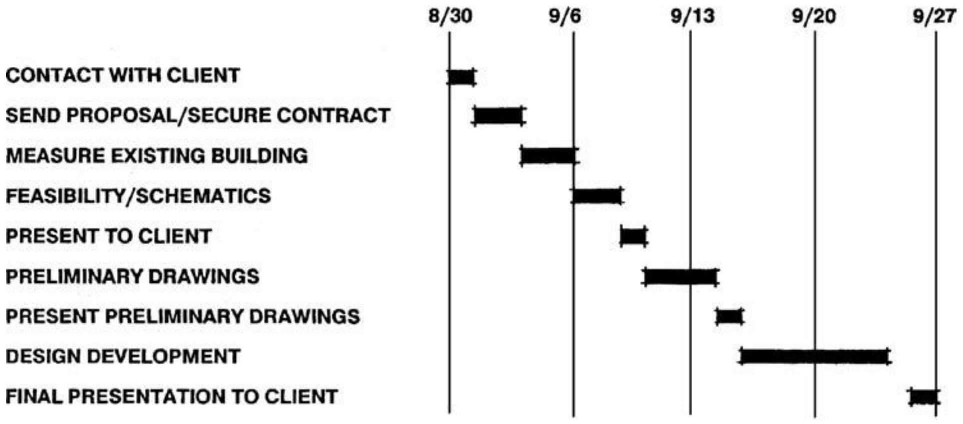

FIGURE 19.14 Project evaluation and review technique in the form of a bar chart that graphically shows the time span required to complete project activities

Next, the finishes are applied, and then the electrical covers, lights, plumbing fixtures, and other units are trimmed out. This sequence is controlled by the general contractor, who uses a scheduling technique such as PERT (Project Evaluation and Review Technique) or CPM (Critical Path Method) (Figures 19.14 and 19.15). The designer does not control the schedule or supervise the work; that is the contractor's responsibility. A designer might refer to this stage as supervision; however, the service is better described as coordination and observation. Supervision can imply that the designer is responsible for the outcome of the work, which could cause him or her to be named in a lawsuit if the project fails. The client could decide to sue both the contractor and the designer if a problem arises. Architects have mostly eliminated the use of the term *supervision* in their work after many lawsuits awarded damages on the premise that if an architect supervised a project, he or she—not the contractor—was then responsible for the finished project. However, the designer does carefully track the schedule and assists the contractor in keeping things moving properly. A regular meeting time is generally scheduled with the client to discuss any changes during the construction phase. Various business forms are available to use throughout this phase, such as the change order, transmittal, and field reports (Figure 19.16).

During construction and installation, the designer performs services that are commonly called contract administration. In this phase, the designer sometimes approves the money amounts due to the contractor and suppliers and makes recommendations to the client for proper payment. However, if the designer finds that the work or materials are not up to the standards called for in the contract documents, he or she can recommend that the client not pay until problems are corrected. The designer is generally paid monthly at an hourly rate for services in this phase, although in some cases, a percentage of the construction cost is paid.

Purchasing

A unique phase in the interior design field is that of purchasing items such as furniture, accessories, furnishings, and many other products that are not purchased or installed by the contractor. The designer is involved in this phase in a number of ways.

If the designer is specifying only, he or she will assist the client by selecting the proper items and coordinating with the supplier to get the product placed in the interiors at the appropriate time. The designer might prepare purchase orders for the owner and help check prices and delivery schedules.

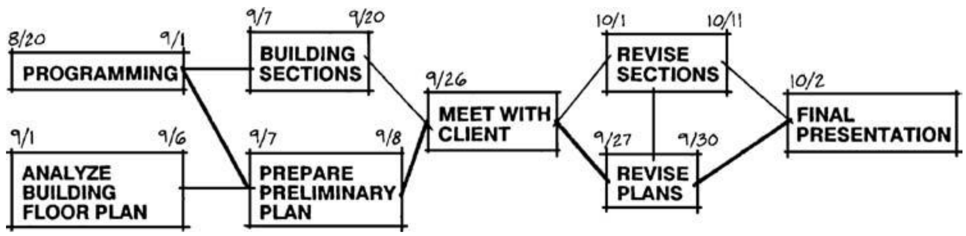

FIGURE 19.15 Example of a critical path chart indicating the shortest time of the project activities noted in the darker lines

FIGURE 19.16 In the construction and contract administration phase of a project, transmittal forms are used to communicate with others and provide a record of those particulars.

TRANSMITTAL LETTER

KILMER & ASSOCIATES

ARCHITECTS / INTERIOR DESIGNERS
601 KENT AVE., ANYTOWN, TX 3106-050
Phone: (623) 555-5555/ Fax: (623) 555-5556
email: kilmer@verizon.net

PROJECT: **New Dental Office for More Smiles**
1827 North Howard Ave., WA

ARCHITECT'S PROJECT NO: **06008**
DATE: **January 6, 20XX**

TO: **Dr. Gary Saxton**
Dr. James Henre
2995 Jones Street
West Joplin,TX 47497

If enclosures are not as noted, please inform us immediately. If checked below,
( ) Acknowledge receipt of enclosures.
( ) Return enclosures to us.

WE TRANSMIT:
(**X**) herewith ( ) under separate cover (via) **delivery**
( ) in accordance with your request ______

FOR YOUR:
( ) approval (**X**) distribution to parties ( ) review & comment ( ) record
( ) use ( ) ______

THE FOLLOWING:
(**X**) Drawings ( ) Shop Drawings ( ) Samples ( ) Literature

COPIES		DESCRIPTION / ATTACHMENTS		DATE
6	sets	Construction drawings	39 sheets (24"x36")	various dates
4	sets	PDFs of Construction Drawings (11"x17")		various dates
3	DVD disks	Construction Drawings (PDF format)		

Here are the construction drawings to distribute to the 3 builders. I also printed 1 set (11"x17") for both of you to share. If you need more copies, just let me know.

Please give each builder 2 sets of the large drawings, 1 set of the 11"x17" drawings, and one DVD disc.

If they need more copies of the large drawings, they can contact Print Specialties – who have the drawings on digital file and can print out more large drawings as needed.

I have asked them to file a bid in writing by the end of the month, as that should be plenty of time for them to pull their prices together.

I will be out of town until about Feb. 3 – but will be in touch by cell phone. I believe your secretary has that number on file.

Thanks!

BY: ______
KILMER & ASSOCIATES
W. Otie Kilmer, AIA/Architect

COPIES TO: w/ enclosures
( )

If the designer is merchandising as a part of promised services, he or she prepares written purchase orders (Figure 19.17) and sends them to the client for approval. Partial payment of the cost of the item is requested at this time, and the order is sent to the supplier. When the item arrives, the designer inspects it for damage and has it stored, or preferably delivered, to the project at the appropriate time. The final payment is then requested from the client.

Occupancy or Move-in

When construction has progressed to an appropriate point, the client occupies, or moves into, the project. The designer assists the client in overcoming any obstacles that disrupt a smooth relocation. The work might be completely finished, or a few small items might still remain for the workers to do. The term *substantial completion* is used to determine whether the project is complete enough for the client to move in. If the area is not completely

PURCHASE ORDER

Designer's Company Name
Address

Date ____________

Project Name ____________

P.O. No. ____________

TO ______________________________
____
____
ATTN: ______________________________

Quantity	Description of Item(s)	Net Unit Cost	Extended Amount

PLEASE COMPLY WITH THE FOLLOWING:

_____ Above purchase order should be billed direct to Designer.
_____ Acknowledge receipt of this Purchase Order and confirm delivery date, as the time schedule will be critical.
_____ Tag the order as instructed.
_____ Delivery is estimated to be _____ weeks.
_____ The order should be drop shipped, FREIGHT PREPAID, to the client.
_____ The order must arrive on the project site no later than ____________.
_____ These items should not arrive on the project site before ____________.
_____ Please advise the Designer at once if there are any changes in schedule.
_____ Delivery required inside of building.
_____ Any additional cost to the above order (i.e. packaging, crating, etc.) must be verified in writing for approval within five (5) days of receipt of this purchase order.
_____ Bill of Lading and name of carrier must be attached to invoices sent to Designer.

____
Authorized Signature

FIGURE 19.17 Example of a typical purchase order used for ordering furniture and other interior items

finished, the designer compiles a punch list to indicate which items need to be finished or corrected before the owner makes final payment to the contractor. In some cases, the designer might be requested to prepare moving specifications for the moving company or even take bids from several firms to do the work.

Post-Occupancy Evaluation

After the installation is complete and the client has occupied the project for a specified length of time, the designer should go back and assess the performance of the new environment and his or her own work. This post-occupancy evaluation (POE) can be performed at six months, a year, or longer, depending on the agreement between designer and client. If problems have occurred, it is better for the designer to be a part of the problem-solving team than to be blamed for executing bad solutions. From these evaluations, the designer can translate what was learned and apply these findings to new projects. Conducting a POE is an excellent way to gather user-centered evidence and research for future projects. Compensation for this work is arranged with the client. A designer might perform this evaluation at no cost if he or she deems it important to the education process, research, and future work.

Professionalism and Regulation in Interior Design

Trends of regulation and professionalism will continue to develop in interior design. Education and training of interior designers will expose students to solving more complex problems, integrating design for quality of life, and keeping abreast of technological advancements. Client needs, concern for our environment, and design for cultural differences will create more demands on educational training and in turn raise the levels of expertise and professional standards in interior design.

Interior design is becoming a regulated profession through various licensing, certification, and accreditation agencies. These developments will continue to move the professional practice of interior design toward legal recognition and responsibility. The public will become more aware of these movements and will commission dedicated professionals instead of unqualified practitioners for interior design projects.

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Glossary

abstract design A type of design derived from natural or geometrical designs, but stylized to a level that makes it difficult to determine the source.

acoustical tile Fiberboard or fiberglass materials used in ceiling materials to absorb sound, rather than reflect it.

accessible A building, facility, or portion thereof that can be used by people with a physical handicap.

accessible route An unobstructed path through a building or facility that can be negotiated by persons in wheelchairs or with physical disabilities.

achromatic Colors that lack hue – specifically black, white, or gray.

acrylic paint Water based paint, versus oil base.

acoustics Science dealing with production, transmission, control, and effects of sound.

adaptability The capability of buildings or portions to be altered to accommodate persons with varying degrees of disabilities.

adaptive restoration Restoring older structures for a new use versus the original purpose they were intended for.

adobe Sun-dried bricks of earth and straw. (Some modern adobe contains cementous additives.)

aesthetics Attractive or pleasing in appearance, or what is often deemed beautiful.

afterimage When the human eye focuses on a strong hue, then switches to a neutral ground, the complement hue appears.

airborne particulate Suspended particulate matter in the atmosphere, such as dust, emissions from industrial activities, and plant pollens.

air-conditioning Process of providing cooled air or other medium into the interior of a building.

alcove Recessed space or niche in a wall or space.

alkyd paint Synthetic resin which provides the vehicle for paint and coatings

alternative energy Energy produced from a source other than conventional fuels such as coal, natural gas, or burning of wood.

aluminum A non-ferrous lightweight metal, often very light in weight.

ambient air The surrounding air.

ambient lighting Uniform illumination which is generally diffuse and provides the general light of a space.

analysis Part of the design process involving breaking down a problem. See chapter 6.

alloy The combination of several metals and/or other materials to produce a substance.

ampere Unit of measurement for the rate of flow of electrical current.

analogous colors Colors that are adjacent on a color wheel.

analysis Breaking down or dissecting the whole to study the parts and their interrelationships.

anodize Process of placing a protective film on metal through electrolysis and chemical reactions.

anthropometrics The measurement and study of the proportions and size of the human body.

antique An object from earlier time periods, often 100 years ago or before 1830 (according to U.S. customs laws).

apse The polygonal or semicircular projection in church architecture.

applique Transfer process for color or pattern that uses a pressure-sensitive coating on one material to allow transfer to another.

aquaculture Intensive process of rearing and harvesting fish than possible in the natural environment.

aquifer Underground water concentration often used for a resource.

arabesque Decorative motif containing a leaf and scroll pattern with stems spiraling from a root or other element.

arcade Series of arches and columns in a covered walkway.

architect Person who designs buildings and related structures. The title is protected by licensing laws in the United States.

architrave The lowest portion of an entablature, such as a column in classical architecture.

armoire French term for a large, free-standing cabinet or wardrobe piece with doors.

artificial light "Manmade" source of light source versus natural light from the sun, moon, fire, etc..

ashlar Masonry construction of rectangularly cut stone.

asymmetrical balance Arrangement of different objects so that they tend to stabilize or balance one another.

atrium A central space or courtyard surrounded by a building. Historically, it was the center courtyard of a Roman house; today it can also mean a glassed-over central space.

austrian shades Window shades that are scalloped in appearance and fold up.

awning Covering made of metal, canvas, or another material.

awning window Window that is top hinged and swings out.

baffle Device that deflects air, sound, or light.

balance The arrangement of objects that creates a physical or visual equilibrium.

ballast electrical device that starts the current flowing in a light fixture (primarily fluorescent).

balustrade A series of vertical supports of a stair rail.

banquette A built-in seating unit, or upholstered bench along a wall: usually found in restaurants.

barrel vault Semi cylindrical form (rounded or arch shaped) vault.

baseboard protective finish board covering where the floor and a wall meet.

bas-relief Sculptural technique where the projection is slight from the surface and the form is not undercut.

batik Fabric process by utilization of resist dyeing. Coating parts of the textile with wax for the parts not to be dyed.

batt A blanket of material, such as insulation, placed between framing members.

Batting Fibers such as wool or cotton

batten A strip of wood or metal used to cover the joints between panels or boards.

bauhaus A school of art, design, and architecture in Germany from 1919 to 1933 advocating the integration of art and technology, it led to the development of modern design.

beam Large horizontal member in a structural system that carries loads to vertical columns or walls below.

bearing wall Wall capable of supporting loads.

bentwood Wood strips softened with steam and bent around forms for permanent shapes when dry.

bib Exterior faucet with threads or other means for attaching a water hose.

biocide chemical capable of killing microorganisms and life, such as a herbicide, pesticide, or fungicide.

biodegradable The capability of something to readily decompose naturally in the environment through decaying organisms.

biodiversity Wide range of diversity within animal or plant species, and other microorganisms.

biomass Organic matter such as plants, animals and insects that are an energy source and can be converted to fuel.

biomimicry Examination of nature and its processes to inspire the solving of human situations and problems.

board and batten Siding technique placing battens (narrow strips of wood) in a pattern over wood siding. The original intent of the method was to hide seams between the vertical patterns.

bond Method of joining masonry that affects the strength of the assembly, durability, and appearance.

brick veneer Facing of brick installed in front of a wall.

brown coat The second coat of a three-coat plaster application.

brownfield Designation for and industrial or commercial site or facility that is idle or underused due to perceived or real environmental pollution

bi-product Secondary material produced in a manufacturing process, other than the principal product—often unintended.

btu Abbreviation for "British Thermal Unit", which is the standard measurement for heat gain or loss.

buttress A structure built against a wall to reinforce or support it.

cabriole leg Furniture support resembling the shape of an animal's leg.

cant A bevel or slope on a material.

cantilever A horizontally projecting element (beam or structure) that is secured at one end only.

capital The uppermost portion of a column or pillar.

casement window A window that has outwards swinging sashes, similar to a door swing.

cement A powder of alumnia, slica, lime, iron oxide, and magnesia that is burned in a kiln. Cement is used as the binding ingredient in concrete and mortar.

chamfer A beveled edge or corner, usually cut at 45 degrees.

chase Space within a building for routing ducts, wiring, or piping.

chroma The intensity or saturation of a particular hue.

chord Term used to denote the diagonal, top, or bottom of a truss component.

clerestory A windowed wall placed high in a building, usually between two roof levels.

coffer A three-dimensional decorative pattern in a ceiling, dome, or vault. (Also, a chest or strongbox.)

column Load bearing member placed vertically, such as a post.

complementary colors Any two colors directly opposite each other on a color wheel.

compost Decomposition of organic matter which is then used as fertilizer or soil conditioner.

concrete Cement and aggregates combined with water to become moldable. It cures to a strong, heavy permanent building material.

concrete masonry unit (CMU) Modular concrete block cast with or without hollow core cells.

conduction The transfer of heat energy through matter, as from a warm material to a cooler material.

coniferous Evergreen shrubs and trees with needle shaped leaves and often including forms such as pines.

console Architectural term used to describe a cabinet that sits on the floor, or an element projecting from a wall that forms a bracket.

convection The transfer of heat energy through the atmosphere, such as in air currents.

corbel Masonry construction technique which places courses cantilevered courses beyond the lower courses.

corinthian Ancient Greek architectural order with large capitals decorated with acanthus shaped leaf carvings.

cornice The crowning horizontal member of an architectural composition. A horizontal band near the ceiling or at the top of a window for concealing drapery tops and rods.

cork Elastic material of the outer tissue of the cork oak tree; often used for flooring in interiors.

cove lighting Type of built in architectural lighting system often constructed in a recessed channel near the junction of a ceiling and wall.

cradle to cradle (C2C) Biomimetic approach termed by architect William McDonough employed in life-cycle analysis of a "no waste" approach for recycling products and systems modeled after nature.

credenza A side desk, buffet, or storage cabinet, patterned after the Renaissance *credence*.

cripple Partial height and vertical load bearing member in the wall framing for a door or window.

curtain wall Exterior part of a building that generally does not support loads.

damper Adjustable plate device in an air duct or chimney that regulates air flow or drafting.

daybed A couch that can also serve as a bed.

daylighting Practice of utilizing natural light into buildings to reduce the need for levels of electric artificial light.

deciduous Hardwood trees that have broad leaves that are produced in an annual cycle of growth and dorminancy.

design process A sequential method of creating and solving design problems.

dioxin Highly toxic chemical compounds that are the by-products of industrial processes of manufacturing, burning, or molding.

direct lighting Lighting technique where light from a source strikes an area directly, without first bouncing from secondary surfaces.

distressed A technique used on wood to give the finish an appearance of age.

doric Simplest ancient Greek architectural order consisting of a horizontal plane on the capital.

dormer A vertical window set in a sloping roof, or the roofed projection from a sloping roof.

drywall Common name used for construction using gypsum panel boards, versus the "wet" method of lath and plaster.

ductile Property of a metal that allows it to be drawn into a wire shape.

dutch door Style of door with independent, swinging lower and upper halves.

efficacy Comparison of the brightness of a luminaire (lamp) source with the amount of energy used to achieve this level.

eave Roof section that projects over a wall below.

eclectic An effect achieved by choosing motifs and forms from various sources, philosophies, and periods.

ecology Scientific study of the relationships of living organisms with each other and their environments.

efflorescence Powdery deposit of the surface of masonry or concrete, which is the result of water leaching to the surface and forming chemical salts.

egress The path and related elements of a building that provide a safe exit and meet the applicable regulatory codes.

emphasis A design principle that gives importance to an area or object to make it stand out and hold the interest of the viewer.

enamel Glossy surface coating such as a paint or other materials on glass, metal, etc.

energy efficient Creation of services, products, or systems that use less energy to perform their function.

engineered lumber Process of combining derivatives of wood products (sawdust, chips, strands) with heat and glues to produce a variety of engineered wood products such as joists, beams, flooring, etc.

entablature The upper portion of a classical order, which is composed of the architrave, cornice, and freize.

ergonomics The study of human beings and their relationships to working conditions and environments.

exterior insulation and finish system (EIFS) Assembly of reinforced stucco applied as several coatings to the surface of an insulated plastic foam board.

fascia A horizontal band or facing, generally found on a building's roof projection.

fenestration Placement of windows in a wall.

fiber Slender filament of natural or synthetic material used to spin or weave into a yarn.

fire resistant Barrier of material or assembly that slows the spread of fire.

firewall Wall assembly that slows fire from spreading between adjacent spaces, and often rated in 1,2,3, and 4 hour increments.

flange Horizontal bottom and top sections of a metal beam.

flashing plasticized or metal sheets used to make an assembly weather tight.

flat slicing Method of cutting wood veneer from a log by slicing parallel to a line through the center of a log.

float glass Sheet glass produced by floating molten glass over a layer of molten metal.

floor joist horizontal structural member that spans between supports and carries floor loads.

fluorescent Light produced in a glass tubular lamp by discharging electricity through mercury vapor to produce light.

flush Level, aligned, or even.

formaldehyde Colorless and toxic organic compound often occurring in the natural atmosphere or derived from methyl alcohol. Commonly used as a disinfectant or preservative, but can cause significant health concerns to humans.

form The three-dimensional shape of an object that exhibits volume and mass.

fossil fuel Fuel product such as oil, gas, and coal) formed by natural processes of the decomposition of buried dead organisms such as plants or animals.

frieze Decorative board of cornice trim attached to a building.

fresco Art of painting on moist plaster.

furred Term used for the construction of a separate surface on a ceiling or wall assembly.

gable Vertical triangular shape of the end of a building formed by the roof from the eaves to the ridge.

galvanized Process of treating a metal with zinc, to thwart rusting.

gauge Term used to measure the thickness of a material or the diameter of a wire.

geodesic dome A hemispherical structural form based on straight bar-shaped members or triangulated surfaces.

geothermal energy Form of thermal energy produced and stored in the Earth's core, as radiated to the surface. Extracted as heat source from hot springs, rock, and drilling techniques.

girder A large beam generally placed horizontally to support roof and floor joists or other smaller beams.

glass block Hollow masonry unit made of glass.

glazing Construction technique of placing glass in frames.

glue-laminated beam Structural wood beam composed of horizontally layering wood with glue and pressure: commonly called glulam.

graywater Waste water in a building (such as a sink or shower) that does not contain contaminants as those found in a water closet discharge. Can often be used for irrigation of plants.

greige Textile in its natural, unbleached, or dyed state.

greenhouse gas Atmospheric gas that absorbs and emits thermal radiation and is the primary greenhouse effect that warms the Earth's lower atmosphere and surface globally.

green design Related to sustainable design and champions the philosophy of designing the built environment to comply with sustainability, economic, and social sustainability.

ground fault interrupter circuit (GFIC) Electrical device that quickly disconnects a circuit when current is leaked to the ground.

grout A thin paste mortar used to fill cracks, provide setting beds, or join masonry and tile units.

gypsum board Thin paper-faced panels of gypsum (a plaster-like substance) used for basic interior and exterior walls, ceilings, and other surfaces. Also called wallboard or drywall.

habitat Natural environment which an organism lives, such as an animal or plant.

harmony A design principle that expresses a combination of parts into a pleasing whole.

hassock An upholstered footstool or seat.

head The top (horizontal or curved) section of a window or door.

hearth Noncombustible horizontal surface in front of a wood burning fireplace, although the term is also used with gas fireplaces.

heartwood Center region of the cells in a tree, often with no or minimum knots.

heat pump Mechanical unit used to heat or cool a building utilizing refrigeration cycles.

hopper window Type of window that is hinged at the bottom and swings inward or outward.

hose bib Water faucet that is placed on an exterior wall and frost-proofed in cold climates.

hue The distinctive attributes of a color that enable it to be named and assigned a specific place in the color spectrum – such as red, yellow or blue.

hvac Term for Heating, Ventilation, and Air-Conditioning of a building.

hydronic heating Use of water as the transfer medium for heating and cooling of buildings. It can be heated or chilled water, depending on the application.

ideate The process of imagining or conceiving an idea.

indigenous Native, or related to a specific country, region, or geographical area.

indigo Natural blue vat dye made from the indigo plant.

indirect lighting Lighting technique that directs a light source output to a secondary surface and is reflected towards the primary surface.

indoor air quality (IAQ) Refers to measurement of the air quality in buildings as related to the health of the occupants.

infrastructure Environments that integrate systems for people movement, communications, power, wastewater disposal, and information.

inlay A design produced by inserting one material into another, producing a flush, decorative surface.

ionic Ancient Greek architectural order that features fluted columns and scroll volutes on the capitals.

insulation Materials that prevent the excessive transfer of heat, cold, sound, and electricity from one space or medium to another.

integrity The quality of being honest, sincere, or complete in principle.

intensity Brightness or dullness of a hue (color).

international style Twentieth century style of design that emphasizes structure, function, and material and is devoid of ornament or a national identity.

jalousie window Type of window composed of narrow glass (or other material) slats held horizontally in an adjustable frame and that operates similar to venetian blinds.

jamb The vertical side sections of a window or door frame.

joist A horizontal framing member of a floor or roof that supports a bearing surface and generally frames into a beam or other members.

jute Glossy fiber from an Asian grass and used to make burlap, sacks, twine, backing for carpet, or upholstered furniture.

juxtapose To place side by side or closely related together.

kiln dried Refers to the drying of wood in a kiln to reduce the moisture content.

klismos Ancient Greek chair with a curved back and legs curving upward and inward.

laminated veneer lumber (LVL) Structural wood member made by gluing wood veneers together.

lamp Term for an electrical device that emits light. Commonly called a bulb.

landfill disposal site for burial of nonhazardous waste

landing A horizontal platform at the bottom, intermediate area, or top of a stairway.

latex Elastic compound or paint, usually water based.

lath Metal or wood base material to which plaster or stucco is applied.

lattice open framework (often wood) that is arranged in a grid pattern.

lavatory Terminolgy used to denote a washbasin, generally in a bathroom. The term is used versus a "sink", which refers to kitchens, laundry rooms, and other spaces.

leed Acronym for Leadership in Energy and Environmental Design. An international green building rating and certification system developed by the U.S.Green Building Council (USGBC).

light pollution Excessive or obtrusive artificial light introduced by human activities, leading to the alteration of natural light.

line A design element that connects two points. Can also depict the outline of a form or shape.

lintel Horizontal structural member that spans openings and carries loads from above.

lockset Door hardware assembly that is secure.

louver Assembly used to open, often for exhausting or receiving air flow.

lumen The measure of the flow of light as a unit of time from a point source.

lux Unit of illumination equal to one lumen per square meter.

mantel The horizontal shelf projecting over a fireplace.

marquetry An inlay technique that sets shells, ivory, metal, or woods into a wood veneer.

MDF Medium Density Fiberboard.

metamerism The effect of different kinds of illumination in modifying the appearance of a color.

methane Abundant colorless and flammable gas and a potent greenhouse gas in the Earth's atmosphere.

mezzanine Story placed between two floor levels: a balcony that projects over a floor level.

millwork Building products (wood or composites) used for finish work such as moldings, trim, and cabinetry.

modular A standardized series of units or measurements that are scaled in a manner to allow their integration with one another in a variety of ways.

molding Strip of wood or plaster that protrudes from a plain surface, such as a ceiling, door, or wall.

monochromatic Color scheme based on a single hue.

mortar A mixture of cement, plaster, or lime with water and sand, used to bond units in masonry and tile construction.

mullion The vertical dividing bar in windows, glass doors, or other glazed assemblies. Also referred to as "muntin."

multifamily dwelling A building containing more than two dwelling units.

muntin See mullion.

nap A fabric surface that appears fuzzy due to the composition of short fibers or hairs.

nave The main part of a church, usually between the side aisles and extending from the entrance to the chancel.

newel Post that serves as the termination for handrails or guardrails.

niche Small half-domed recess or hollow in a wall used primarily for the display of a statue or other focal piece.

nonbearing wall A wall that has no load bearing properties.

nosing The projecting edge of a tread over a riser in stairs.

oculus Relating to the eye or lens of an optical instrument. Also, the circular roof opening in the Roman Pantheon.

off-gassing Release or evaporation of a gas that was trapped or dissolved in a material and often associated with indoor air quality.

orders The name given to the classical architectural styles of Greek and Roman columns and their related parts.

organic Relating to a living entity such as creatures, humans, or plants.

orientation Alignment, arrangement or placement of something in relation to other factors, i.e., the points of a compass.

ornament Refers to an embellishment that is decorative in nature versus functional.

ottoman A low, cushioned footstool sometimes referred to as a hassock.

ozone Gas formed by atmospheric electrical charges or ultraviolet light breaking down oxygen.

pagoda A religious structure of the Far East. Generally a pyramidal temple of several stories.

paradigm A model or example of something.

particulate Natural or mansmade minute particles of liquid or solid in the Earth's atmosphere, such as dust, smoke, or water vapor.

passive solar Process of capturing and utilizing solar energy without usage of other energy producing mechanisms.

patina Finish on wood or metal surfaces produced by age, waxing, use, or exposure to the elements, particularly moisture.

pediment A triangular form above a door, window, or portico.

photovoltaic The production of electrical energy from sunlight utilizing solar cells.

pilaster A vertical column or support projecting partially from a wall.

plaster Thick pasty material of lime, sand, and water which hardens when dry. Used for finishing interior ceilings and walls.

plenum A concealed space below the floor or above the ceiling used for mechanical and electrical equipment or operations.

polychrome Application of many colors on an object, such as multi-color painting of murals, walls, or vases.

pollution Introduction of chemical substances or energy (noise or light) into the environment that often produces undesirable effects – particularly in health issues.

portico Porch, covered entry, or colonnade of a building.

postconsumer material Term typically used to denote materials that have reached the end of their useful life for the original intent. Considered waste unless recycling process used to change the material into a new product for reuse.

postmodernism A design movement in the 1970's and 1980's which is a reaction against the modern movement.

primer Base or sealer first coat applied to a surface to prepare for subsequent finish coat(s).

proportion The relationship of parts to each other or to the whole.

proxemics The study of the cultural and spatial needs of people and their interactions.

pvc (Polyvinyl chloride) Synthetic thermoplastic made by the polymerization of vinyl chlorides.

quoin The wedge-shaped keystone of an arch or a large angled stone at the corner of a building.

radial balance Arrangement similar to symmetrical balance, but radiating outwards from a center.

radiation The transfer of energy through the air by way of electromagnetic waves, such as from the sun.

radon Chemical found in the out gassing of decaying ground based uranium and considered a human health hazard at elevated levels.

rafter Sloping timber or beam used to support a roof sheathing.

rattan Tough stems of palms used for construction of wickerwork and caning of furniture.

reclamation Collection and restoration of materials that are often thrown away in the waste stream, and reused for a beneficial outcome.

recycling Process of collecting and processing materials into raw materials or new products; reducing the amount of solid waste disposal in landfills.

reflectance The amount, expressed in a percentage, of incident light that is reflected from a surface.

refraction The deflection or bending of light rays from their direct path when passing through a specific medium.

reinforced concrete Concrete with steel reinforcing rods added to increase the tensile strength.

rendering A pictorial representation of a proposed design, generally in perspective: it can be in black and white or in color. Also called delineation.

resilient flooring Type of flooring that has more give than hard flooring such as ceramic tile. Resilient types includes rubber, cork, asphalt, vinyl, and combinations.

resin Material derived from certain plant secretions or synthetic blends; used in the making of plastics and varnishes.

reuse Using a material or product in its original form more than once.

rhythm A design principle characterized by a regular recurrence of features or elements.

riser The vertical section of a stair between the treads.

rug Loosely laid finish fabric or carpet that covers part of a floor versus a wall-to-wall fixed installation.

run The overall total horizontal distance of a stair; the sum of all the treads and any landing.

rubble rough fragments of broken stone and used in masonry techniques.

rush Hollow reed-like tall grass plant used for furniture making.

r-value A measure of resistance in a material to thermal transfers.

sanitary sewer Plumbing system used to carry industrial or domestic sewage wastes from a building. Operated separately from storm drainage, which carries surface water runoffs.

sash Term used for the frame of a window that holds the glass in place.

scale The relative size of an object as related to a familiar standard, i.e. the human body.

scribe Cutting and fitting assemblies such as cabinetry or countertops to the irregular face of a wall surface.

sconce Wall mounted bracket used for candles or light fixtures.

settee A small two or more person sofa or bench with a back and arms.

shade Value of a hue produced by adding black or white.

shape The identifiable contours of an object or space.

shellac A liquid film used in finishing wood and other surfaces. Made from dissolving the wastes of the lac bug in alcohol solutions.

shim Tapered piece of wood used to aid in leveling parts of an assembly, such as a window or door frame.

sick building syndrome Combination of elements in a building that contribute to the acute comfort effects or health of the occupants. Often related to poor indoor air quality.

sill Horizontal part of a building overhang, such as a roof.

simultaneous contrast The contrast or differences between intensity, value, and hue. A perceived change of color when one color appears as two different hues when placed on, or adjacent to, different colored backgrounds.

sleeper Recessed wood or metal furnishing strip in a concrete floor to which floor finishing material adheres.

soffit The horizontal underside of a projecting cornice, eave, or ceiling. Also, the boxed-in section of a ceiling above a sink, cabinets, etc.

solar heating Principles utilizing sunlight energy to produce heat for buildings or devices such as water heaters.

soldier Masonry term used to describe a brick laid on its small end, with the narrow face to the finished face of the wall.

solvent Substance that dissolves another to produce a solution, such as the pigments in paint.

space A design element consisting of a continuous expanse of distance extending in all directions.

spline Thin material (often wood) that joins two pieces of material together.

stain Part of a finishing process in painting that involves pigments suspended in oils, water, or other agents.

stainless steel Steel alloyed with chromium to make it rust and stain resistant.

steel A metal alloy of carbon and iron.

stoneware A durable, dense, and waterproof pottery containing silica or sand and flint in the clays. Often used for distinctive dinnerware.

stringer Sloped member(s) that supports the risers and treads of a stairway.

stucco A plaster-type mortar mix used primarily on exterior surfaces.

stud Steel or wood framing member used in a vertical direction to build walls.

sustainable design Socially responsible methods that encompass the needs of the present without compromising future generations, and preserving our natural environment and resources.

symmetrical balance Arrangement of objects in a mirror-image axis. Also called bilateral balance.

synergism The combined working efforts of the parts that together produce a total output greater than their individual effects.

synthesis Integrating the parts together to form a whole.

task lighting Light required for performing a specific activity.

taupe Brownish gray color mixture.

taxonomy System of ordering and arranging something into groupings or related categories.

tempered glass Glass that is heat-treated to resist breakage and breaks into small pieces versus large sheets of common glass, that breaks into larger pieces.

tensile strength Capacity of a material to resist tearing apart under longitudinal stresses.

terra-cota Type of reddish brown clay that is kiln fired without glazing.

terrazzo Stone flooring made by combining crushed stone and cement, then grinding and polishing to a smooth surface.

tetrad colors Any four colors spaced equi-distantly around a color wheel.

textile A fabric construction made by weaving, knitting, etc.

texture Apparent surface quality as perceived through tactile or visual senses.

thermal mass Capacity of a material to collect heat, store it, and release slowly. Often used in passive solar techniques.

thermostat Electrical device that monitors and maintains the temperatures in a HVAC system.

threshold The doorsill or piece of material that lies beneath a door or doorway.

thru Architectural terminology or slang for the word "through".

timber Wood members that are large than 4 inches by 6 inches (102mm by 153mm) in cross-section.

tint The shading of a color resulting from the addition of white.

tone The value or quality of a hue – tint or shade.

toxic waste Waste material or garbage that can cause injury or death to living creatures.

track light A luminaire mounted on a surface or recessed electrical raceway that can be repositioned or removed.

transom Small window or opening placed above a door or other window.

tread The horizontal portion of a stair: the part that is stepped on.

triad colors Any three colors that are equi-distant from one another around a color wheel.

trombe wall A passive solar system utilizing glazing panels over dark-colored masonry or concrete walls. It collects, stores, and releases heat into the interiors of a building.

Trompe-l'oeil A painting of scenes or objects that creates an illusion of reality for the observer. From the French, "Deceive the eye".

truss Structural assembly of steel or wood composed of chords and connectors.

tufting Weaving technique where yarns are drawn through a base (often fabric), producing an array of dots on the surface.

uniform building code (ubc) One of several national building codes that sets standards of materials and construction methods for compliance to health, safety, and welfare needs of the general public.

unity A design principle that produces a harmonious relationship among all the parts of an object or space.

valance A header assembly over the top of a window that directs natural or artificial light upward or downward.

value The darkness or lightness of a color in a gray scale from black to white.

vapor barrier An impervious barrier (often plastic sheeting) that prevents water vapor migration into areas of a building.

variety A design principle that is used to express differences in objects or spaces to counteract monotony or sameness.

varnish Transparent and tough film made of a combination of alcohol or oil and resinous substances.

veneer A thin surface of a quality material that is applied over another of lesser quality: usually seen in plywood construction where thin plies are layered over composite wood construction.

venetian blind Generic term for horizontal window covering made of rotating slats.

ventilator A device that allows for the admittance or expulsion of air.

vernacular Belonging to the distinguishing characteristics of a peoples' culture and native language.

vestibule Small entry room or hall to enter a building or pass between other interior rooms.

vinyl Polymer compound used to make a variety of products.

visible spectrum The portion of visible light energy that we can see and those that contain visible colors.

volatile organic compound (VOC) Organic chemicals that release gases from a solid or liquid form at room temperatures, and can have long-term health effects on humans.

waferboard Wood material or panel composed of glued and pressed flakes of wood. Commonly called Oriented Strand Board (OSB).

wainscot Paneling or wall treatment that does not reach the ceiling.

waste Discarded items such as trash, refuse, or garbage that are termed useless.

wastewater Contaminated water that is a result of bathing, washing, toilet flushing, or manufacturing processes.

water closet The technical name of what is usually called a toilet.

wavelength Distance measured between the progression of a wave (such as light) from any given point to the corresponding point in the same phase.

welding Fusing together of metal using intense heat with gas or electrodes.

wetland Swamps or marshes with standing or recurring saturated water.

wicker The weaving of vines or twigs, such as used in furniture construction.

winder Triangle shaped tread of a stairway.

work triangle The imaginary triangular path in kitchen design that connects the three major centers (refrigerator, cook range, and sink).

wrought iron Malleable and soft iron that can be forged into shapes.

xeriscape Landscaping techniques the conserve water and utilizes low-maintenance practices.

yarn A string produced by twisting fibers or other materials for use in fabric construction.

zero clearance A term used to describe a metal fireplace that can be set into combustible walls with little or no clearances.

zoning Designation and allowances in land areas for specific types of uses, activities, enterprises, and buildings.

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