LANDSCAPE ARCHITECTURE THEORY

AN ECOLOGICAL APPROACH

MICHAEL D. MURPHY

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Contents

Preface

The art of progress is to preserve order amid change, and to preserve change amid order.

—*Alfred North Whitehead*

During the early part of the twentieth century, it was commonplace to hear farmers, as an expression of their industry and energy, boast of having "worn out" several farms during their lifetime. Although such comments are no longer heard today, the essence of this notion lingers as a shadowy background in our collective consciousness, a legacy of our historical experience.

When we consider that, each year, productive agricultural soil continues to be lost from the United States at a rate ten times faster than natural regeneration, or that each of us sends a ton of waste to the landfill, it is apparent that we have not completely abandoned the idea that critical landscape resources, as well as the space to dispose of them at the end of their (presumed) useful life, remain abundant. Our attitudes—and, as a consequence, our understanding—lag behind what science tells us about the relationships between society and the landscape.

Conceptually, the landscape is complicated: it may be described as a natural scene, as a designed setting, or as an ecological system for organizing energy and matter. Although we think of the landscape as a place, it is better understood as a process of physical and biological evolution.

Through design, we act to manage the continuing process of landscape evolution—sometimes by accelerating the process, sometimes by slowing it down, and sometimes by changing its course—to improve the conditions of the environment in ways that enhance our own quality of life and create meaningful and compelling places as the setting for human activity. Today, as we gain increasing power to change the landscape, we also increase our responsibility to do so wisely, to protect the landscape as an invaluable resource, and to invest the human-built environment with enhanced purpose, meaning, and experience.

Often, it is the visual clues that provide insight into the conditions requiring design attention. But to ensure that designs lead to durable improvement in the human-landscape condition, rather than mere temporary shifts in form or style, we need to consider all the salient factors of the landscape, human interactions, and the activities to be accommodated before reaching decisions about what a transformed landscape will become.

Through their creative efforts, landscape architects are asked to respond to a series of questions concerning the issues their clients must resolve when changing the landscape: What is the nature of the conflict to be resolved? What is its cause? What conditions must be created to resolve it? What form are they to take? How are unintended consequences to be avoided?

The underlying purpose of the design theory explored here is to provide the understanding required to resolve these questions and to ensure that the answers reached lead to successful change in the landscape. In essence, the process of design may be compared to the art of painting as described by Edgar Degas: "easy when you don't know how, but very difficult when you do."

Theory serves to make design less difficult and more predictable in the creation of imaginative and effective design results. The successful transformation of dynamic and complex environments requires insights from many disciplines in order to reveal all the implications of the changes to be imposed.

As a discipline, landscape architecture is situated at the interface of the arts, the sciences, and the humanities. This unique position provides many perspectives from which to assess design success or failure. It also provides access to many opportunities for design innovation.

This investigation of a theory of landscape architecture takes an ecological approach, examining the people to be designed for in relation to the environments they inhabit and how designs might be crafted to facilitate a mutually sustaining relationship between people and land. The book focuses primarily on three areas of knowledge:

Figure 0-1. *Landscape devastated by drought near Dallas, South Dakota, during the Dust Bowl era of the 1930s, when cultivation was introduced in an area with insufficient rainfall to sustain farming. (Source: United States Department of Agriculture via Wikimedia Commons.)*

1. The nature and processes of the landscape as a biophysical setting;
2. The nature of people, their interactions with one another and with the landscape regarding the conflicts to be resolved in improving the relationships among them;
3. The thinking and design processes needed to apply that knowledge to improve the human-landscape condition.

The chapters that follow are intended to provoke a dialogue about the outlines of the intellectual landscape to be encompassed by design theory. Theory, like the landscape itself, continues to evolve. What is presented here is an introduction to some of the seminal ideas that have informed the practice of landscape architecture over the last half-century with a view toward pointing a way to its future. Some of the authors cited here are landscape architects, but many more are designers and researchers, from a variety of fields, whose ideas have illuminated the search for a theory of landscape architecture.

To supplement the text, ancillary materials are available at http://islandpress.org. The online appendix presents an array of practical information that draws upon extensive research and design experience.

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PART I

Introduction

CHAPTER ONE

Introduction

Man is a singular creature. He has a set of gifts which make him unique among animals: so that, unlike them, he is not a figure in the landscape—he is a shaper of the landscape.

—*Jacob Bronowski*

For thousands of generations, people have modified the landscape to improve their access to resources, security, and comfort (Redman 1999; Diamond 2005; Mann 2011). Over the course of human history, people have increased their ability to shape the landscape to meet their needs and aspirations. But the landscape, having evolved over millions of years, has developed into a complex of interrelationships we have yet to fully comprehend and, as a result, to control. Today we have reached a point at which our power to change the landscape often exceeds our ability to understand and predict all the consequences of those changes. By accident as well as design, human activity has become the primary agent of change in the global landscape (Silver et al. 1990, 50; Union of Concerned Scientists 1992; Suzuki et al. 2004, 71).

Design is our way of guiding change in the landscape to improve the human condition (Rapoport 2005). Landscape architects do this through the creation of places such as gardens, parks, campuses, greenways, and neighborhoods. Theory provides the basis for designing well; to bring about successful change in the landscape. The purpose of theory is to determine what constitutes success in design results and to inform the design process as a useful and successful enterprise. Theory not only

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provides the evidence on which effective landscape change may be based, it also describes the means for bringing it about and furnishes the metrics for evaluating the quality of the environments that are created. The basic aims of theory are to understand the landscape and how it functions, to determine the conditions to be created through design innovation, and to identify the means to realize them. Three questions frame the investigation:

- **How can the quality of human life be improved by design?**
- **How can the quality of the environment be improved by design?**
- **What knowledge and skills are required to facilitate these conditions?**

Many factors are considered in design: the intentions of clients; the needs and expectations of those who are to use the designed setting; how the interactions between users and setting will create situations to be resolved or opportunities to be exploited; the materials of design—in this case, the landscape itself—and finally, the processes of decision making and creative expression as they influence design outcomes.

From an ecological perspective, context is critical to understanding. This introductory chapter begins with a discussion of some of the issues that influence our understanding and design of the landscape and provides context for the material to follow. Subsequent chapters describe a series of knowledge areas and their underlying values that inspire the changes we impose on the landscape, inform our reasons for doing so, and guide us in reaching design decisions based on a foundation of reliable evidence.

The designer's role is to "reimagine and remake the human presence on Earth in ways that work over the long haul" (Orr 2002, 3). In the past, designs by landscape architects were intended to be functional and beautiful and inspiring. In the future, they must also be restorative, life sustaining, and regenerative—for people as well as for landscapes.

Further, technological innovation represents a growing influence on how we design and develop the landscape. But our primary theoretical concern with technology is to assure that this powerful tool is applied wisely: that it is used not to do the same things more efficiently, but to bring us to a clearer understanding of how to do things better, while consuming and impacting less. The role of technology is to support the *intentions* of design without interfering with the *artistry* of design.

The material presented here is a recent history, not of the works of landscape architecture or of their creators, but of the knowledge and ideas that have guided their understanding of the landscape in their efforts to change and improve it. Our first aim, then, is to establish the context for design as a practical and theoretical pursuit.

Landscape Architecture

The term *landscape architecture* was coined by Gilbert Laing Meason in his 1828 book *On the Landscape Architecture of the Great Painters in Italy*, and *landscape architect* was first used as a professional title by Frederick Law Olmsted and Calvert Vaux in connection with their work on New York's Central Park in the mid-nineteenth century, after Olmsted found that his title as architect-in-chief was unsatisfactory in describing their role (Twombly 2010, 24). The term came into general use after the formation of the American Society of Landscape Architects in 1899. Today there are many ways to define landscape architecture. The description provided here is intended to be inclusive of a broad range of practice and research areas shared by most practitioners and academics.

Landscape architecture is the design discipline dedicated to understanding and shaping the landscape. As a profession, it provides site planning, design, and management advice to improve the character, quality, and experience of the landscape, typically as a setting for human activities. The purpose of landscape design is twofold: to guide change in the form of the landscape to create and sustain useful, healthful, and engaging built and natural environments; and to protect and enhance the landscape's intrinsic cultural, ecological, and experiential qualities.

The primary role of landscape architecture is to organize the complexity of the landscape into comprehensible, productive, and beautiful places to improve the function, health, and experience of life. To do this effectively, design practitioners need to understand the landscape and the ways people interact with it, and to apply effective design process and implementation methods.

Attending the dynamics of human development is the challenge to

Figure 1-1. *Central Park in New York, an artificially created landscape established in 1857 by designers Frederick Law Olmsted and Calvert Vaux. (Source: Francisco Diez via Wikimedia Commons.)*

continually re-form the landscape to better accommodate people's evolving requirements. These requirements include the provision of needed resources, space for activities, satisfaction and appreciation of the physical setting, enhancement and preservation of environmental and human health, and the creation and expression of cultural and environmental sense of place. To achieve these multiple, often-competing objectives, designers need a clear understanding of human and environmental processes and the ways they interact to shape the landscape we experience and rely on. To understand these processes, designers also need to be aware of the considerations that influence the way we comprehend and interpret the world around us.

Values

Our values shape the way we define the landscape and influence the actions we take to change or protect it. **Values** are the ideals or principles we consider important in our lives, the ideas that give purpose and meaning to our thoughts and actions (Rokeach 1973). They are qualities that society considers worthwhile as ends in themselves—such as liberty, truth, and justice—that form the basis of our customs and institutions. Judgments about ethical behavior are a manifestation of values (Snow et al. 2000). Values are based on the comparative worth we ascribe to things, whether tangible or intangible.

In general, the values of landscape architecture lie in three broad areas: aesthetic, ecological, and social (Thompson 2000). Landscape architecture is committed to enhancing human experience, sustaining environmental quality, and establishing social equity. Just as importantly, landscape architecture values the spiritually satisfying and psychologically health-giving benefits of people's harmonious relationships with one another and with their environment. More than anything else, landscape architecture values a holistic approach to addressing utility, beauty, and health as complementary, not competing interests.

Aesthetic values refer to the quality of the human experience and the extent to which that experience brings sensual and emotional pleasure and satisfaction. The goal of social equity implies that the role of the designer is to speak on behalf of the users of designed settings—in particular the young, the elderly, or the infirm—and for the health and stability of the ecological and cultural environment in which human activity occurs and on which human existence depends (Beatley 1994; Enlow 2006). Social justice and equity are at the heart of what landscape architects do and why they do it; in fact, social good is the purpose of professional licensure: the protection of public health, safety, and welfare. Designers' responsibilities lie as much with the public good as with that of private clients since, in addition to safeguarding the general public, protecting the welfare of users and the environment is the best way of protecting the long-term interests of the custodians of the landscape: clients, both present and future, who own or exercise control of the landscape.

Control of the landscape for survival and prosperity is a universal concept. The concept of territoriality and the domination of space and resources is widely observed in nature and well documented for all forms of life as a way of defining the individual and organizing the group to assure survival (Ardrey 1966; Hall 1966; Altman 1975). The landscape is more often considered, and valued, as property, territory to be owned, than as an environment that we collectively inhabit, and for which we have a shared responsibility (Gintis 2007).

Values influence our understanding of the landscape and shape our attitudes toward it, and hence, they inform our collective thinking and behavior. Our values shape our vision and guide our decisions about the landscape and what we wish to achieve by its design and development. The quality and character of the shared landscape is a direct reflection of prevailing values and attitudes. One of our most prevalent attitudes is that the landscape is a commodity.

Commodity

We are consumers of land and resources as well as products. In good economic times and bad, society pursues a model of ever-increasing production and consumption as the driver of an expanding economy. A prevailing attitude toward the environment is that it is a resource to be exploited for maximum human benefit in the shortest possible time (Redman 1999). The landscape is considered important primarily because it is a commodity that can be exchanged in the marketplace as the source of raw materials from which products can be manufactured. Unfortunately, this socioeconomic system of continuing growth and expansion has not yet developed a means of conserving or expanding the resources to be exploited as demand increases, or of reincorporating expended materials back into the landscape for reuse with the effectiveness that we find in ecological systems.

Social systems are commonly viewed as separate from ecological systems. This is relevant to landscape architecture theory because it helps us to understand how we as a society value the landscape, as it is our values that shape decisions about how we regard, design, and use it. As will be described below, our relationships with the landscape are reciprocal, not one-way. Ecosystems function cyclically, revealing that a one-way extraction of materials—treating the land as commodity only—is antithetical to the health of the ecosystem on which our health depends.

A half century ago, conservationist Aldo Leopold envisioned a land ethic whereby mankind, owing to its superior intellectual capacity, serves as a steward in addition to functioning as an integral part of the larger system of the landscape, which, he believed, included geology, climate, and other organisms living in harmony: an ecological community (Leopold 1966).

But it is difficult to hold the view that we possess land and, at the same time, to conceive ourselves as being a part of it, a component of the ecological community. In our collective view, it is almost unthinkable that we would belong to the land rather than the other way around. For the most part, we define land as a commodity belonging to individuals (Lahde 1982). Land defined as "property" has "value," and land without economic benefit is "valueless." Our intellectual relationship to the landscape is often better characterized as domination than as stewardship.

These issues raise fundamental questions: Where does the landscape fit in this paradigm of determining whether land has value or not? Does it have value to us in any context other than economic? Do we consider the landscape to have intrinsic value, or is its value only utilitarian when it has been subdivided and transformed into property? If it has value, can we enhance and protect the value of the landscape through design? Do designers—as shapers of the landscape—have a responsibility to the landscape, or only to those who own or occupy it, the people we call "clients" and "users"?

These questions are central to an examination of landscape architecture theory because they enable us to consider the status quo and question whether it is structured to promote or obstruct design innovation. As society evolves, the answers change. In the search for design theory, it may not be the destination but the journey that is most important to understanding.

Finally, it is helpful to understand that things placed in the environment stay there—somewhere. For example, wastes—things without value—are either reincorporated into the system, or, if they are materials that have no history of reintegration, they remain in the system, no longer contributing to landscape function but interfering with it.

Thus, it is imperative that we understand the environment we wish to improve as an *ever-changing whole* in order to determine which of its aspects are relevant to the outcomes we intend when its features or processes are rearranged by design. Although often conceived as a commodity, the landscape is, more importantly, a process and a place that, by design, is either enhanced or diminished.

Landscape

Another consideration is to define what is meant by *landscape*. The traditional definition of **landscape** is an area of the Earth's surface that has been modified by human activity (Jackson 1984). This comes from the Germanic *landschaft*, literally meaning, in English, "a small collection of buildings as a human concentration in a circle of pasture or cultivated space surrounded by wilderness" (Motloch 2001, 3). Landscape is, by definition, land *shaped* by human activity. The definition is often expanded to include natural areas, such as wilderness, that evince no human modification. This seems appropriate since, in reality, no place on Earth has escaped the influence of human activity, whether through direct settlement, husbandry, or deforestation, or by indirect actions such as habitat modification or air pollution (Berleant 1992; Sanderson et al. 2002; Mann 2005). Microbiologist René Dubos argues that "There is no 'natural' ecology. Man has changed everything in nature" (Dubos 1968). Consequently, the traditional definition is inclusive, encompassing all contiguous land areas of a definable character—such as a forest landscape or a desert landscape.

Landscape historian J. B. Jackson (1984) summarized the word *landscape,* ultimately, to mean "a collection of lands" making up the visible features on the surface of the Earth, and their relationships to one another. Thus, the essence of landscape, as opposed to land, is *land beheld*: the characteristics of the land as perceived by the senses rather than a purely intellectual construct. The transitory characteristics of a perceived environment, such as changing patterns of light and shade, or its variability through the seasons, are an integral part of our understanding of a landscape.

Landscape is a broad term encompassing the totality of our physical surroundings. The landscape is observed, characterized, and understood differently by people in different situations and from different landscapes, conveying a different meaning to each of them. Geographer Donald

Meinig (1976) described landscape as the union of the physical and the psychological: "composed not only of what lies before our eyes but what lies within our heads." Thus the landscape is an entity that is defined by our senses and interpreted by our intellect. It reflects prior experience as well as prevailing cultural, social, and economic values. Landscapes express, in addition to their own biophysical makeup, the character of a society as it has evolved over an extended period of time. When fully understood, the landscape may be comprehended as more than just a physical condition and more than just an emotional response to perception, but also as one of the most accurate reflections of a society, its values, its technology, and its aspirations.

Contemporary approaches to designing the landscape are intended to address the complexity of the challenge before us: to maintain balance in the environment as we alter its form and function to provide for people's needs, while simultaneously maintaining the richness, integrity, and vitality of existing ecological and cultural systems. It is in response to the processes of landscape development that the environmental-change disciplines have evolved. Each such discipline—architecture, engineering, landscape architecture, urban planning—addresses a different kind of process and employs a different theory, knowledge base, and technology. Each of these disciplines provides answers to a different type of development problem involving, say, buildings, infrastructure, or setting.

One of our most important avenues of inquiry is to determine the areas of responsibility for these different disciplines so that we can better manage successful interaction and synergy among them. One of the disciplines most closely allied to landscape architecture is architecture.

Architecture

A discussion of landscape architecture theory would be incomplete without reference to architecture, in particular as it compares with landscape architecture. The two disciplines have much in common. They share a common search for excellence through design to improve people's activities, convenience, and aesthetic experience. They both are concerned with the skillful application of technology, use of materials, economy of construction, and efficiency of maintenance. And they both address the world through a common design paradigm and share a common approach to the delivery of design services. Architecture is found in all inhabited landscapes, and often becomes one of their defining features.

In the past, a great deal of the theory of landscape architecture was borrowed from our older sister (perhaps mother) profession. In landscape architecture, the term *architecture* is used in its generic sense, referring to the process of calculated, orchestrated change to determine a desired future outcome. Originally, not only the process but also the principles of architecture were applied to the design of the landscape—as may be seen in Renaissance landscape designs such as the gardens of the Château de Vaux-le-Vicomte in France or Villa d'Este in Italy. But *architecture* is principally about the art of building. *Landscape architecture* is concerned mainly with making places and only occasionally concerned with buildings. Thus, the knowledge areas and values on which the two disciplines are based are different. And although the goals of architecture and landscape architecture are essentially the same—to create an improved living environment—their respective roles in meeting them differ.

Architecture as a design discipline is concerned with the formation of structures to shape, shelter, and facilitate specific human activities—such as governance, healing, worship, or learning—in ways that employ materials elegantly and effectively. Architecture is concerned with expressing the building and its context, referential to both itself and its culture in space and in time. In architecture, it is almost unthinkable that the structure, as the tangible manifestation of human influence, is not a conspicuous and distinctive physical expression. In landscape architecture, on the other hand, this is not always the case: it is not uncommon that the touch of the designer is so restrained, and the expression of design so subtle, that the landscape appears almost untouched, as if in a "natural" state (Jensen 1990). Indeed, since the seamless integration of new activities into the larger framework of the landscape is one of the landscape architect's principal challenges, imposition of a subdued or naturalistic expression, consistent with the character of the existing landscape, is a common design strategy (Howett 1987).

Although architecture and landscape architecture may employ the

Figure 1-2. *The gardens of Villa d'Este at Tivoli, near Rome, designed by Pirro Ligoria and Tommaso Chiruchi, ca. 1550, according to architectural principles. (Source: Christopher Sharp.)*

same procedures in determining and implementing change, the changes they effect do not produce the same kind of result. In architecture, the design is usually intended as a discrete artifact, such as a building. The landscape, on the other hand, although sometimes recognizable as a place with individual identity, is also extensively and seamlessly connected to other places in the broader context of the environment. Unlike buildings, landscapes are in a persistent state of change and need to be both understood and designed as such. The landscape is a continuous matrix within

Figure 1-3. The Gardens of Versailles, designed by André Le Nôtre, ca. 1661, with a geometric architectural character. (Source: Gardens at Château de Versailles, France, via Wikimedia Commons.)

which nodes of activity and meaning are created. It is these nodes that we think of as having design expression and identity.

If landscape designers, in contrast with architects, fail to understand that landscape is process, their designs may fail to integrate with reality in continuing and meaningful ways. If designed as an object or static setting, the designed landscape will fail to become an integral part of the larger landscape condition as a dynamic process. Without this temporal/conceptual integration, design ideas will remain rooted in the static concepts of discrete architectural artifacts and the designer will lose the opportunity to contribute to continuing change and improvement—that is, to the evolution of the living landscape as a systemic process (Hedfors 2014).

For theory, the existential question is: How might this kind of dynamic design that acknowledges landscape as a process be performed? But before that question can be answered, it is necessary to address a more fundamental question: What is design?

Design

The term *design* can be a source of confusion. *Design* is both a noun and a verb: we describe the process and the product with the same term (Steinitz 1995). In theory, we are concerned with design as a verb: as an act of creation. There also is some question about whether design is an art, a science, or a form of mathematics. Engineering designer John Chris Jones describes design as "a hybrid activity, which depends, for its successful execution upon a proper blending of all three and is most unlikely to succeed if it is exclusively identified with any one" (Jones 1992, 10).

Design is undertaken to determine the best way to form some new condition. It is a process of thoughtful consideration that precedes the physical act of making—an attempt to determine how to get it "right" before committing effort and resources to a course of action. Design is one of the most common, and most human, of all conscious acts. The artist Josef Albers said, "To design is to plan and organize, to order, to relate and to control. In short, it embraces all means opposing disorder and accident. Therefore it signifies a human need and qualifies man[kind]'s thinking and doing" (Albers 1977, 75).

Design has been defined variously as an activity to:

- **devise a course of action to transform existing conditions into preferred ones** (Jones 1966; Simon 1969);
- **envision "a desirable future and invent ways to bring it about"** (Ackoff 1981, 62);
- **"make decisions about changing the physical world to achieve identifiable goals"** (Zeisel 1988, 5);
- **determine a safe path to a desired future condition** (Weisbord 1992).

For most work by landscape architects, the act of shaping the product is indirect (in contrast to a potter, for example, who shapes earthen vessels by hand directly.) Designers determine what the new form will be and others (typically, independent earthwork, construction, or planting contractors) execute the work on the basis of instructions from the designer. The imagined future condition guides the implementation process that brings the new idea to reality. Design, then, is the process of determining the future form of an object or place—directly or indirectly. In either case, design is the imposition of ideas on the environment, the transformation of conditions, as they exist, into something we imagine them to be. The principal characteristics of design are purposeful *change* and *improvement*. Design changes the landscape in one of two ways: by the creative and heuristic activity of re-forming spatial environments through direct construction, or by design through maintenance: shaping the landscape through management practices with the design process taking place over an extended period of time (Hedfors et al. 2013). In either case, **design** is defined here as a process of reflection and consideration to guide intentional change in the environment to achieve identifiable goals. It is an intellectual process undertaken as a precursor to action.

Central to the design process is the evaluation of the changes being considered, in order to determine the likelihood that they will lead to the satisfaction of the intended areas of improvement. Some of the most common of these areas of improvement (design intentions) include:

- **functional utility and convenience**
- **enhanced aesthetic experience**
- **comfort and shelter from elements**
- **access to resources or amenities**
- **human health, safety, and welfare**
- **ecological health and sustainability**
- **economy of construction and maintenance.**

Although these areas of improvement describe the "intentions" of design, they are not the "things" that are designed. *What* is designed is different from *why* it is designed. Designers impose changes to the arrangement and form of the features of the landscape—landform, plants, water, paving, furniture—in order to create improved relationships among them. These relationships are intended to result in benefits that do not presently exist. It is interesting, however, that, among the common purposes of design, we do not typically consider the need to ensure a capacity for *continued change* in the future. Even though we implicitly understand that change is the only constant, designers nevertheless perpetuate a tendency toward the creation of fixed or static form in the landscapes we create.

Furthermore, although design is intended to bring about improvement, there is a growing body of evidence that the quality of the landscapes we collectively create, as well as those left unaltered, is declining rather than improving, in part because they have been conceived as static, isolated features embedded in the dynamic matrix of a fluid environment. And there is another consideration. Often, designers address the problems of the landscape's subsystems, not conditions of the landscape as a whole system. Our design solutions are only partial, while the problems of the landscape exist as interrelated wholes.

The way we currently design and manage the landscape impacts many of its natural and cultural systems negatively, simply because we do not fully understand what these systems are or how they function (Suzuki et al. 2004; Diamond 2005). In some cases, our designs are bringing about disorder in many aspects of the landscape. For example, in our quest for reliable urban drainage where development has encroached on flood-prone areas, designs that denude and pave stream channels destroy much of the landscape's diversity in plant and animal species. To create conditions of comprehensive environmental improvement—providing long-term as well as short-term benefits—design change needs to ensure the protection of the present context as well as to bring about improvement in a broad range of design intentions. To do this successfully, the designer's influence must be more than superficial. Design intervention needs to institute systemic change in the environment whereby each of the features and processes affected will not only be improved, but just as importantly, each one will also bear a beneficial influence on the others (Mitroff et al. 1993).

Designs bring about genuine improvement when they favorably influence the broad spectrum of interrelated conditions—the system—in which improvement is sought. The quality of a design, like a chain, is only as strong as its weakest link. Only when all aspects of the system act in concert to mutually reinforce one another is the overall result likely to lead to holistic improvement in the landscape.

Design as a Profession

A comprehensive examination of landscape architecture theory needs to include consideration of how its practitioners are organized into a professional body and how this influences design outcomes. A **profession** is a vocation that has, as its purpose, the delivery of objective counsel and service to society. In addition to being an occupation requiring specialized knowledge for the delivery of its service, a profession is a social organization formed around a value system held in common by its members. This means, among other things, that to its members, consistency with the internal values of the profession is an important indicator of success. The benefit of this is that the profession establishes and maintains standards of education and performance that society can rely on. The disadvantage is that standard performance is not exceptional. This is one of the reasons that exceptional work by practitioners is often singled out for praise and emulation.

The difficulty with professional standards is that they promote the delivery of standard performance: that is, conventional, not exceptional or innovative performance, the unique designs that might be required by a particular landscape or design setting. The social pressure of peers may do more to promote conformity than innovation, and may lead practitioners to view landscapes in conventional ways rather than to consider each site or each commission as unique and deserving of special attention to its understanding and design.

Furthermore, over the course of a professional career, as new knowledge and technology become available, the requirements of professional tasks and services change. Because the nature of professional practice evolves continuously—as society and technology become more complex—continual learning is required for the practitioner to remain abreast of new techniques and understanding. Professional practitioners are constantly confronted with situations of uncertainty, uniqueness, instability, and conflicting values, thus presenting circumstances for which rigorous formal preparation and professional experience have not directly prepared them. This is both the dilemma and the opportunity of contemporary professional practice (Schön 1983).

One of the practitioner's first steps in rendering a design service is to frame the problem in a way that conforms to the practitioner's professional expertise—which may or may not be germane to the issues to be resolved. The designer's expertise, for example, may lie in recreation planning and development, but the client's most pressing problem may be with the landscape's function as a wildlife habitat. Because many problems are unique as well as unstable, they may lie beyond the bounds of the professional's previous practice experience. In either case, it is through the process of framing the problematic situation that the practitioner organizes both the ends and the means for resolving the client's problem. One of the hallmarks of successful professional practice is the ability to "take a convergent knowledge base and convert it into professional services tailored to the unique requirement of the client" (Schein 1972, 45). For example, the designer may have gained all her experience dealing with site-development problems, such as pedestrian circulation or site drainage, but through creative application, she can apply the same kind of thinking to the organization of a neighborhood or a nature preserve. To avoid the pitfalls of conventional thinking, the designer must be able to apply convergent knowledge through the use of divergent thinking skills. This ability relies on two intellectual characteristics: what Donald Schön (1983) has described as *knowing-in-practice* and *reflection-in-action*:

- **Knowing-in-practice** refers to the day-to-day understanding a practitioner brings to the problematic situation. This knowledge is based on formal training but also, more importantly, on the practical experience of dealing with a particular class of problems—what is sometimes called the "art" of practice, for which there are no hard-and-fast rules to be acquired through formal education.

- **Reflection-in-action** refers to the deliberative process of constantly asking oneself, "What am I really doing here?" and "Why am I seeing the situation in this particular way? Am I going about this as a matter of course based on past experience, or am I thinking creatively about the situation based on the evidence before me? Have I gathered the appropriate evidence on which a reasonable conclusion can be based?" This is the essential material of a progressively improved professional practice and is the basis for an increased capacity for knowing-in-action—the ability to apply what is known to resolve conflict or create opportunity. Reflection serves to question the tacit understandings that accumulate through repetitive experiences in practice in order to make new sense of situations of uncertainty and uniqueness. It serves as an antidote to the tendency of converting actual cases into the familiar ones to which the professional practitioner is accustomed and confident in undertaking.

It is through their expertise in knowing-in-practice and reflection-in-action that professionals engage in the dialogue, discovery, and reframing necessary for creating uniquely appropriate interventions to resolve the client's problems, as well as for the future of the practice through which their services are delivered. The designer must have the capacity to both diagnose and resolve a particular type of problematic situation—sometimes that of the client and sometimes that of the professional practitioner in service to the client—and, of equal importance, the skill to communicate that capacity in the time-constrained market environment.

Design Theory

The role of design is to impose artfully formed and scientifically sound change in the landscape. The theories that address these considerations fall in two broad categories: *substantive theory* and *procedural theory* (Ndubisi 1997).

- **Substantive theory** promotes better understanding of the landscape as the interface between human and natural processes. It is descriptive and predictive. Substantive theories originate from the natural and social sciences as well as the humanities, and they inform our understanding of people and the environment, and perhaps more importantly, of how people and landscape interact to bring about change.
- **Procedural theory** addresses methodological issues: ideology, process, and principles of design. These theories describe functional and procedural relationships concerning the application of knowledge in order to facilitate human use and to resolve conflict in the landscape. They originate from design practice as well as the academic development and technical application of knowledge in a social setting.

Substantive theory describes the knowledge used to frame and inform design interventions. Procedural theory describes the methods of its application to guide the planning and design management of landscape environments. Regarding land planning, Ian McHarg articulated a theory of human ecological planning that he summarized as follows:

> All systems aspire to survival and success. This state can be described as syntropic-fitness-health. Its antithesis is entropic-misfitness-morbidity. To achieve the first state requires systems to find the fittest environment, adapt it and themselves. Fitness of an environment for a system is defined as that [condition] requiring the minimum work of adaptation. Fitness and fitting are indications of health, and the process of fitting is health giving. The quest for fitness is entitled *adaptation*. Of all the instrumentalities available to man[kind] for successful adaption, cultural adaptation in general and planning in particular appear to be the most direct and efficacious for maintaining and enhancing human health and well-being. (1981, 12)

As with all living systems, it is the underlying quest for survival, fitness, and health—individually, socially, and ecologically—that motivates reasoned planning and design activity, although it is often expressed as a desire to meet some narrow, short-term, often functional, perceptual, or economic goal. In a broad sense, the concern for health (ecological, physiological, and psychological) has become one of the driving forces of design change. It is for the purpose of defining and satisfying these ends that procedural theories are formulated.

Substantive theories are developed to help us understand the interrelationships to be influenced when changing the landscape. To a considerable extent, substantive theories provide the basis for design goals: that designs promote relationships of improved harmony between human activity and the environment. Some goals are related to facilitating specific activities (e.g., improving functional convenience or visual experience) or resolving conflicts (e.g., reducing the risk of incompatible activities such as intersecting pedestrian and vehicular traffic, or development in flood zones). The design goals specify what is to be achieved by changing the landscape.

Procedural theories guide the strategies to be employed in achieving the design goals—planning and design processes employed to devise a course of action for developing critical information and applying it to improve the environment.

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The remaining chapters are organized into two sections: substantive theory and procedural theory. This organization is intended to lead the reader through a sequence of investigations into different aspects of landscape architecture theory and to describe the interrelated concepts on which they are based.

Substantive theories are discussed in chapters 2 through 6, which deal with the environmental and human dimensions of the landscape, and with considerations of design form and purpose as areas of knowledge that inform design thinking.

Procedural theories, dealing with landscape planning and design processes and design collaboration, are discussed in chapters 7 through 9. Chapter 10 examines the multidimensional aspects of design thinking and creative expression. Chapter 11 concludes with a summary of the implications of ecological design.

PART II

Substantive Theory

CHAPTER TWO

Substantive Theory

When scientists say "theory," they do not mean an idea created out of thin air, nor do they mean an unsubstantiated belief.

—William L. Allen

A **theory** is a statement, based on observation or experimentation, to explain some aspect of the observable world. It is an explanation for a set of facts. The role of theory is to provide understanding and predictability in the creation and application of knowledge. It is the basis for practical action (Swaffield 2002).

Scientific theory refers to a well-established description or model of reality based on empirical evidence. Theory provides the frame of reference and principles for a discipline or field of inquiry: a set of propositions to explain the meaning of a body of observations. These propositions are accepted as valid until further investigation leads to improved understanding. A scientific theory is not a proof but a verified hypothesis supported by evidence that can be independently tested by repeating the observation or experiment. In the design fields, theory is also used to describe conditions that are not easily quantified, such as aesthetics or creative process.

Landscape architecture theory comprises the field of knowledge employed in education, research, and practice to describe the intellectual framework for understanding and managing the landscape. The landscape is managed through the activities of design, planning, and maintenance, described by Per Hedfors (2013) as follows:

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- **Landscape planning** refers to the *strategic activity* of determining and selecting among future options for changing or preserving the landscape.
- **Landscape design** is the *creative activity* of determining specific changes in the landscape through the integration of quasi-permanent arrangements and features into the dynamic systems of nature.
- **Landscape maintenance** is the *continuous care* of a landscape to achieve or sustain landscape form and process.

In landscape architecture, the primary areas of theoretical interest lie in landscape planning and design. In essence, planning determines *what* will happen in the landscape, and design determines *how* it will happen. Then maintenance determines landscape form over time. This chapter reviews some of the substantive theories influential in landscape architecture—theories that address the understanding of landscapes and the motives underlying their alteration and management to improve mutual fitness between and within natural and human systems.

Although theories of maintenance are usually not issues of primary concern, they are, nevertheless, areas of importance in landscape architecture. This is illustrated by one of the world's most famous sites, the fifteenth-century Ryōan-ji temple garden in Kyoto, Japan. The form and pattern of the dry landscape's pebble base are sustained by continuous maintenance. Each day, Buddhist monks rake the gravel into shape. The form of this landscape has been preserved over five centuries by consistent maintenance. Ultimately, the form of any landscape is determined by the maintenance it receives, even though this may not be apparent to the casual observer. Designers are seldom involved with the long-term maintenance of their creations, but it's worth mentioning here that how such maintenance occurs needs to inform design decisions in order to improve the likelihood that a design, once installed, can be sustained in its intended form. It is not unusual, for example, that landscapes receive less attentive maintenance than their designers expect, and understandably this results in the diminished quality of these landscapes over time. As a consequence, one of the designer's most common regrets stems from the loss of a landscape that was well conceived and implemented, only to be

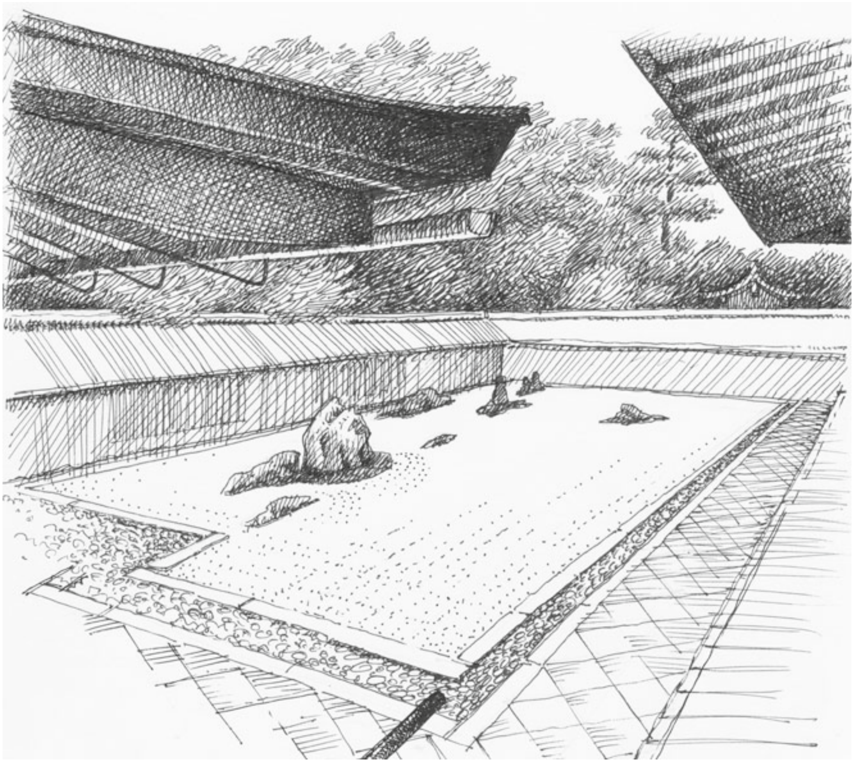

Figure 2-1. *Ryōan-ji dry landscape rock garden in Kyoto, Japan.*

degraded through inappropriate or inadequate maintenance. It also is the case that some landscapes are created by maintenance over time. In these cases, maintenance is the implementation process.

In either case, maintenance is an essential aspect of landscape development, or anything that is to be sustained over an extended time. Since the landscape is always in a state of evolution, it is also moving away from its existing state. The form of the landscape is under constant pressure to change as natural forces weather away the durable features and either introduce new plant species in places unintended or cause plant species in places the designer intends to decline or die out (Weisman 2007). Design is traditionally conceived as a process of determining some specific, desired state and establishing that new form as a quasi-permanent condition. This implies the future maintenance of the desired form by arresting reversion to its previous state or progress toward other states. Maintenance to retain the conditions of a design is an unending process of returning the landscape to some desired form as natural processes act to continue its evolution. Designs undertaken without a clear understanding of these forces may result in either very temporary conditions or conditions requiring substantial investment to maintain for the duration of their useful life. The more resilient the new form, the longer it is likely to endure. The underlying premise of an evidence-based design approach is that decisions informed by a sound understanding of people, the environment, and the forces of change increase the likelihood that the proposed design interventions will lead to the desired benefits intended from changing or preserving the landscape.

During the last half of the twentieth century, and increasingly during the twenty-first, we have witnessed the unparalleled, and in large measure unanticipated, accumulation of human-induced change in the landscape, some of which has proven detrimental to human and environmental health. If theory is to play a useful role, it will influence how designers go about each project they undertake. To formulate a theory that operates on a routine level in addressing ordinary problems, and to show how their resolution influences the larger systems of the landscape, may well be one of its most important objectives. That designers have been unable to make greater progress in addressing these needs is an unfortunate but common attribute of history (Diamond 2005). Progress is a slow process. One of the most important benefits of theory is to assure that the accumulated benefits of design create steady progress.

Design Philosophy

Over the last half-century, two opposing philosophical positions have shaped our approach to landscape architecture theory. Both positions are based on the notion that quality of life is inextricably linked to people's relationship with their environment. One position, advanced by landscape architect Garrett Eckbo, describes landscape architecture as a design discipline—not a science—in which the role of the profession is to create new and innovative ways for people to experience their physical environment (Gerhard 1992). This approach has a long-standing tradition and was established as early as the nineteenth century with the 1889 publication of Camillo Sitte's *City Building According to Its Artistic Fundamentals* (Ozdile 2008), and in the early twentieth century by Harvard president emeritus Charles W. Eliot, with the posthumous publication of the writings of his son (landscape architect Charles Eliot), stating that "landscape architecture is primarily a fine art, and as such, its most important function is to create and preserve beauty. . . ." (Eliot 1902, 1910, 40; Hubbard et al. 1917, 1). The proponents of a concept that may be described as "landscape architecture as art" have been the primary adherents of this view.

An alternative position describes landscape architecture as functioning principally as a profession of stewardship (McHarg 1969; Scarfo 1988; Lyle 1994; Ndubisi 1997; 2014), identifying and preserving, for enhanced human benefit, the intrinsic qualities found in nature through research and ecologically sound land planning and design. The proponents of what might be described as "landscape architecture as science" have been the primary adherents of this view.

Both of these positions have been instrumental in informing contemporary landscape architecture theory and bringing us to our current, more holistic and integrated perspective. To borrow a phrase from George Bernard Shaw, the scientist looks at the world and asks, "Why?" The artist looks at the world and asks, "Why not?" The important question for design is whether we must choose between them. It should be clear that an understanding of why things are the way they are does not lead directly to an improved vision of how they might be. Conversely, any design speculation that ignores what has been learned from the past places us at risk of repeating past mistakes. Innovation is necessary to address problems in new and more imaginative ways. The role of the designer is to facilitate innovative relationships by imposing change in the form of the environment. But change alone is not enough. It must be change that corrects past mistakes and takes advantage of new insights and opportunities.

One of the primary limitations of approaching landscape design as an art form arises, in part, from the traditional emphasis in art on the achievement of creative individuals. The landscape as a system is too complex to be understood or designed, from the perspective of a single individual or discipline, as an isolated work of art. Another problem with a purely artistic approach to design has to do with the limitations of human sensory perception. The creative arts are filtered through the narrow biological channels of cognition (Wilson 2012). But as remarkable as our senses are (Bushdid et al. 2014), humans are severely limited in their ability to comprehend reality through the senses; we cannot perceive an atom or an ecosystem.

Conversely, to approach design strictly from the perspective of science also has disadvantages. To design the human habitat as if it were a rationally organized machine, with emphasis on rigid adherence to known aspects of reliability and efficiency, falls short of the complex needs of society and individuals for many reasons, aesthetic consideration being only one. Equally important to people are the creative opportunities and experiences the landscape provides for participation, choice, and exploration. Human desires for exploration and experimentation necessarily exceed the limits of the known.

A holistic approach to design synthesizes these divergent ways of thinking into a more robust and integrated understanding that takes full advantage of both scientific evidence and human creativity in the search for a more vibrant and sustainable living environment, on the one hand, and a more aesthetically rich and humanely opportune one, on the other. Designers in the future may visualize their role as more akin to that of orchestral musicians, making the best of their performance in concert with others, than that of solo instrumentalists. Today, these different design approaches—design as art, design as science—are no longer understood as mutually exclusive, but mutually reinforcing.

Sustainable Development

Although the idea of sustainable development first emerged in the global arena at the 1972 UN Conference on the Human Environment at Stockholm, and then took over a quarter century to become established in our collective thinking, in fact it is a concept with a long history. In the late eighteenth century, English demographer and economist Robert Malthus described the danger of people outstripping their resource base through overpopulation (Malthus 1798). The sustainable use of landscape resources was advocated by forester Gifford Pinchot in the early 1930s when he advanced the concept of *sustained yield*, a term originated by American diplomat and polymath George Perkins Marsh (1864) for the conservation and renewal of forests (Alston 1972).

At that time, the concept related to the ability of land to sustain wildlife, livestock, or timber production (Stoddart et al. 1955). Ecologists concerned with improving production from heavily managed natural systems, such as grasslands for animal grazing and forests for timber production, referred to the land's **carrying capacity**: how many animals or plants the landscape could support, or "carry." By the mid-twentieth century, the ability to use technology to impose change on the landscape was developing faster than our ability to understand all its implications. Some visionary ecologists began to recognize a growing problem with regard to sustaining human development, but few others noticed this looming crisis before the mid-1960s (Ordway 1955; Eisely 1957; Sears 1959). It was becoming evident to thoughtful observers that unquestioned reliance on technology to bring about improvement in the landscape was leading to consequences that were neither intended nor desirable (Carson 1964; Ehrlich 1968; Odum 1969). In 1959, ecologist Paul Sears wrote:

> What other peoples have accomplished without the benefits of science suggests what we might do once we learn to make technology our servant rather than our master. To that end I propose a question whose answer lies beyond the reach of science, however much science may illuminate the search. If we care what the future may bring forth, what do we desire it to be? Once we know what kind of world we want, science gives us abundant means to shape it. (Sears 1959, 17)

Today, we are coming to an understanding of what kind of world we want and the connections that exist between choices and the landscape. At least there is growing consensus about what we do *not* want from the environment: soil erosion, habitat loss, ecosystem fragmentation, species extinction, atmospheric and aquatic pollution, climate change, diminished quantity and quality of food and water. To these we can add excessive noise, disruptive and unsafe landscape organization, visually chaotic and unpleasant surroundings. Today, we are even beginning to recognize the loss of darkness in the night sky and the ability to see the stars as deterioration in our environment. Since the early 1970s, sustainability has emerged as a prominent aspect of our understanding of the environment, and now it is recognized as an internationally accepted goal (McHarg 1969; Commoner 1971). As a society, we are coming to the realization that we have a responsibility to protect as well as the power to change the landscape.

While sustainability is an issue of concern to everyone, for landscape architects, the issue is even more immediate, since they must incorporate these considerations into their everyday actions and decisions.

Contemporary theory in landscape architecture attempts to integrate the apparently polar positions of innovative change and stewardship, and focuses on the development of holistic design strategies to improve the human condition and sustain environmental health and productivity in perpetuity. Stewardship (maintaining what we have in a healthy state) without innovation (changing the way we meet needs) is not possible in a rapidly changing world. For human environments to become sustainable will require improved understanding of the ecosystem and radically changed patterns of consumption behavior (Papanek 1984). Sustainable design and development will have to align with ecological principles and processes (Odum 1969).

Ecosystem management is a land-management approach based on the integration of ecological, economic, and social principles to manage biological and physical systems to safeguard sustainability, biological and habitat diversity, and ecosystem productivity (Wood 1994). It is implemented to regulate ecosystem structure and function and also, as a consequence, system inputs and outputs to achieve socially desirable conditions (Agee et al. 1988).

Unlike historic land-development and land-management approaches, ecosystem management does not focus on the delivery of specific resource "goods" and "services" to society, but rather on sustaining the ecosystemic structures and processes necessary for the delivery of goods and services (Franklin 1993). This is a radical departure from the position of most contemporary development activity. It is also significantly different from the approach of most design professionals such as landscape architects as well as their clients, who tend—by virtue of prevailing economic

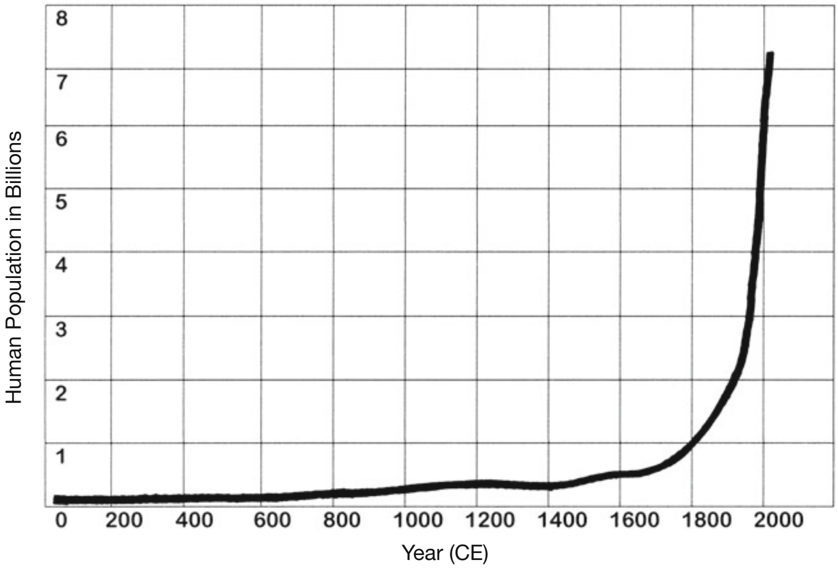

Figure 2-2. *Global population growth in billions over the last 2,000 years (based on Kremer 1993).*

paradigms—to be project (object) oriented rather than system (process) oriented, the benefits of the enterprise deriving from the short-term success of the individual venture (creating wealth by producing goods or services) rather than from an integrated approach to bringing about collective long-term benefits to the quality of societal/environmental relationships.

One of the most important aspects of sustaining a healthy landscape is recognition of the interrelated systems in which life is embedded. The soils, water, and atmosphere at the Earth's surface have evolved over hundreds of millions of years to their present condition through the dynamic activities of the biosphere. It is this web of interrelationships that makes life both possible and sustainable, the perpetuation of which is the basic intention of design. This complex of living organisms, integrated with their inorganic environment, continues to develop and change. The system is not in equilibrium (Wilson 2002). It continues to evolve and respond in reaction to changing circumstances and disturbance. When we introduce change in a system in disequilibrium, we cannot know, with any certainty, what the results will be. When we destroy ecosystems and drive species into extinction, we accelerate the process of change to a new but completely unpredictable future—a result contradictory to the intentions of design. Ultimately, degradation of the ecosystem threatens our own survival.

There are several broad areas of concern in creating a sustainable future. Among these are the need to ensure the diversity of biotic and cultural resources, the need to increase our reliance on renewable resources, and the need to manage urban, industrial, and agricultural landscapes in ways that achieve more than productivity alone. We must begin to design and manage in ways that ensure the *means* of production as well as the output.

To redress the inequities between these targets and current land-development and -management practice, a series of interrelated principles has been proposed as a way to increase resource productivity and to sustain it into the future (Hawken et al. 2003). These principles include:

- **Reestablish urbanism, agriculture, and industry according to ecological models with closed-loop systems and movement toward zero waste.**
- **Shift the primary focus of agriculture and industry from the production and sale of goods (such as cars) to the provision of services (such as mobility), for greater integration and efficiency.**
- **Reinvest in the environment and its natural capital as the basis of all future prosperity.**

To act on these recommendations will require innovative departure—design change—from much of our current practice. We have only begun to design landscapes as regenerative systems. Our concepts of development remain as fixed as our concepts of design, as we can observe in our development efforts to establish concrete realities—such as constructing new landfill sites on which to dispose of urban waste—rather than reshaping relationships to guide and manifest *processes*—such as establishing urban life-support systems that eliminate waste as a byproduct to be disposed of (Lyle 1994). If we are to begin to design sustainable landscapes, it will be necessary to focus on continuous recycling to optimize functions and processes on many levels rather than maximizing the one-time extraction and use of resources. For some kinds of systems, such as economic or urban systems, maximizing for some invariably means minimizing for others, such as natural systems, many of which (natural drainage patterns for rainwater evacuation, for example, or rivers as systems to clean water) the urban systems rely upon. We are only beginning to recognize the advantages of designing for the benefit of both existing and introduced systems; this means conceiving of design as the creation of a new and integrated complex of mutually supportive natural and human systems with the capacity to support as well as regenerate themselves over time.

In our quest to maximize extraction and reduce the burden of maintenance, we have introduced new "low-cost and low-maintenance" materials into the landscape, many of which are toxic to people and the ecosystem. The presence of chemicals to manage ecosystems is ubiquitous; we prefer

Figure 2-3. *Drain inlet and street bioswales, designed by Chris Mulder Associates Inc. to collect storm-water runoff and convey it to a constructed wetland in a residential subdivision. (Source: Michael Murphy.)*

Figure 2-4. *Constructed wetland and bird sanctuary for a residential subdivision, designed by Chris Mulder Associates Inc. to treat surface runoff before it enters open waterways. (Source: Michael Murphy.)*

to apply herbicides, for example, rather than to plow weeds (or accept less "controlled" landscapes). We use disposable bottles rather than permanent ones that can be cleaned for reuse. Unfortunately, these chemicals and containers, though they may last for generations, rarely stay where we put them; they find their way into streams and rivers and eventually into the oceans, where they accumulate and work their way back into our own food chain (Carson 1964). In our attempt to reduce costs in one area, we are accumulating even greater (environmental) indebtedness elsewhere.

Our current patterns of behavior are based as much on habit as on the application of evidence and reason to chart a sustainable course for the future (Nelson et al. 1982). These problems present a challenge to the designer. Sustainable development is as difficult as it is important to achieve. One of the first steps in meeting this challenge is to understand why people engage with one another and the environment as they do.

Environment–Behavior Studies

Historically, one of the most serious criticisms of the design professions (architecture, landscape architecture, and urban design) has been their lack of a knowledge base from which to propose changes to the environment. Design professions are defined primarily as problem-solving disciplines. But before problems can be solved, they must be identified and understood (Zube 1987; Rapoport 1990). Although engineering has quantified the structural aspects of building, design problems are not primarily structural in nature. The purpose of design is not to employ technology, but, through its application, to provide improved shelter, sustenance, and services for society.

For designers to understand the problems they intend to solve, they must possess not only technological competence and knowledge of the physical and ecological dimensions of the landscape, but also of the sociological and psychological characteristics of the people they serve. Environment–behavior research has been an emerging area of intellectual focus within the design disciplines for the last forty years, but only over the last twenty-five has it begun to significantly impact design thinking and assume a prominent position in theory (Cooper 1965; Whyte 1980; Zube 1986; Zeisel 1988). Proponents of a behavioral science approach to design argue that the built environment can be successfully understood and managed as a system of behavioral settings—without considering subjective aesthetic judgments such as appearance or visual preference, but instead focusing on social and cultural factors, such as safety or community interaction, as the main variables influencing the character and quality of environments (Cooper-Marcus et al. 1986; Rapoport 1990). Under this paradigm, the traditional considerations of materials and technology are only secondary, modifying, or constraining influences.

The basis of an environment–behavior approach to design is the notion that there is a relationship between the environment and human experience and behavior, and that this influence can be understood to inform design thinking. We intuitively understand how the environment acts to influence behavior. People, for example, are generally more excited in a carnival atmosphere, or more relaxed in a quiet park. Conversely, it is also true that our behavior has an influence on the environment. If people repeatedly follow a single path between two points, it becomes worn to the extent that it is physically expressed as a trace in the landscape. Environment and behavior may be seen to be interactive when, as a consequence of our discovering a path worn into the landscape, it attracts others to adopt the same behavior. There are ecological relationships between environment and behavior owing to their influences on one another. The greater our understanding of these relationships, the greater our ability to apply that knowledge to guide design decisions and create predictable behavioral settings.

Without the benefit of evidence regarding people's specific behavioral requirements, designers may rely on past experience to guide the development of design ideas. When designers believe that they know what the design problems are, they are unlikely to expend much energy verifying what they believe or testing whether it is supported by reliable evidence. In such situations, what we witness is the human behavior of designers. It is understandable for a designer to focus attention on known problems such as implementation or maintenance. But focusing only on known problems can interfere with the investigation of the behavioral problems of those being designed for in order, for example, to determine the most appropriate setting for multicultural harmony in a public space.

In the absence of systematic, comprehensive problem discovery and identification focused on by environment–behavior research, designers often miss the most difficult and challenging—that is, real—problems by substituting their own self-posed problems, as defined by the internal values of their profession—that is, trivial and easily solved problems. It is easier, for example, for a designer to create a setting that conforms to a particular style than one that reduces vandalism or increases citizen participation.

Systematic evaluation of the mutual interactions of people and the environment is concerned primarily with what to design and why; posing human criteria for designs based on an understanding of person–environment interactions (Cooper-Marcus et al. 1998) suggests that this type of investigation deals with three general questions (Rapoport 1977; 2005):

- **How do people shape the environment**—which characteristics of people, as individuals or groups, are relevant to shaping the environment?
- **How and to what extent does the physical environment affect people**—how important is the designed environment in fostering desired relationships, and in which contexts?
- **What are the mechanisms that link people and environments** in a two-way interaction?

Geographer Jay Appleton (1996) suggests that people have an innate preference for certain protective or sheltering settings. This is described as a prospect-and-refuge relationship between an observer and the landscape. The basic premise of **prospect-refuge theory** is that people evolved as an "edge" species in a savanna environment over many thousands of generations (Wilson 2002). The forest edge condition, within the open grassland-woodland environment of the savanna, provided a sheltered prospect (Nasar et al. 1983) from which people could view the open landscape in search of food and shelter. The edge condition also provided the benefit of a protective refuge that concealed the viewer from predators or enemies. The theory postulates that since people favored and occupied this type of landscape during a lengthy period of our evolutionary development, this preference has been encoded in our subconscious as a precognitive response to an environment that provides a prospect-and-refuge setting. The theory suggests that to satisfy security, one of our most basic human needs, designed environments need to provide a recognizable and beneficial relationship—a prospect-and-refuge condition—if they are to be preferred on a fundamental subconscious level.

Even in the twenty-first century, human behavior continues to be shaped by the need for identifying potential threats in the environment and locating protective shelter. The prospect-refuge theory can be easily tested to demonstrate its apparent influence on behavioral choices. For example, people are more often observed choosing to sit on benches under the shelter of trees at the edge of an urban or park open space than on benches without shade in the middle of a space where they would be conspicuously located in the full view of others. People exhibit a preference for viewing others rather than being viewed in this kind of setting, although there are, of course, exceptions. It may be that people simply prefer to sit in the shade rather than the sun. Theory provides useful guidance to designers in considering the use of public space, but the design decisions must still be made on the basis of evidence and value judgments. In selecting from among available options to address a wide range of problems and opportunities, the theory may explain but does not determine design choices. Generally, design choices are made to reach the most equitable and harmonious balance among a range of competing interests, of which human perception and behavior are among the most prominent.

Systems Theory

The basic challenge of design is to manage the interface between cultural and environmental systems (Senge 1990). Systems theory provides a means of comprehending reality on a holistic basis and has become our most important means of understanding complex conditions such as those found in the landscape. It also provides the scientific basis for much of what designers do when they manage change in complex environments. Systems thinking provides a structure for unifying the broad theoretical positions that have been brought together to form the discipline and practice of landscape architecture.

Landscape architect John Motloch explains why an understanding of systems relationships is integral to successful design:

> For landscape management, planning, and design to effectively integrate diverse systems, landscape designers must be systems thinkers (thinking integratively and with cognizance of systems dynamics). They must be committed to landscape management, planning, and design that optimize the health and productivity of diverse physical, ecological, and human systems. Landscape designers must aspire to manage, plan, and design people–environment relationships and human interventions that promote landscapes of high relevance and deep meaning that are sustainable (address today's needs while sustaining the ability to address the needs of the

future) and regenerative (function to regenerate system capacity). (Motloch 2001, 1)

Classical science has focused on *analysis*, with the assumption that the whole is the sum of the parts and that understanding *structure* leads to an understanding of nature. Management thinking has focused on *function*, defining systems by their outcomes and studying their effects on the environment. This approach is based on the assumption that understanding function is necessary for understanding the whole. Behavioral science focuses on *process* as the defining aspect of a system. Each of these approaches originates from a different system of inquiry, and each one has contributed to improved understanding.

A **systems approach** assumes that "structure, function, and process represent three aspects of the same thing," and together with their surrounding environment these three aspects form a complementary set (Gharajedaghi 2005). These system constituents are defined as follows:

- **Structure** of a system defines its components and their relationships.
- **Function** defines the purposeful outcomes or products of the system.
- **Process** defines the activities in which the system components are engaged.

Understanding of the system as a totality is possible when the constituents are considered as a unified whole. A landscape system, for example, comprises the *structure* of its physical attributes in conjunction with its biological components, its *function* to exchange nutrient elements and water, and its *process* of organizing and exchanging energy to support life. Taken together, these constituents constitute what are called *ecosystems.* Only by considering the relationships among the constituents are they, or the systems of which they are a part, understood.

Systems, then, are defined as "wholes" consisting of entities and relationships that function through the interrelatedness of their parts. Systems exhibit existential properties independent of their parts (Motloch 2001):

- **The behavior of each element of a system has an effect on the behavior of the whole.**

- **The behavior of the system elements and their effect on the whole are interdependent.**
- **The elements of the system are so interconnected that they cannot functionally exist as independent subgroups** (Ackoff 1981).

In physics, quantum mechanics has revealed that, at the subatomic level, objective reality does not exist as a definable state, but only as the probability of reality as expressed through the presumed interrelationships among particles. One of the great discoveries of the twentieth century was that reality is best understood through relationships. This shift in attention from objects to relationships—from a focus on the discrete components of nature to the contextual structure in which they exist and the forces that motivate them—changed fundamentally the scientific view of nature and enabled, among other things, the science of ecology to develop. Attention to the structure, function, and processes of environments as complementary realities, rather than the mere quantification of objects within them, is providing the design disciplines with an opportunity to better understand the environments they act to influence. This improved understanding enables us to view environments as settings of dynamic and meaningful relationships rather than as static voids awaiting "improvement" from the hand of the designer. To design in a way that takes all the subsystems (biological, geological, social, spatial, political, etc.) into account requires that designers possess a holistic understanding of the system and its specific subsystems that they intend to influence.

Systems theory holds the promise of providing the unifying theoretical field to integrate knowledge of the way that nature, and society as a part of it, organizes itself. Systems thinking is particularly important to design because it is based largely on pattern recognition and organization, a fundamental principle of design thinking. "The idea of a pattern of organization—a configuration of relationships characteristic of a particular system—became the explicit focus of systems thinking in cybernetics and has been the crucial concept ever since" (Capra 1996, 80). The evolving nature of pattern organization is becoming increasingly important to landscape planning and design. In changing the landscape, it is important not only to organize different elements in an appropriate pattern of relationships but also to integrate that new organization into the larger patterns of the landscape in ways that are mutually beneficial.

Although we tend to think of the landscape as a biophysical setting, it can also be conceived as a repository of information residing in the organisms and systems comprising it. These systemically integrated organisms and their environment engage in processes of information exchange through their interactions with one another. As an organism learns where water or food is to be found in different seasons, it patterns its behavior around taking advantage of that information to assure its survival for as long as that pattern of resource availability exists. The organism "learns" how the system functions in order to ensure its reproductive success and survival. Examples of this may be seen in the timing of the birth of offspring or migration patterns that correspond with the availability of food supplies, such as that seen in the annual migration of monarchs as they complete the round-trip from Canada to Mexico even though no individual butterflies live long enough to complete the trip.

Through our senses, we are constantly monitoring the environment for useful information. We then process that information to integrate it with what we already know in order to determine what our surroundings hold in terms of interest, opportunities, or threats. On the basis of what we learn, we make decisions that guide our actions. **Learning** is described as the process by which a system alters its structure to adapt to its environment and increase its capacity to survive (Hutchins 1996, 135). The same is true for the organisms inhabiting that system. The more we learn, the more fit we become to survive in our environment. Learning is a formative—that is, a creative—process. We change as we learn. And as we learn, we increase our capacity to realize our potential as individuals and as societies.

Landscapes exhibit these same learning and change characteristics. When streams dry up or food sources disappear, the organisms in the landscape learn new ways to meet their needs and they change their behavior accordingly, as, for example, animals or plants migrate to new territories as climate changes. From a systems perspective, there are seven principles of learning (Hutchins 1996, 137):

1. **Learning is driven by a desire to explain a discrepancy between present experience and expectations based on knowledge of the past.** Learning is undertaken to better understand the present and thereby better predict the future and improve the probability of survival. Recognition that a discrepancy exists between what is expected and what is experienced motivates learning.

2. **Learning requires feedback and comparison with an accepted standard.** Learning does not occur without feedback to evaluate understanding or performance in comparison to an internal or acceptable external standard of evaluation. Delayed feedback or feedback rejected as illegitimate does not advance learning.

3. **Learning is the active reconstruction of past knowledge or skill to integrate new information or behavior at a higher level of complexity.** Memory occurs at an objective physiological level in the nervous system; thus, learners actively construct the meaning of what is known by the way the thinking processes are organized.

4. **Learning is socially mediated and contextual.** Learning has an "ecological context." When what is learned is influenced by the knowledge accepted by others, their beliefs, and their effect on the learning process, it is socially contextual. Objective thinking and learning are influenced by social pressures to conform to accepted group standards.

5. **Learning requires integration to achieve automaticity**, which is dependent on motivation and persistence. Significant repetition is necessary in order to integrate new knowledge or behavior to the extent that their application becomes an automatic response. Unless new knowledge or skills are fully integrated, old learned forms reassert themselves when the process is destabilized by stress or new information, and we revert to old patterns of thinking or acting, often when they are least useful.

6. **Learning is both a single-looped and double-looped process** (cognitive and metacognitive). It is thinking directed toward learning new things as well as thinking directed toward the process of learning—thinking, and thinking about thinking.

7. **Learning is both process and product.** Process and product are different aspects of the same thing, but seen from different vantage points. Learners cannot achieve the product (knowledge) without the process (learning) taking place. They cannot meaningfully engage the process without a product (knowledge) resulting.

These principles resonate strongly with the process of design. Design is the culmination of a learning exercise, the purpose of which is to determine some future course of action: in the case of landscape design, an altered arrangement of the environment to satisfy specified performance requirements (Lynch et al. 1984).

If we begin from the premise that we must know what is desired in the future and what existing conditions require modification, it becomes apparent that we must learn these things in order to design effectively. From a systems approach, design problems are best understood as a set of interdependent problems that are definable only by their specific interactions (Ackoff 1981). Because the world is changing rapidly, designers must learn continuously to be able to incorporate information into designs that result in the improvement being sought. On a fundamental level, a systems design approach requires three things (Tomasello et al. 2005):

- **The establishment of a reference value or desired goal toward which the system acts;**
- **The ability to cause actions to change the environment in order to bring about improved system performance;**
- **The ability to determine when the state of the environment matches the reference value or achieves the desired goal.**

The challenge for designers is to learn how best to achieve these requirements in a complex and dynamic environment.

The principle of holism contends that, as a result of synergistic interactions, the whole of a system is greater than and different from the sum of its parts (Smuts 1987). Things exist as interrelated wholes rather than individual parts. Holistic thinking emphasizes the organic and functional relationships between the parts and the whole acting as an integrated system of mutually interdependent relationships. These relationships function continuously to bring about the emergence of new (systemic) properties.

Contemporary ideas about systems discount the notion that we can understand the whole by examining the parts; by examining the parts individually, we fail to comprehend the essential relationships among them (Wheatley 1992). The essence of a system derives from the interaction of its parts acting as a whole, not the parts acting separately (Capra 1996). Thus, a society does not exist separately from its physical environment; a society and its landscape constitute a discrete system. If a system is taken apart, it loses its essential properties. When you disassemble a car and lay the parts out on the shop floor, you no longer have a "car"—you only have the parts. When the parts are integrated and interactive, the result is a system: a condition in which the whole is capable of actions greater than the sum of the actions of its parts.

One of the critical aspects of a systems view is its redirecting of attention from objects to relationships—a shift from objective to contextual thinking. Unfortunately, the world is reluctant to change its fundamental intellectual framework: systems learning is a slow process. Nevertheless, attention to relationships is important because, in design, it is always the relationships rather than the parts that are most important. The world is filled with examples of landscapes, machines, buildings, and cities that are well designed—and with others that are not. The examples in both categories may contain the same type and number of parts. Having all the right parts is necessary but does not, in itself, lead to a successfully designed whole. The parts must be arranged into harmonious patterns and durable relationships with one another and with their context. From a systems approach, the primary units of analysis are not elements, but relationships.

In many ways, designers have always been systemic thinkers, organizing a complex array of parts to produce a unified whole. The primary difference between Motloch's description and the way designers have worked in the past is mainly a matter of where attention is placed. A systems approach expands the range of considerations. In the past, designers tended to focus attention on the specific place or object being designed, and the main focus for design was on the interrelationships within the subsystem, not the relationships with the larger landscape system of which it was a part. We now realize that in designing the landscape, this objectively focused view is inadequate for understanding the complex of relationships that are influenced. The designed system's influences exceed the limits of the site being changed. Today, for example, we also must consider the implications of design regarding its potential effects on surrounding social and ecological systems, or on the problems of acquiring, and later disposing of, the materials employed, after their useful purpose has been served—before they are incorporated into the landscape. The responsibilities of contemporary designers are significantly increased by the adoption of a systems approach. But so are the prospects that their design interventions will lead to comprehensively successful and sustainable results.

The state of a system may be categorized by the success of its interactions with the outside environment. Open systems are subject to influences from outside the system, and in turn, they exert influences beyond the system. Closed systems are isolated from outside influences and the exchange of energy, matter, and information with the environments in which they are found. These are only general characterizations, since natural systems are rarely either fully open or closed. But the description is useful because it reinforces the notion that influences beyond our control are important in the consideration of design decisions. From a systems perspective, considering the nature of outside influences redirects attention toward more than just the immediate problems but also to the state of the broader context of the physical and social landscape in which they exist—which may be the cause of the problem under consideration.

The landscape as an open system is subject to the exchange of materials and energy from the external environment. The problem of designing with an open system is that we are unable to control the influences that exist between the system being designed and its surrounding environment, such as when pollution enters a system by way of prevailing wind or changes in land use stimulate associated changes in traffic patterns or noise. Open systems exhibit a number of common characteristics:

- **Interdependence** in the relationships among subsystems and the overall system, or the "suprasystem";
- **Hierarchy** among subsystems and the suprasystem, which exhibit specific patterns of influence within and between system levels;

- **Tradition** in the way that systems are subject to their own unique history and the irreversibility of time during which complex interrelationships became established and entrenched.

Any system has its own hierarchy of subsystems and at the same time exists as a subsystem within the hierarchy of a greater system. Each level of complexity has the explanation for its mechanisms in the levels below, and its significance in the levels above. In an African savanna ecosystem, for example, the lions exist as a predatory subsystem because of the available energy that is organized by the subsystem of grazing animals that convert the energy captured by photosynthesis in the subsystem of the grassland. Each level in the food chain exists because of the one below. Antelope colonize the region after the grassland becomes well enough established to provide a predictable source of food. Lions, in turn, assume a predatory role in the food chain after the antelope become well enough established to provide the lions with a reliable food source. Once established as a subsystem in the ecosystem, the lions serve to keep the numbers of antelope in check and prevent weak individuals from transmitting their characteristics into the gene pool. The function and well-being of each level, or subsystem, in the food chain is interdependent with the others.

The history of an ecosystem describes system change over time that enables the hierarchically arrayed subsystems to become established and their interrelationships integrated into quasi-permanent patterns—until there is a change in the system. For example: reduction of the grassland through drought or the introduction of farming would bring about a decrease in the antelope population that, in turn, would cause a reduction in the number of lions due to the loss of available food source at each level. Alternatively, if the number of lions were reduced through hunting, the antelope population could expand, increasing pressure on the grassland. Increased grazing pressure would bring about deterioration in the productivity of the grassland as a food source, causing a collapse of the antelope population. The essential properties of the system derive from the interactions among its hierarchically interrelated subsystems—the interaction of the parts acting as a whole, not the parts acting separately.

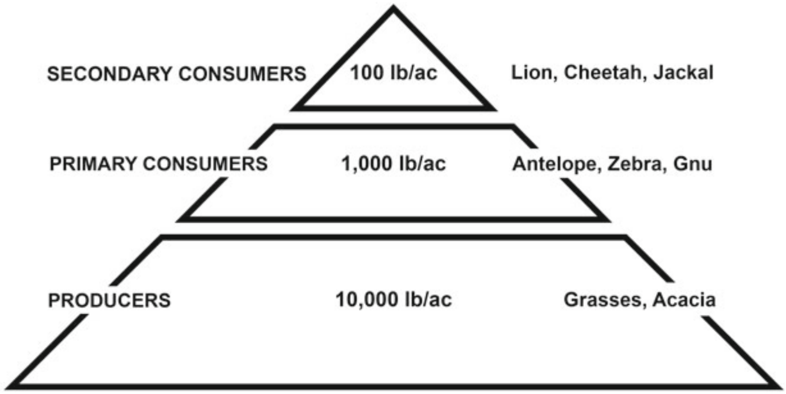

Figure 2-5. *Example of the food chain for a savanna ecosystem showing the tenfold decline in energy, expressed in pounds per acre, available for transfer to each ascending trophic level.*

When the elements are taken apart (or managed independently, as with the introduction of farming or hunting), the system loses its essential properties and ceases to exist in its previous form: the system as previously established is no longer sustainable.

Systems theory has become our most important means of comprehending reality on a comprehensive basis—that is, of learning what must be known to design effectively. It provides the structure for unifying the broad theoretical positions held by the many disciplines dedicated to understanding natural and built environments in ways that integrate knowledge of the processes by which nature and society organize themselves. It also provides insight into the processes of learning and decision making that lead to improved design performance.

There are a number of reasons why systems theory is important to landscape architecture:

- The environment is highly complex and complex conditions require a systems approach to understand them.
- The environment is dynamic. This dynamism leads to continual change and, as a consequence, makes continual learning about these interrelationships, and particularly extrapolations about future relationships, a necessary feature of successful design process.

- Like the landscape, design problem solving is an unending process. Because problems and solutions are in constant flux, problems do not stay solved. And, even when problems remain relatively stable, their solutions may become obsolete, sometimes before construction is complete (Ackoff 1981). Consequently, the process of design problem solving requires a systematic learning and decision-making process.

Landscape improvement is an ongoing process of systems management, and design is a specific step in the change-management process. To be successful, landscape designers need, among other things, to understand that they are contributing to the continuation of a process of landscape change, not establishing a final form of the environment. Designers may hope that designed changes will be durable, but they should not expect that they will become permanent conditions. Because of their intrinsically dynamic nature, system "forms are not rigid structures but are flexible yet stable manifestations of underlying processes" (Capra 1982, 267).

An important consequence of systems thinking has been the shift from a purely quantitative view of the parts of nature to a more qualitative understanding of nature as a whole: a shift from the singular focus on substance to a more balanced assessment of both the form and the substance of interrelated phenomena. As a society, we are still in the process of shifting our view from the concept of the machine to ecosystems, and unfortunately this view is not yet fully accepted in the corporate, political, or academic communities (Capra 1996, 4; Suzuki et al. 2004). The decision-making world seems to be trapped in a crisis of perception. If we perceive things as being in static categories—unchanging and unrelated—we will continue to address them as such. This we observe, for example, when we see that streets are designed as one system, utilities as another, buildings as another, and open spaces as yet another in the formation of cities. None of these closely related urban systems are typically designed as integrated components of a suprasystem—that is, a city—with respect to their beneficial relationships with one another. Dysfunctional or poorly functioning urban environments are the result when the different system components—in this example, the urban subsystems—are designed and managed independently by their different, and turf-protected, departments and constituencies.

The stability of a system is an important indicator of how much change it can absorb, which, in turn, reveals the extent of design possibility. Systems, whose essential properties are a function of the interrelatedness of their parts, may be described according to the relative stability of these relationships (Capra 1996; Motloch 2001). In terms of their stability, systems may be characterized as:

- **Equilibrium structures** that are highly integrated, interactive, self-perpetuating, and stable. Equilibrium structures are evidenced by climax ecosystems, such as prairie grasslands or redwood forests (or thriving cities) that have remained essentially unchanged over hundreds or even thousands of years.
- **Dissipative structures** that are highly spontaneous, dynamic and inherently unstable (Prigogine 1980). Examples of dissipative structures include ecosystems undergoing rapid change, such as may be seen in the early stages of ecological succession in heavily disturbed landscapes (or development transition in deteriorated inner cities) when short-lived plant communities (or business enterprises) invade and colonize degraded areas. The character of these landscapes changes rapidly as successive communities take over from the pioneers to expand species diversity, interaction, and stability in a new form.

Stable systems present an obstacle to design change. Unstable or destabilized environments present design opportunities. It is useful, before undertaking significant change initiatives in complex systems, to understand the extent of change that might be possible and the energy required to bring change about without disruption. Understanding the ecosystemic context of human settlement provides a useful approach to the design, management, and growth of the urban landscape. For the parts of a system to be fully understood, they must be comprehended in their systemic context. One cannot, for example, see the relationships within a system by looking only at the parts. We cannot understand the feeling of power and speed to be experienced from driving a car, or the feeling of freedom of independent movement, by examining the car's parts on a shop floor. Nor can we foresee the potential for relationships such as traffic jams that these cars might represent once many of them are in movement (or attempt to be in movement) at the same time.

A systems approach to design of the landscape includes understanding, arranging, and managing the integrated features, processes, and spatial patterns of the community and its host environment—the urban landscape and its regional hinterland—to improve the quality of their interdependent relationships. The quality of the design ideas that drive these interventions, and in particular the environments that result from them, should be evaluated by the extent to which the whole system integrates with and responds to the demands being placed on it—that is, the satisfaction to be derived from system outputs at all levels. Although the individual designers (architects, engineers, landscape architects, park planners) may be responsible for the different parts, when each one is designed as an integrated component of the whole, whole environments will result.

The importance of design ideas cannot be overstated. Ideas are to design what light is to vision. Ideas are the enabling vehicle that convey and make tangible the meaning and form of design change. When design ideas focus solely on the creation of objects, systems will be affected—but not necessarily as intended. When ideas are expanded to integrate the consideration of environmental and social contexts, they can shape landscapes as whole systems in ways that are useful and sustainable for all system levels and components.

Given the realities of the ecological context of life on Earth, it is only when the whole system is successfully formed and managed that sustainability of its subsystems is possible. To bring us to the new reality of a sustainable future, however, is an undertaking with some risks. Not the least of these is a threat to the status quo and all who may have a vested interest in its perpetuation; this may include designers, their clients, and their projects. Inherent among the unforeseeable consequences of change is an implicit threat to current professional values, methods, the knowledge base, and the definition of what constitutes "good" design.

To survive—to preserve itself and its values—society must pursue change based on a continuing supply of new ideas. As light is the energy that drives the ecosystem, ideas are the energy that drives society. For landscape design ideas to keep pace with rapidly developing events and the demands for a more fitting relationship between society and the landscape, the discipline will require access to the most advanced knowledge, technologies, and methods. An important role for practitioners and academics alike is to guide the future development of the profession in ways that preserve the best of the discipline's traditional aims while simultaneously shaping new holistic values, appropriate to the requirements of rapidly changing demands. The profession continually incorporates new knowledge and develops new methods for creating places that are responsive to these evolving values.

To meet the needs of people and the environment holistically requires that we consider the interrelated concerns for quality of life and quality of the environment from an integrated, systems perspective. Some of the interrelated aspects for which design consideration must be made include:

- cultural and social dynamics in a multicultural context;
- environmental processes to maintain viable ecosystems;
- physical and functional relationships;
- resource economy and stability;
- sensory and perceptual considerations;
- historical, cultural, and ecological precedent.

The systems criteria for achieving holistic integration of these considerations through design are characterized by the:

- satisfaction of human needs and aspirations;
- healthy relationships between people and the landscape;
- symbiosis between the urban landscape and its environmental context;
- multidimensionality of relevant knowledge areas and performance criteria;
- interdependence between criteria originating from different sources;
- dialectic between problems and possible solutions.

Sophisticated, rigorously managed design methods and technology are needed to effectively integrate new knowledge into advanced design thinking. It is the role of science to provide the evidence—the knowledge and understanding of the landscape and human systems to be managed by design. The role of design is to creatively apply knowledge in a comprehensive and effective way. The principal knowledge area of the design disciplines is decision-making process: the knowledge of innovation in knowledge application. In addition to command of the processes of insightful knowledge application, systems management of the landscape requires access to the science of people and the landscape if designs are to improve the likelihood that they will have a beneficial influence on the outcomes of the change initiatives undertaken. Collaboration among different disciplines not only provides the strategies for successful knowledge application, it is also one of the primary indicators of successful design practice (Coxe et al. 1987, 8).

The primary knowledge domains on which landscape architecture is based, environmental and human factors, are discussed in the following chapters.

CHAPTER THREE

The Biophysical Landscape

The thin mosaic, the tissue of the planet, is in upheaval. An urgent need exists for new tools and new language to understand how to live without losing nature. The solutions will be at the landscape scale—working with the larger pattern, understanding how it works, and designing in harmony with the structure of the natural system that sustains us all.

—Grant Jones

The real wealth of the Nation lies in the resources of the earth—soil, water, forests, minerals, and wildlife.

—Rachel Carson

Unlike the artist, the landscape architect does not begin with a blank canvas. The place to be designed already exists as a complex of exquisitely interrelated physical, biological, and chemical processes. Just as biophysical processes interact to shape the natural environment, they also affect the built landscape.

Before the homogenizing influences of mass communication and shared technology, a distinguishing characteristic of settlements throughout the world was the way they reflected the unique patterns of their local cultural and ecological processes. Contemporary development, however, is typically undertaken with limited consideration of local landscape dynamics as a beneficial force to be harnessed and celebrated through ecologically integrated urbanization. Instead, natural features and processes

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are more often seen as constraints to development, and designs are formulated to reduce their negative impacts on the increasingly standardized development patterns being pursued. This approach has had far-reaching consequences, contributing to deterioration of important ecological processes. To successfully manage the natural systems of the landscape, designers must possess a basic understanding of what the landscape is and how it works. This is not to suggest that designers need to become proficient ecologists or geologists. They do, however, require a fundamental grasp of the interrelationships between the biological and physical systems of the landscape, and with that understanding, they can position themselves to make informed design recommendations.

A basic understanding of landscape processes provides designers with insight into the biophysical interrelationships of the environment, enabling them to pose insight-provoking questions to those who understand the landscape and its processes in depth. By taking advantage of the expertise within the scientific community, designers are able to employ greater knowledge than they possess themselves. To take full advantage of the knowledge available, designers need to know what questions to ask of biological and geophysical scientists and how the information they provide can best be applied through the change initiatives they propose.

This chapter reviews some of the basic considerations of geology and ecology to describe how the landscape functions and the ways it is influenced when design change is initiated. The processes described here present an elementary outline of landscape structure and function that can help designers identify some of the conditions that they need to respect and sustain if they are to be instrumental in the creation of a healthy and vibrant landscape environment, a prerequisite to a healthy and vibrant human environment.

Physical Conditions

To understand landscape as dynamic process, we first need to consider the overall structure of the environment and the forces that have created it. At a global scale, the form of the terrestrial environment is shaped by plate tectonics, geologic processes normally operating over hundreds of millions of years (Oliver et al. 1990). Continental movement, mountain building, earthquakes, and volcanism are typical products of these processes. The character of the global landscape is shaped by the Earth's underlying forces (Bloom 1969; Dott et al. 1994):

- **Internal heat**—The internal heat of the Earth drives plate-tectonic movement and magma flowing from the interior of the planet, accounting for some of the Earth's most impressive landscapes. These include many large-scale landforms such as mountain ranges, volcanoes, and island arcs where these forces are particularly active, such as on the Hawaiian Islands and the western margin of the Americas.
- **External heat**—Solar radiation provides the primary source of energy that, when converted to mechanical force, shapes the landscape. These forces include climate patterns and wind-driven waves. The influences of weather are among the most active agents of surficial landscape change, particularly as they affect seasons, flooding, erosion, and deposition. Climate is critical to the modification of geologic materials due to its influence on chemical and physical weathering processes.
- **Gravity**—The innate attraction between bodies is an inexorable force exerted on all matter, expressed on Earth by material constantly moving to its lowest level of potential energy, resulting in activities such as mountain weathering, mass movement of rock on steep slopes, water flow, soil creep, erosion, and sedimentation processes. The gravitational attraction of the sun and moon drive the tides in their daily raising and lowering of both the surface waters, with an average tidal range of about two feet, and also the Earth's crust, where the rise of solid rock on the side of the Earth facing the Moon is estimated to be about one foot.
- **Hydrologic dynamics**—The hydrologic cycle is a heat-exchange process that withdraws vast quantities of water from the oceans and other bodies of water and transports some of it, in the form of water vapor, over the landmass, where it is precipitated in a continuous cycle that provides fresh water to the terrestrial environment. From there, water is returned by gravity to its ultimate reservoir in the oceans. This cycle provides the water to sustain life on land and drives the processes of erosion and deposition on the Earth's surface that shape landscape relief.

These fundamental forces, acting individually and in concert, actuate the Earth's long-term geomorphic evolution. Because they influence the landscape at all scales, these forces also change local conditions over shorter time intervals. Even minor changes in landscape relief as a result of floods, earthquakes, or landslides, can result in devastating disruption of urban systems, including the destruction of buildings, highways, and infrastructure.

We tend to think of processes such as river flooding or hurricanes as steady-state systems with the record of the recent past as an indicator of future expectations. Periodicity and severity, however, are difficult to predict. The debate over the last quarter century concerning global climate change has revealed that although these systems change continuously, the timing, extent, and dynamics of this change are not well understood.

Short-term cycles, such as favorable weather cycles, can mislead developers and policy makers into promoting land-use decisions that place people in harm's way and threaten the integrity of natural systems, as Hurricane Katrina demonstrated along the Gulf Coast in 2005 and Hurricane Sandy in 2012 along the Eastern Seaboard. Although we are constantly reminded that "civilization exists by geological consent, subject to change without notice" (Durant 1946), our memory is often short. In some cases, however, there is no memory at all, as with shifts in long-term climate patterns, because there is no past evidence within the time span of literate human occupation and instrumental measurement.

A convenient way of visualizing landscape dynamics is to think of the landscape as a series of superimposed layers. The geologic base, configured by topographic relief, influences the deposition of soils that overlie it, which, in turn, influence the patterns of vegetation and animal life overlying them. All these are influenced by the atmosphere, with its climate constituting the uppermost layer in the series, further shaping these landscape components through weathering and seasonal dynamics. These layers, or landscape subsystems, function as an integrated set of dynamic interrelationships that constitute the landscape as an entire system. The interactions of these landscape subsystems integrate to produce the landscapes we observe, through the features of:

Figure 3-1. *Flooding from Hurricane Katrina in 2005 in an area where development has occurred in a landscape subject to periodic inundation. (Source: Jocelyn Augustino via Wikimedia Commons.)*

- **Geology**—the consolidated bedrock, underlying the surface, that provides the basic structure to the landscape. Evolving geological conditions initiate a cascade of changes in the biophysical systems situated on them. Considerations for design include the relationships it bears to surface geology, soils, relief, groundwater, and potential movement dynamics.
- **Soil**—the body of unconsolidated decomposed rock fragments and humus overlying the geologic base. Soils are formed by influences such as weathering and biological activity acting on the parent rock over time. Design concerns include the soil's structure, depth, position, moisture relationships, organic content, nutrient components, and the extent of their change through processes of soil development, erosion, or deposition (the depositing of materials by the action of wind or water).
- **Hydrology**—the pattern of water movement over the landscape surface and through voids in the geologic substrate. For the designer,

concerns include the patterns of seasonal or climatic change as cycles shift from drought to flood, and the location, quantity, and quality of water sources as they affect geologic processes, biological activity, and human use.

- **Topography**—the slope, complexity, and orientation of landscape relief and its influence on rainwater runoff, groundwater flow, airflow characteristics, and soil movement. Although topographic development is a dynamic process that influences the other landscape subsystems, it is best understood as an expression of the interactions of other systems rather than a landscape system operating independently.
- **Climate**—the long-term pattern of weather (i.e., temperature, humidity, precipitation, wind) of a region as it is affected by latitude, altitude, relief, and proximity to water bodies and their currents. Design concerns include factors such as seasonal dynamics, comfort, and energy use.

Each of these subsystems may be described as an individual aspect of the landscape, but understanding them comes primarily from determining their interrelationships. Landscape topography, for example, is the product of surface water moving across the geologic base. To design intelligently requires an understanding of the potential these systems have to change over time and how they influence one another as well as human activities. Particular attention is paid to the potential hazards these aspects may pose, such as damage from hurricanes, floods, subsidence, earthquakes, drought, wildfires, or other events that directly threaten human life and property. The destruction resulting from catastrophic events, however, is only one aspect of design consideration. For example, the overall cost of repairs to buildings and infrastructure due to the chronic influence of expansive soils, estimated at over $15 billion annually in the United States (Nelson et al. 1992; Buhler et al. 2007), exceeds the costs of the other natural hazards combined. These losses are the result of predictable conditions, not unexpected events.

Additionally, the designer must consider how human activities conflict with the workings of natural systems—for example, construction that disrupts drainage patterns by diverting groundwater recharge and the flow of sediment, or that destroys the biological productivity of soils. The power of contemporary technology increases our ability to change the landscape in ways that were barely imaginable a generation ago.

Geology

The geologic base of the landscape, the substrate on which the biotic components rely, is a system in perpetual transition (Oliver et al. 1990). The geological environment is best understood as a complex and dynamic system, changing constantly, albeit slowly, in response to the forces acting on it. The geological features we observe in the landscape are a visible record of past as well as continuing processes. This process of geologic evolution is described as the **rock cycle** (Tarbuck et al. 1996), which traces the transformation of igneous rock undergoing weathering and transport to produce sediment deposits that, when subjected to lithification, are transformed into sedimentary rock that is later buried deep within the Earth and subjected to intense heat and pressure to be transformed into metamorphic rock. The cycle is completed when metamorphic rock is subsumed into the interior of the Earth, as occurs when the abutting edge of one continental plate overrides another, subjecting the metamorphic rock to the extreme heat and pressure required to melt it and, once again, form magma. The geology of the Earth's surface region is continuously reshaping itself, using the same materials to repeatedly produce different forms over time.

The physical environment provides both the setting and the source of the building blocks for terrestrial life, which serves as the agents to organize energy and elemental materials of the environment. The chemical components from which organisms build themselves and operate their metabolic processes exist in the biosphere in a fixed supply. These chemical components must be continuously withdrawn from the environment, used by living organisms, and then returned to the landscape to be recycled for reuse by subsequent generations of organisms. By continuously combining with other elements and constantly changing in form, these elements move through solid, liquid, and gaseous states, and in so doing, create opportunities for their repeated recapture and incorporation into the biota. Oxygen, for example, exists as a gas in the atmosphere as free oxygen (O_2), as liquid water in combination with hydrogen (H_2O), or as a solid in glucose ($C_6H_{12}O_6$). If it becomes bound up as a stable solid, as when it combines with silicon to form silica, or quartz (SiO_2), it is unavailable as a chemical constituent for life.

Because many of the geophysical processes that carry out these transformations operate at vast physical scales over geologic time intervals, they typically do not reveal themselves at the human timescale. Common geologic processes such as floods, volcanic eruptions, or earthquakes are among the most common events in nature, and yet they occur infrequently—at least, they seem infrequent when measured in human timescales. It is only when we are confronted by these events that we become aware of their destructive influence. For example, we observe this in cities that are flooded repeatedly because development has been located in an active floodplain or vulnerable coastal setting. In other cases, minor flooding is intensified by development that increases rainwater runoff due to the proliferation of impervious surfaces—streets, roofs, parking lots, and sidewalks—that reduce opportunities for surface water infiltration and thus diminish the recharge of groundwater aquifers. These geologic processes are continuously active in the landscape and must be central to design considerations when the landscape is altered to support human activity.

Soil

The soil mantle of the landscape is a reservoir for water and nutrients, and the structural anchor for plant roots. Soils occur in patterns related to their underlying geology, topography, climate, and overlying vegetation. They are formed from the accumulation of decomposed rock fragments on the land surface, transformed over time by physical and chemical weathering, from freeze/thaw cycles, or wind, for example.

One of the primary functions of the landscape is the continual formation and development of soils from organic and inorganic materials on the Earth's surface. Through the interactions of chemical, hydrologic, and organic processes, soil constituents are organized into visibly, structurally, and chemically distinct layers called *horizons*, each of which is characterized by differentiation in minerals, particle sizes, colors, and organic constituents. Topmost layers contain the greatest amount of organic material, while lower layers contain accumulations of fine mineral particles that have been leached down through the soil column by water percolating through it.

Some soils, called *residual soils*, originate directly above the rock from which they derive. Others, *transported soils*, develop from material that has been removed from the parent rock and deposited elsewhere by the action of wind or water. *Organic soils*, such as peat, are composed principally of decomposed organic matter. The active processes of soil formation and development transform these materials into the growing medium supportive of terrestrial life.

Soils are usually described by the texture of their dominant mineral constituent, such as sand, silt, or clay particles. Sand particles are the largest of the soil minerals, and clay the smallest. Each of these soil particles

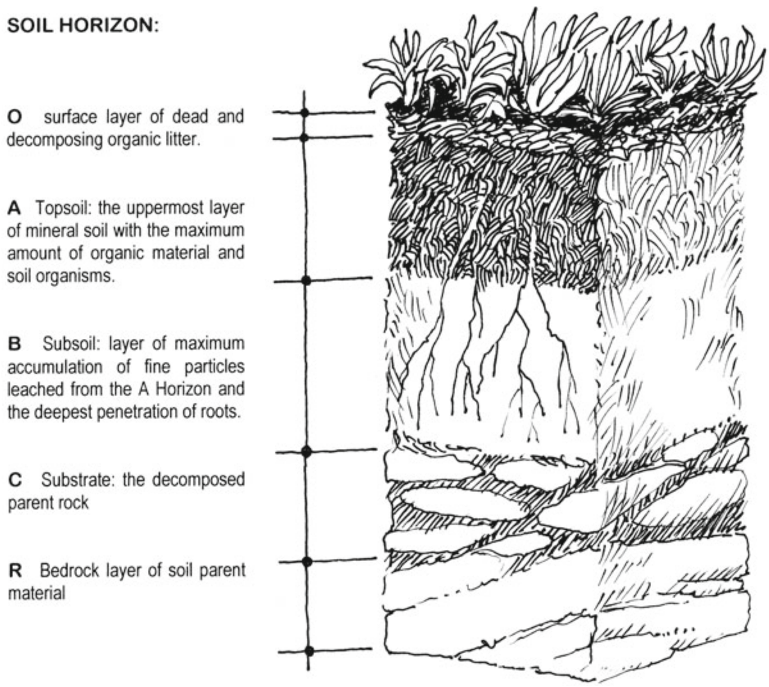

Figure 3-2. *Typical soil profile. (Source: USDA Natural Resources Conservation Service.)*

imparts different textural properties to the soil; coarse, sandy soils are characteristically loose and highly permeable to moving water, whereas fine-textured clay soils tend to be plastic, dense, and slowly permeable. Soils that combine sand, silt, and clay particles in roughly equal textural contributions are referred to as loam.

But a soil is more than its mineral constituents. It is a complex of minerals, air, water, microorganisms, and living and decaying organic matter. One of the important organic constituents of the soil is *humus*: a dark-colored material derived from decaying animal and vegetable matter but lacking in the recognizable characteristics of any of its contributing constituents. The uppermost segment of the soil column, known as the *soil biomantle*, is the region where most soil and near-soil biota exist. In the processes of living and reproducing, these organisms perturb the mineral stratification of soil to create a critical zone of the biosphere that forms the planetary interface between the Earth's five global spheres: the pedosphere (from *pedon*, Greek for "soil"), atmosphere, biosphere, hydrosphere, and lithosphere as they interact to influence the Earth's life-sustaining processes (Johnson et al. 2006). As a consequence of the critical relationship between soil and life, maintaining the health and genesis of the soil through the actions of plants, burrowing animals, insects, and microorganisms is an essential but often overlooked link to sustaining a healthy landscape.

Biologically productive soils ideally comprise some approximation of 45 percent mineral matter, 5 percent humus, 25 percent pore space, and 25 percent water (Tarbuck et al. 1996). Soil is best understood as a complex ecosystem made up of minute plants and animals coexisting in relationship with their mineral matrix. An ounce of fertile soil contains millions of microscopic organisms representing thousands of different species, such as algae, bacteria, fungi, and protozoa (Kohnke et al. 1995).

Understanding the landscape and predicting the results of design change requires attention to both long-term and short-term geologic processes. The long-term processes establish the base condition that designers have to work with, while the short-term processes are the conditions they influence in reshaping the landscape. Soils are among the first and most fragile components of the environment to be affected by any type of development. Recognizing the value of soil and maintaining its viability is one of the highest priorities of sustainable landscape development.

Hydrology

The availability and movement of water are among the most critical influences on the nature and character of a landscape. Because all aspects of life are dependent on water, understanding the likely behavior of the hydrologic regime is one of the most critical areas of knowledge available to improve or sustain the quality of landscape.

The **hydrologic cycle** describes the continuous circulation of water through the biosphere (Tarbuck et al. 1996). This process, powered by the energy of the sun, provides the vital link between the oceans as global reservoirs and the continents with the water demands of their terrestrial ecosystems.

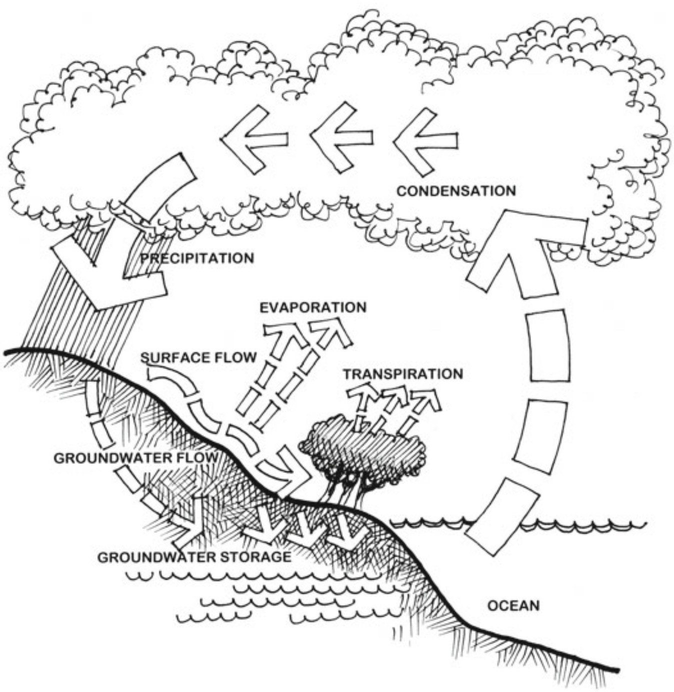

Figure 3-3. *Hydrologic cycle showing movement of water through the global environment.*

The landscape relief in which we live—mountains, valleys, plains—is a direct reflection of the movement of water as it traverses the face of the landscape. The form of hills and valleys reveals the paths of streams carving into the land surface and carrying eroded material to lower elevations where it is deposited downstream. Streams cutting across a steep gradient incise deep, narrow channels in the landscape, removing surface material rapidly and transporting it downstream to be deposited in lower-lying valleys or coastal deltas. The Grand Canyon of the Colorado River is an exceptional example of this kind of actively cutting or "youthful" river channel (see fig. 3-4). In broad valleys with a gentle slope, repeated flood deposits accumulate to build and enrich the soil and replenish nutrients and moisture. When runoff exceeds the capacity of stream channels, streams overflow their banks and inundate the surrounding valleys. Once this happens, the floodwaters, unrestricted by the confines of channels, lose their velocity and no longer have the capacity to hold excess sediment in suspension. When these particles precipitate, a thin layer of sediment is deposited over the valley floor, producing new soil. Each flooding event contributes to a continuous raising of the valley floor, and over time, creates an increasingly level plain and streambed—a plain created by repeated flooding. As the gradient of the floodplain levels out, the river, finding less gradient over which to flow, begins to meander across the nearly level valley floor (see fig. 3-5), lengthening its channel, and thereby increasing its water-carrying capacity, thus reducing its frequency of flooding.

As meandering streams continuously move across the floodplain, they carve into the outer banks of channel curves and deposit materials on their inner banks. Channels shift laterally due to cutting from the differential in water-flow velocity in the stream course. The water on the outside of the curve is deeper and moves more swiftly, eroding sediment that is deposited by the slower-moving water on the inside of the bend. The progression of these *cutbanks* and *point bars* slowly but constantly shift the location of streambeds in response to these cutting and depositing actions. The Mississippi River Valley is an example of this kind of depositing or "mature" river channel. Streams express these cutting and depositing processes in both the contour of the landscape and the nature of the soils that are found in different positions on the land surface. Deep floodplain

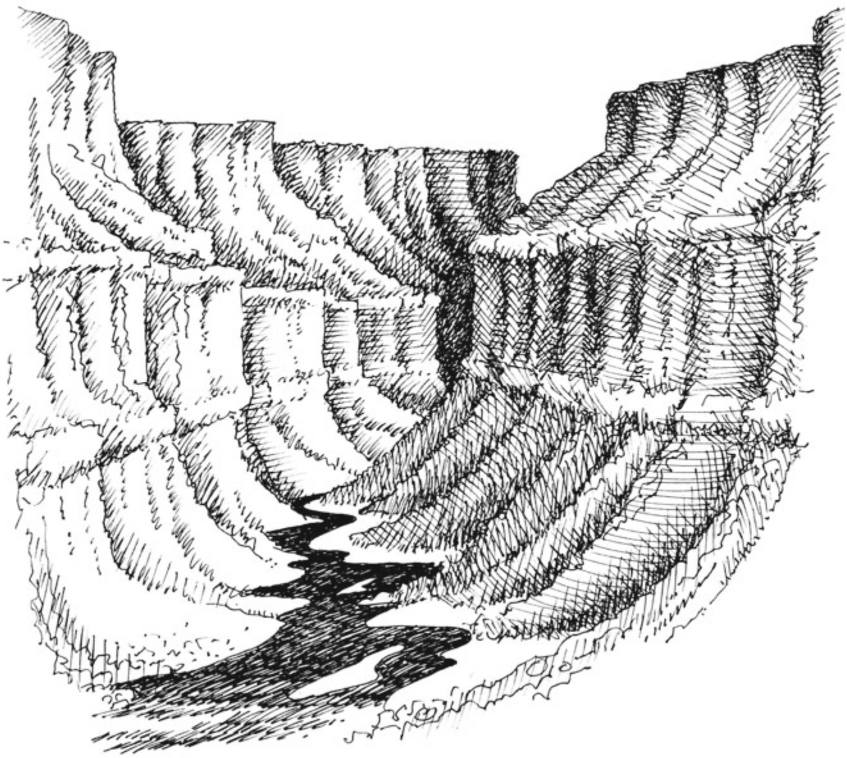

Figure 3-4. *View of the Grand Canyon showing how, over millions of years, the Colorado River has incised a vertical depression into the Earth's surface. (Source: adapted from Ranney 2012.)*

deposits are found in low areas; thin, coarse-textured soils on steep slopes; and well-developed soils of moderate depth on level ridges and terraces.

Corresponding with these general topographic conditions and their associated soil patterns are related patterns of vegetation and wildlife. Low-lying flood zones tend to have the greatest scale of vegetation and diversity of species due to the extended periods of continuously available moisture and the deeper, better-developed soil structure and fertility created by the frequent nourishment from flood deposition and increased organic accumulations. The greater the soil's water-storage capacity, fertility,

Figure 3-5. *Meandering river pattern in a floodplain.*

and depth to anchor plant roots and supply nutrients and moisture, the larger and taller are the trees found on them. Unlike youthful, actively cutting streams, which tend to be more linear and sharply incised, these relatively level, mature (that is, depositing) riverbeds meander constantly across the ever-deepening soils of the floodplain, sometimes cutting off river bends to leave oxbow lakes.

The material eroded from stream channels and the watersheds they drain is transported as dissolved suspended sediment and baseload, shifting the landscape seaward in a constant process of lowering mountains and building alluvium (soil material deposited by streams). The general landscape patterns created by this process are comprehensible, and they inform the careful observer of both past events and, significantly, of potential future activity in the landscape. It is only on the basis of predictable future conditions that designers can reliably organize human activities in the landscape to enhance benefits and avoid catastrophic loss. As an example, the Rio Grande boundary between Texas and Mexico was once altered by a shift in the riverbed that removed about one square mile of land from Mexico. The use of a dynamic landscape feature to demark a static political boundary led to a century-long dispute over jurisdiction (Hammond 1935).

One of the most overlooked aspects of hydrology is the flooding potential along major stream courses and drained wetlands. Each year, floodwaters inundate towns and cities during the spring thaw or rainy season. And each time there are renewed commitments to send relief to those who have been inundated. Unfortunately, those who are flooded out of their homes are often found to be living in floodplains or poorly drained areas that are known to experience periodic flooding. In addition to low-lying land, there also are steep areas destabilized by cutting and filling operations that concentrate runoff and direct it into areas where flooding was previously unknown. Also to be considered is the exacerbation of flooding by excessive paved surfacing in urban zones, creating increased runoff and flooding at levels and frequencies that did not exist prior to development. Avoiding or removing settlement from these areas is rarely contemplated. Identifying the limits of the floodplain—which is clearly expressed by topographic relief, vegetation patterns, and soil characteristics—can guide new development to avoid such disasters.

Climate

Attention to the influence of climate on ecosystems has intensified in recent years in response to problems with flooding, growing water demands, and changes in global climate patterns. Designers have the opportunity to use climate information to better integrate human activities into regional climatic regimes as well as to improve local human–landscape relationships.

The UN Commission on Sustainable Development has warned about the potential severity of problems posed by climate change (2007). Among the potential threats they describe are coastal flooding, heat waves, drought, accelerated species extinction, and the challenge of providing food and water for an increasing global population.

Climate conditions vary according to a number of factors: insolation (solar radiation), humidity, wind, elevation, latitude, and many others. One of the most influential climatic factors is seasonal change. This

Figure 3-6. *Landscape engulfed by wind-blown soil due to short-term climate change on the American Great Plains during the Dust Bowl of the 1930s. (Source: Library of Congress Prints and Photographs Division.)*

annual cycle of warming and cooling results from uneven heating of the Earth's surface throughout the year (Molles 1999, 16). Two factors account for this. The number of hours during which the Earth receives solar radiation during the seasons varies, with longer days and greater exposure during the summer and reduced exposure during the shorter days of winter. The Earth's surface is heated during the day and cools during the night. In summer, there are more daylight hours than dark, and in winter the situation is reversed. The imbalance between diurnal and seasonal heating and cooling is one reason for the alternating seasons (see fig. 3-7).

The other factor has to do with the angle at which radiation strikes the Earth. Radiant energy, which may be conceived as parallel solar rays striking the Earth's surface, is most concentrated and delivers the greatest heat energy when the sun is directly overhead—that is, when the angle of

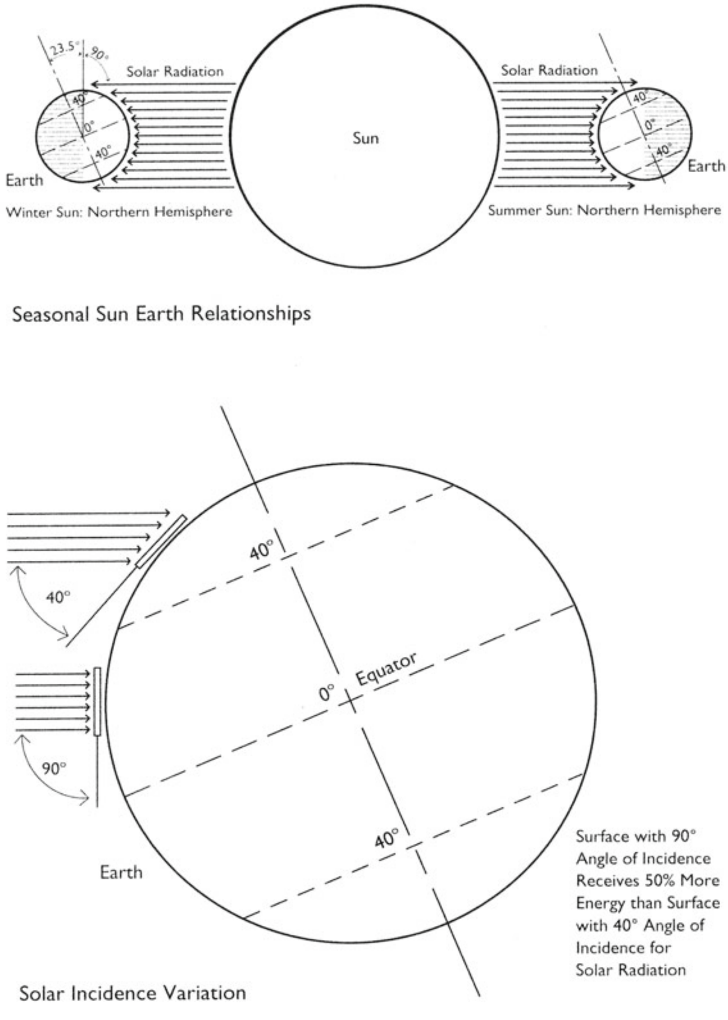

Figure 3-7. *Sun-angle relationships to the Earth's surface.*

incidence between solar radiation and the Earth's surface approximates 90 degrees (Marsh 1998).

Knowing the seasonal pattern of temperatures, sun angles, and day length gives designers a level of predictability not only about temperature but also about where sun or shade may be expected throughout the year and whether or not it would be beneficial for an activity to be protected or exposed (see fig. 3-8). This information enables the organization of a site to arrange human activities and urban features to take advantage of solar radiation in winter when it is desired and to provide shelter in the summer when it is unwanted (White 1960; Olgyay 1973).

The utility of this information is illustrated by the design and orientation of a simple house, using sun angles to determine the arrangement of building form and the placement of sheltering roofs, shielding walls, and window openings to optimum solar-energy advantages (see fig. 3-9). The application of knowledge of the environment to improve design performance is illustrated by the design and siting of a building to allow sun penetration during the winter for interior warmth and illumination and to block direct sunlight entry during the summer to preclude excess interior heating. Careful planning and design allows for significant climate amelioration with minimal reliance on mechanical heating, cooling, and lighting systems (White 1976). Reducing the energy required to operate these supplementary systems, and the consequent addition of thermal and chemical pollution that results from them, could significantly improve comprehensive design performance.

The sun angles for a site can be calculated for the solstice and equinox days with simple formulas (Degelman 1998). The formulas are applied to calculate local sun angles for College Station, Texas (at 30°N latitude), as shown below and illustrated in figure 3.8.

- Midday sun angle above the horizon for the summer solstice, June 21 : 90° – latitude (of site, in degrees) + 23.5° (declination) = sun angle at noon (in degrees); hence: 90° – 30° + 23.5° = 83.5°
- Midday sun angle above the horizon for the winter solstice, December 21 : 90° – latitude (of site, in degrees) – 23.5° = sun angle at noon; hence: 90° – 30° – 23.5° = 36.5°
- Midday sun angle for the vernal/autumnal equinox, March/September 21 : 90° – latitude (of site, in degrees) = sun angle at noon; hence: 90° – 30° = 60°

In addition to these ordinary applications of climate information, designers also must consider climatic extremes and exceptional events. By

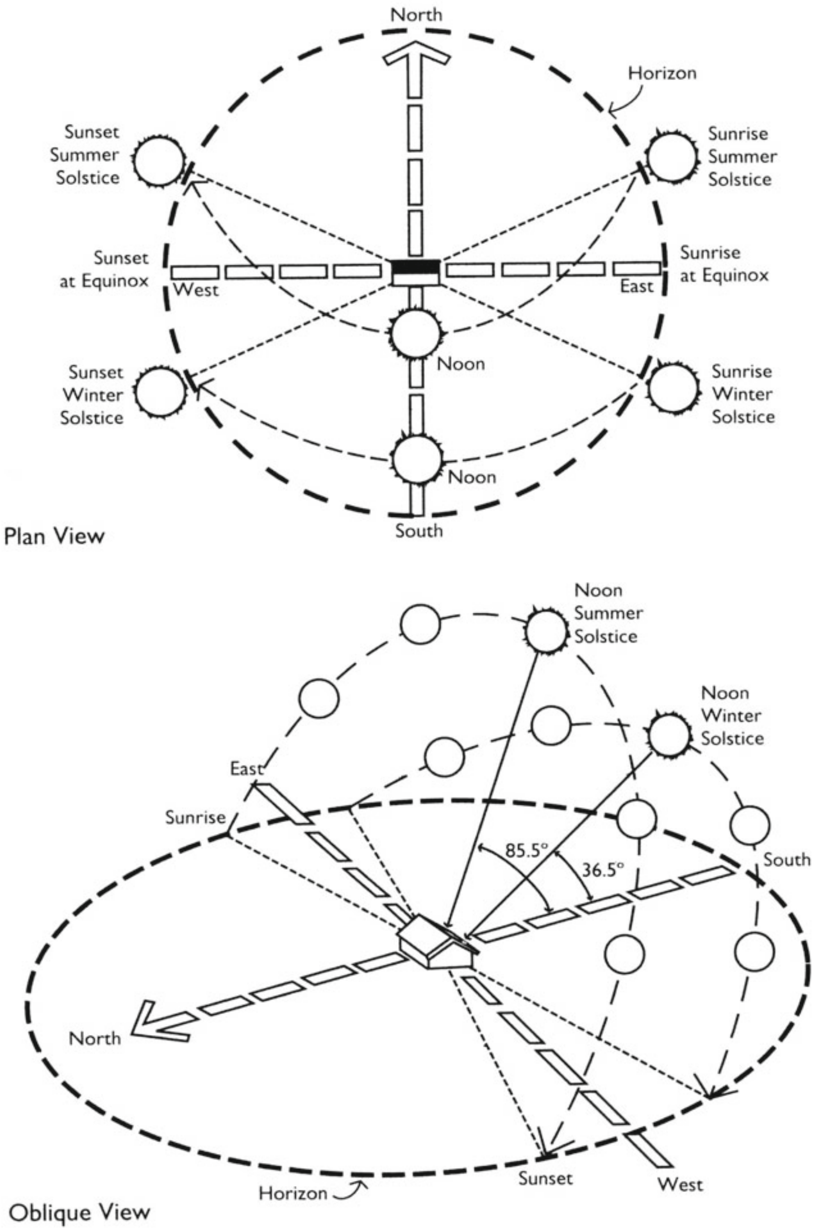

Figure 3-8. *Seasonal variation in sun angle and radiation intensity on the Earth's surface and its impact on buildings (Byrne 1974, 28, 29; Marsh 1998, 299).*

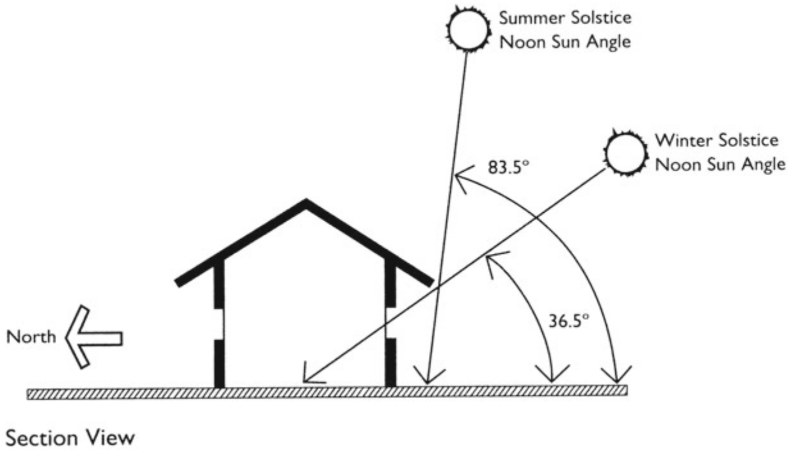

Figure 3-9. Building cross-section showing contrasting shelter and penetration of radiation at different midday sun angles during summer and winter solstices (Marsh 1998, 299; Olgyay 1973, 144).

hard experience, designers have become aware of the need to understand the effects of wind patterns that foster wildfires, rainfall that precipitates flooding and mudslides, and violent storms such as hurricanes that down power lines and threaten coastal areas. Designers cannot alter these climatic patterns, but they can employ knowledge of them to determine where best to locate (or not locate) human activities in order to limit the destructive effects of relatively predictable climatic events or take remedial actions to reduce their negative effects.

Biotic Conditions

Organisms exist in the landscape where they are able to adapt to the unique circumstances of a particular environment, where life-sustaining conditions exist at the specific levels they require—arid deserts or moist tropical rainforests, for example. The physical attributes on which terrestrial life depends include heat, light, water, air, and nutrients. Collectively, these factors constitute the limiting factors for life. The interrelationships among these factors establish the environmental context in which organisms occur and to which they are most adapted or "fit" to survive.

Due to the complexity of conditions on the Earth's surface, influenced by latitude, elevation, seasonal variation, proximity to water, etc., each landscape presents a slightly different set of conditions and, as a consequence, creates an environment with its own distinctive populations of plants and animals.

Plants, and the patterns in which they are distributed, are among the most obvious features of the landscape, and for this reason they have a pronounced influence on the character of the landscapes we perceive. For example, an open prairie landscape is profoundly different from a closed forest. Our image of a tropical island is defined by the presence of palm trees along a beach shore. We tend to think of plants as the defining element of these landscapes. But another way of thinking about landscapes is to view plants as indicators of underlying order, and species-distribution patterns can be understood in relation to the physical aspects of the environments in which they occur. The presence of certain plants indicates the availability of moisture, soil fertility, temperatures, and length of growing season, whether the soils are deep or shallow, wet or dry, fertile or sterile, acidic or alkaline.

Climate is one of the most important, and most obvious, factors in the establishment of plants and animals in the landscape. Sunlight and moisture are critical considerations governing the success of plants in a particular environment. Sunlight can be either intense or diffused, it may result in high temperatures or low, and it may be available for longer or shorter seasons. According to the **principle of limiting factors**, the maximum amount of organic production possible in a landscape is limited by the critical resource that is least available (Smith et al. 2015). That is, the most deficient factor (temperature, moisture, fertility, etc.) will govern the productive potential of the landscape. The organisms found in the landscape reveal the conditions presented by its unique combination of these limiting factors.

Vegetation

Vegetation is one of the most obvious features of the landscape, and the patterns of plants, as they are distributed throughout the landscape, are the most visible expression of the landscape's biophysical structure. They also are one of the most significant features of landscape design. Plants' growing conditions result from different combinations of the landscape's climate, soil, relief, and exposure. Low-lying areas, for example, may have greater soil moisture than hilltops or south-facing slopes with greater sun exposure than north-facing slopes. Plants reflect these different conditions in nature, and when similar patterns of species are used by design, the landscape reinforces the spatial arrangement as well as the function of the landscape. When plants are used in conditions that are not naturally supported—such as planting tropical species in an arid environment—they require additional resources to assure their survival. If the mismatch between species and growing conditions is too great, an intended planting arrangement cannot be sustained.

Indigenous species are the plants for which natural evolution has created the most-fitting relationships for survival in any landscape. Although it is rarely necessary to rely completely on indigenous plants in design, neither should it be necessary to avoid them completely. When indigenous plants are employed to form the skeletal structure of a design's planting scheme, they provide reliable performance over the extended period of their expected use—so long as the conditions on which they rely have not been significantly altered by, for example, soil depletion or loss of sufficient water resources. Furthermore, plants used in locations conducive to their viability support the design's capacity for self-regeneration, extending its presence as an enduring pattern in the landscape. This is particularly true when there is adequate species diversity to maintain or enhance landscape resilience. But even when native or well-adapted introduced species are used in design, short-term changes in landscape conditions, such as flood or drought or abnormal temperatures, can make them difficult to establish or sustain. When introduced plants require exceptional resources, such as supplemental fertilizer or irrigation, they have the potential to bring about unanticipated alterations in the ecosystem as a whole.

In the United States, nearly a third of all domestic water consumption goes to landscape irrigation, and in summers the amount of domestic water used out of doors can exceed that used for all other purposes during the entire year, especially in areas with hot, dry climates. Due to inefficient delivery and management practices, as much as half of that water is thought to be wasted (Environmental Protection Agency 2014).

Employing vegetation as a material in the landscape is an important area of design consideration, and one for which certainty cannot be assured. Reliable plant selections are made on the basis of extensive knowledge of the landscape and the species available for use within it. This is an important consideration under normal conditions. Under conditions of adversity, such as drought or limited availability of water, it becomes a necessity.

One of the critical aspects of plant use is to ensure that the health of the landscape is not jeopardized by the introduction of species that impair or destroy local habitats. In addition to altering the water regime of an area, introduced species can impact habitats negatively by becoming invasive, displacing the indigenous plants needed by wildlife for their food sources and nesting cover. Introduced plant species also have the potential to serve as hosts for other organisms, bringing with them pests harmful to local species. The introduction of invasive exotic species, usually by misguided design intent, represents one of the most destructive changes to many regional landscapes. The competitive vigor of introduced species, with their absence of evolved predators or other ecological relationships, can lead to wholesale changes in local vegetation patterns as the invasive species gradually displace those on which local wildlife (insects, birds, amphibians, reptiles, and mammals) rely. Such changes cascade through the ecosystem, affecting all the other organisms adapted to and reliant on the former vegetation patterns.

In some instances, an invasive species is successful because of its ability to outcompete indigenous plants for water or nutrients. In cases where plants highly efficient in withdrawing groundwater become extensive, they can rob the soil of groundwater on a vast scale. Dense stands of invasive acacia or eucalyptus in riparian zones have been found to increase water consumption to the extent that they dry springs and lower water tables and the seasonal levels in streams (Richardson et al. 2007). In the arid and semi-arid American Southwest, the mesquite tree has expanded its range and species dominance significantly over the last 150 years of intense grazing and has become a serious competitor with grasses used

Figure 3-10. *Stands of exotic eucalyptus trees such as these in California withdraw groundwater and increase wildfire hazard. (Source: Library of Congress Prints and Photographs Division.)*

for livestock forage (Olmsted 1857; Bedunah et al. 1984). In California, invasive eucalyptus stands increase wildfire hazard.

To successfully introduce and sustain vegetation in the designed landscape, the designer must command considerable knowledge of the conditions on which these plants rely and have access to the resources, particularly water resources, they require to thrive.

Wildlife

Another of the landscape's most apparent features is animal life. From a strictly ecological perspective, wildlife, like humans, may be thought of as merely different categories of the biota. However, our anthropocentric frame of reference presents practical reasons for dealing with them separately. Thus, wildlife is dealt with here and people are discussed in the following chapter.

Wild animals are also one of the landscape's most engaging features; as humans, we delight in watching many types of wildlife in natural habitat. Alternatively, a landscape devoid of wildlife appears sterile and lifeless. As Rachel Carson eloquently described in *Silent Spring* (1964), the arrival of a season without birdsong would be an alarming and morbid prospect.

Some of the most important functions of wildlife are the roles these animals play in processes such as plant pollination, germination, and seed dispersal. They also serve to build and improve soils through waste breakdown, soil genesis, and nutrient cycling. Through predation, wild species contribute to pest control and habitat maintenance. Birds can be critical in controlling insect pests. Woodpeckers, for example, have long been recognized as important predators in reducing outbreaks of insect pests, such as the codling moth larvae that damage apple orchards and timber forests (MacLellan 1958; Buchmann et al. 1996). In this role, wildlife plays a significance part in maintaining and preserving habitat and genetic diversity. In areas where large predators such as wolves have been removed, abnormally increased elk populations and the intensity of their winter browsing have resulted in declines in willow density and aspen-stand regeneration (Zeigenfuss et al. 2002; 2008), reducing species diversity and landscape stability.

A balanced wildlife population contributes to the resilience necessary to ensure that resource production remains stable and the system has resistance to threats that might be caused by ecosystem simplification and fragmentation (United Nations Environment Program 1992; Savory et al. 1999).

One of the most valuable ecosystem services is that of nutrient recycling. Due to their mobility, wildlife species have the ability to transport nutrients across ecosystem boundaries (Cederholm et al. 1999). Predators such as eagles, kingfishers, cranes, and other birds that prey on fish function to extract and redistribute nutrients that have accumulated in aquatic ecosystems and return them to terrestrial habitats. Salmon, which spend a substantial portion of their life cycle in the ocean, function to concentrate and return nutrients that have been washed out to sea. They complete the return cycle of nutrients that have passed out to the ocean through downstream flow by carrying them back to the landscape when they swim upriver to spawn (Vanni 2002). Predation by bears and other animals, in turn, returns the nutrients that salmon have accumulated during their time at sea by redistributing them widely in the landscape through their excretions.

It is important to recognize that people do not just share the landscape with other species. People exist because other species and their interactions have created the habitable environment. To preserve our living environment means that we need to conserve other species as well. To conserve wildlife, the habitat must be protected. And to protect the habitat, the flora and fauna that have evolved as its integral constituents need to be protected as the necessary components of a tightly interconnected system. It is more important that design and management sustain landscapes as integrated ecosystems than as collections of species or populations.

Although we tend to think of organisms as specific plants or animals, they are best understood and provide the greatest understanding of the landscape when viewed through the relationships they bear to one another in their setting. Organisms living together and interacting in a common setting are referred to as an **ecosystem**. To understand biological communities and the relationships they bear to the landscapes that they both create and inhabit, we need to view them as integrated systems of organisms within their physical setting.

Ecosystems

To understand the dynamics of the landscape requires an examination of the ways the biological components interrelate with their physical systems over time. This examination, when conducted methodically and scientifically, is **ecology**—the study of the relationships between organisms and their environment (Haeckel 1866). The biophysical structure of the landscape is described as an ecological system: an integrated whole made up of plants and animals interacting with the physical environment to compete for resources and engage in the chemically interactive processes of energy transformation and material cycling.

The force driving the landscape ecosystem is solar energy. Through photosynthesis, plants convert radiant energy into chemical energy in the form of carbohydrates that are required to sustain their growth and metabolism. Radiant energy, once captured by photosynthesis, passes into the ecosystem to create and sustain its flora and fauna. The ecosystem is an energy-processing system organized by life forms that capture and distribute the energy and materials of the landscape into its organizational and spatial patterns. This is characterized by two basic processes:

- **There is a one-way flow of energy from the sun**, being captured by plants via photosynthesis and transferred through the food chain to the other organisms of the system until it has been locally exhausted.
- **There is a continual recycling of necessary elements** that exist in limited supply and are perpetually used and reused by successive generations of plants and animals.

The flow of energy and materials moves from one energy, or trophic, level to another upwards through the food chain. The energy output of any one trophic level becomes the input of the next, with the amount of energy available for transfer being reduced at each level as it works its way through the system. In rudimentary terms, an ecosystem consists of three components: producer organisms like plants, consumer organisms like animals, and inorganic elements like carbon dioxide, water, nitrogen, etc. Energy capture and transfer, as well as nutrient cycling, are the basic functions of the landscape. To accomplish this function, the ecosystem integrates the landscape's biotic and abiotic components into a highly interdependent system (Forman et al. 1986; Smith 1986).

An understanding of the operations of ecosystems is gained from an examination of three basic considerations: the underlying *function* of the environment, the *structure* of the environment, and the *change* brought about by the interactions of function and structure over time. These are described as:

- **Structure**—the spatial relationships among the distinctive ecosystems or "elements" present—more specifically, the distribution of energy, materials, and species in relation to the sizes, shapes, number, kinds, and configurations of the ecosystems.
- **Function**—the interactions among the landscape's spatial elements; that is, the flows of energy, materials, and species among the component ecosystems.

- **Change**—the alteration in the structure and function of the ecological mosaic over time. (Forman et al. 1986)

The ecosystem's organic and inorganic components exist in a state that has coevolved over a relatively long period of time. Moreover, they remain in a process of continual transition to other relatively persistent states as environmental conditions change (Stringham et al. 2003). Continuous change or disturbance in the ecosystem and its response in order to recover or reorganize itself are not anomalies. Change in the landscape is its normal state. As disturbances occur, due to events such as wildfires or floods, the system continually acts to reestablish its previous condition. Or, when recovery is not possible, new patterns of organisms and interrelationships emerge to replace the earlier condition. This dynamic is a basic characteristic of ecosystems. An ecosystem's ability to resist change is determined by its properties of stability and resilience (Holling 1973; Walker et al. 2004); **stability** indicates a system's ability to persist in its current state, while **resilience** refers to a system's ability to absorb change in response to disturbance and to return to its former state through learning and renewal (Folke et al. 2002). An ecosystem's ability to recover from disturbance and return quickly to its prior state is a measure of its stability.

Because landscapes with resilient characteristics tend to recover easily, one of the aims of planning and design is to incorporate these characteristics into managed landscapes in order that they might respond favorably to these normal but unpredictable changes. Conversely, one of the challenging aspects of designed change is to prevent a previously stable landscape from reverting to its previous state after it has been intentionally altered. One example of how this is avoided is through the incorporation of materials, such as indigenous species, that are well adapted to the landscape's natural conditions, which may include periodic episodes such as floods or drought. Another example is through continuous maintenance to retain the landscape in a desired state. Because systems are constantly changing, resilience becomes a vital strategy, not for preserving a current state but for ensuring that the ecosystem can recover quickly after the change that, while unpredictable, is certain to take place.

One explanation for how ecosystems transition from one state to another is described as **ecological succession**: the progression from a relatively simple array of organisms and species structure toward a more complex condition (Connell et al. 1977). The "strategy" or role of succession and resilience in ecosystems is to increase control of the physical environment and enhance protection from disturbance (Odum 1969). One of the main ways an ecosystem does this is by increasing species diversity, complexity, and interconnectivity. The cultural analogues of succession and resilience are seen in urban systems whereby villages become towns and then cities, and in economic systems whereby investment is diversified to "scatter the risk," or in diversified agriculture or mixed-use land-development concepts.

Although ecosystems do not always proceed via linear development, when they do, the process of succession is expressed as a series of transitory communities, the simple pioneer communities being replaced by progressively more complex and stable ones over time. These sequential ecosystems with their increasingly complex patterns of plant and animal communities are called **seres**. Each sere provides for itself by accumulating and organizing increased energy and organic matter, and also for its eventual replacement by creating an environment of improved suitability for the survival of higher-order plants and animals that invade and eventually dominate the system. For example, as plant litter accumulates from the decomposition of simple plants, the structural and nutrient characteristics of the soil improve, providing a habitat conducive to a more-complex species structure with longer-lived plant and animal species.

As ecosystems evolve toward greater complexity, they eventually reach a stable, or **climax**, condition beyond which succession can no longer continue, due to the intrinsic limitations of the environment: soil fertility, moisture, temperature range, available energy, periodic flooding, the presence of fire, or other factors. The coastal redwoods in California provide a classic example of a climax forest. This semi-permanent condition will exhibit the maximum extent of photosynthetic production, species diversity, and species stratification possible in that landscape. Once established, this condition remains until it is disturbed by an action due to natural conditions, such as climate change, or by alteration due to human influence, such as cultivation or atmospheric pollution.

Nutrient-cycling processes and ecosystem complexity illustrate how the ecosystem creates and sustains the conditions and viability of life. It is vital to our long-term interests that the ecosystem be managed to incorporate and protect complexity, resilience, and stability. It is rare, however, that landscape change is undertaken with the maintenance of these conditions in mind—very likely due to our failure to understand the critical necessity for doing so. One way this problem is being approached is through the development of the discipline of landscape ecology.

Landscape Ecology

The recent emergence of **landscape ecology** as a research discipline reflects an awareness of the practical value of a whole-landscape perspective for managing natural or human systems. Landscape ecologists, responding to the growing evidence of ecologically destructive land-use and management practices, have begun to develop systematic methods for understanding landscapes. On the basis of improved understanding of the landscape's structure and function, landscape ecologists hope to improve the ways we design and use the landscape—including urban landscapes—to protect ecosystems, and in particular, to retain and increase their biodiversity as a key ingredient of their continued health and productivity. Understanding the mosaic of the landscape is based on detailed investigation of a few key factors (Ahern 1989; Dramstad et al. 1996). These are characterized as:

- **Matrix**—the general organization of interrelated patterns, such as grasslands, savannas, or forests, collectively forming the overall character of a landscape with a primary role in determining landscape function.
- **Patches**—the nonlinear, unconnected elements of the landscape that are distinctively different from the surrounding matrix and provide habitat opportunities when they are large enough to possess significant interior areas. Examples include wetlands within a prairie, or rock outcrops within a forest.

- **Corridors**—the linear elements of the landscape that differ from the surrounding matrix and often function to connect patches and extend habitat opportunities where separation exists. Examples include streams with wooded margins passing through grasslands or deserts.
- **Edges**—the outer boundary region of patches or corridors where conditions differ from both the interior and the matrix. An example of an edge condition is the interface between grassland and forest, which may contain, in addition to grassland and forest species, some species unique to the boundary region.

Today, habitat increasingly exists as scattered patches of formerly coherent environments that have been reduced in scale and quality by the effects of long-term landscape development and fragmentation. The contemporary landscape is no longer a continuous matrix, but remains as remnants of the original condition disrupted by the activities of agriculture, mining, urbanization, and transportation networks. Understanding the overall structure and function of the landscape as a mosaic of dynamic patches, edges, and connections is an important concept for describing ecosystems and, as a consequence, for informing resilient design and management interventions. Urban greenway corridors are a contemporary example of designs intended to maintain the ecological mosaic and connectivity between patches (Fabos et al. 1995). As a consequence, these greenway systems also retain the natural dynamics of form among their interior patch and corridor areas.

Today, patches are roughly analogous to islands of habitat remaining as isolated fragments of the original condition within the developed landscape. The character of the patch boundary creates an edge effect that influences the flow of nutrients, water, energy, and species along or across it. In general, the longer the patch boundary—the more irregular the form of the patch—the greater its influence on maintaining flows across the boundary to the matrix or other patches. The shorter the boundary and the more regular the form of the patch, the more restricted the opportunity for flow.

As patches become separated and isolated, the corridors that provide connections between them become increasingly critical to the sustainability and health of the ecosystem as a whole. These conditions are observed in both natural and urban ecosystems. In natural landscapes, we find stream corridors connecting separated areas of forest habitat for wildlife. In urban settings, we find bridges connecting neighborhoods bisected by thoroughfares or rail lines. In each case, the corridor serves the same ecological function of preserving community interactions between the separated areas of patch condition.

Unless designs for urban systems integrate with the landscape to sustain biological diversity, consume energy and matter creatively, and maintain vital ecosystem networks and material recycling, we cannot expect them to result in the kind of healthy, flexible, optimizing systems required for sustained landscape use.

Figure 3-11 *Pedestrian bridge at Thesen Islands harbor town, Knysna, South Africa, designed by Chris Mulder Associates Inc./Snyman Roux Structural Engineers, to link residential areas separated by waterways. (Source: Chris Mulder Associates Inc.)*

Goods, Services, and Processes

Society derives many benefits directly from the environment, as well as many more that are indirect and less immediately obvious, often to the extent that they are simply taken for granted. Because these benefits have always been there, we tend to think they always will be. But that assumption may no longer be valid. As the environment changes, so might the availability of things we rely on from it. The environment must be creatively and intelligently managed if we are to assure the continuation of critical resources. Understanding the ecosystem's processes and products is the first step to effective management.

A useful way of describing the benefits of ecosystems is to identify the *goods*, *services*, and *processes* they provide. **Ecosystem processes** are defined as the fundamental maintenance activities (water cycle, mineral cycles, energy flow, and community dynamics) required to keep the system operational. **Ecosystem goods** are the products of these processes, things with direct consumptive value (pure water, food crops, timber) that are extracted from the environment and exchanged for economic return. **Ecosystem services** are the functions that have direct value but are rarely exchanged for monetary benefit. The Millennium Ecosystem Assessment (2005) identifies three categories of *in situ* ecosystem services: *provisioning services* (providing food, fresh water, fuel, wood, and fiber), *regulating services* (providing climate regulation, water filtration, air purification, waste decomposition, crop pollination), and *cultural services* (providing aesthetic, spiritual, educational, recreational functions). The landscape's ecosystemic processes, goods, and services required to support life are outlined in table 3-1 (Lubchenko et al. 1991; Richardson 1994; Ecological Society of America 1995; Daily 1997).

The value of ecosystem goods, services, and processes extends beyond concerns for environmental health. The magnitude of economic benefits, although largely unappreciated, is enormous. Economists have estimated that the annual value of ecosystem services alone is over $30 trillion globally, and as much as $300 billion to the United States alone (Costanza et al. 1997; Pimentel et al. 1997; Southwick et al. 2003).

Table 3-1
Ecosystem Processes, Goods, and Services

Ecosystem Processes:	Hydrologic dynamics and storage
	Biological production
	Biogeochemical cycling and storage
	Decomposition of waste
	Maintenance of biological diversity
Ecosystem Goods:	Food and water
	Medicinal plants
	Raw materials for construction and manufacture
	Fuel for domestic and industrial heat
	Wild genes for domestic animals and plants
	Tourism and recreation
Ecosystem Services:	Maintaining hydrologic cycles
	Regulating climate
	Cleansing air and water
	Maintaining the gaseous composition of the atmosphere
	Maintaining ecological diversity
	Forming, maintaining, and developing soils
	Pollinating crops and other important plants
	Storing and cycling essential nutrients
	Absorbing and detoxifying pollutants
	Protecting plants and animals from harmful radiation
	Providing a source of beauty, inspiration, and knowledge

Human Impact on Ecosystems

North America was changed profoundly after European colonization began in the seventeenth century (Mann 2005). Between 1800 and 1900, some 500,000 square miles of virgin forest were cleared to make way for settlement and agriculture. And although forests have returned in many of the less arable regions, the soils, ecosystem complexity, and species composition have been irreplaceably degraded from their pre-Columbian condition. Many of the original species have since become extinct due to active destruction or from the unintended results of habitat loss or disease and pest invasion of weakened ecosystems. Tragically, and in direct conflict with the goals of commerce, much of the agricultural land created by the clearing of forests has been lost during the intervening period due to poor land-management and agricultural practices. Significantly, these impacts of exploitation and urbanization have not only continued, but increased due to relentless population growth. Species destruction has been accelerated due to a combination of five interrelated factors, all as a consequence of human actions to exploit the landscape: increased demands of a growing human population, over-harvesting, habitat destruction, pollution, and invasion by exotic species (Wilson 2002).

Much of the American landscape was altered because it was perceived as unproductive. Wetlands, among the most productive landscapes on Earth, have long been considered, erroneously, as wastelands to be "reclaimed." By failing to understand the complex webs of life and the energy that originates or cycles through different types of ecosystems, people have failed to understand the value of landscapes that produce no directly recoverable benefits. As a consequence, more than 50,000 square miles of wetlands have been destroyed, with agriculture accounting for 75 percent of the loss (Marsh 1991). Since European colonization, over half of all US wetlands have been destroyed, with a continuing loss of 24,000 acres per year (Revkin 2001). Loss of wetlands reduces biological diversity and productivity, reduces the landscape's potential for carbon sequestration, and leaves coastal communities vulnerable to storm damage and flooding, as was seen in 2005 when Hurricane Katrina killed over 1,800 people along the Gulf of Mexico.

The loss of biodiversity is reaching alarming proportions as well. Among closely monitored species, there was a 30 percent decline between 1970 and 2005. Nearly 25 percent of the world's mammals, 30 percent of amphibians, and 12 percent of birds are now at risk of extinction (Vié et al. 2009). The current rate of species loss is estimated to be some 1,000 times the natural rate of extinction. As James Tutchton put it in testimony before the US House Committee on Natural Resources Oversight: "The impact of 7 billion humans on species diversity is comparable to that of the asteroid that wiped out most of life on Earth 65 million years ago" (Tutchton 2011).

Typically, we do not design to promote synergies among natural and built landscapes or to improve the health of the ecosystem. Species and environments that are not understood to provide direct benefits to society are often the casualties of neglect or active destruction. Consequently, the inadvertent influences of utilitarian development—such as optimizing production from timber forests or cropland—are more often ecosystem impairments than improvements. Although the impacts of human activity are intended, and are often considered to be improvements, careful observers have long understood that there are problems as well as benefits with the way we use the landscape.

Well-developed ecosystems exhibit characteristics of complexity, resilience, and stability. Their energy accumulations tend to be diffused throughout the species structure of the biomass. Consequently, there is little buildup of "excess" energy in any particular segment of a mature ecosystem, primarily because of the system's increased energy requirements to maintain itself in its current state (Odum 1969). A great diversity of life forms precludes the accumulation of energy surplus beyond what is required to maintain equilibrium in any particular species or trophic level. The benefit of this is that, by evolving to optimally sustainable levels of complexity, the ecosystem as a whole gains resilience and stability. In ecosystems under human management, however, biomass complexity is typically reduced in order to increase energy accumulations and extraction for food and fiber in a few species such as cereal crops, fruit, timber, or livestock. This energy "surplus," developed in the lower trophic levels, is then extracted to support increased human consumption, with the intention of improving stability for a growing human population. Unfortunately, this approach, taken to its extreme, runs counter to the requirement for maintaining the viability of the system as a whole and may, in the long run, lead to structural and functional instabilities, not just for the ecosystem but also for human populations dependent on it.

For most of human history, survival depended on the immediate satisfaction of needs for food, water, shelter, and defense. It is only in relatively recent times, with the advent of permanent settlements and agriculture, that humans have lived any differently than other animals and have consciously planned beyond provision for their next meal or season. As a consequence, humankind has developed ingrained patterns of thinking based on short-term rather than long-term considerations. In particular, the longest period of our evolutionary history has not included a requirement to pattern our behavior in relation to its influence on the long-term health of the environment. During most of mankind's time on Earth, the natural environment—wilderness—has been seen as a threat to human existence. A great deal of our collective history is the story of human activity and migration in search of better environments with greater opportunities for resource exploitation. Our understanding of human society and its relation to the landscape has been conditioned by a history of the influence of the landscape on people, not people on the landscape. Even in our recent past, it has not been thought necessary among most Western societies to consider the long-term influence of our actions on the environment. We tend to view the landscape as both powerful and resilient. Nevertheless, evidence shows us this is not the case.

Human society has no established history of providing for the continuing health and viability of the ecosystem. In our collective thinking, the landscape simply exists and we expect that it always will. Furthermore, there is a continuing tendency to see things as they have been seen in the past, in spite of obvious (and often unwelcome) evidence of changes in the landscape and the speculation by many about the unhappy effects these changes may have on future generations. Even though there is ample evidence that the environment on which we depend is either deteriorating or changing in unpredictable ways, we have difficulty in giving it the kind of planning and design attention required to redress its increasingly vulnerable condition. Convention or tradition is the greatest obstacle to future progress. Understanding reality seems to be less a matter of our "believing it when we see it" than of being able to "see it only when we believe it" (Barker 1985). Without conclusive concrete evidence that our paradigm is faulty, confidence in the present understanding, based on past experience and perceptions, continues undiminished.

The most important reason for a comprehensive approach to the protection of the landscape as an ecological system is that we are totally reliant on it to supply our basic needs—both now and in the future. We require a great deal of production from the environment to support our elevated standard of living (by global comparison), as measured by the consumption of energy, cars, houses, technology, year-round fruit and produce, and all the other advantages we have come to expect as a "normal" part of contemporary life. To support a North American life style—the level at which we consume the natural wealth of the ecosystem—each person requires about 7 hectares (17 acres) of productive land to grow food, produce fiber for clothes and houses, provide space for roads and buildings, pump water to drink or otherwise use, and to provide the space needed to accommodate discarded wastes. If we consider that there are 7 billion people on Earth, and only about 9 billion hectares of agricultural land, it becomes clear that there is insufficient land space for everyone to have equal access to the productive capacity of the landscape. If it were equitably distributed, each person on Earth would support him or herself with one and a quarter hectares (about 3 acres) (Wagernagle et al. 1996).

A sustainable future will require careful management of the landscape as a precious natural resource. Moreover, planning and design will have to be based on the most advanced knowledge available. Unfortunately, we as a society have little experience with this kind of planning and we are beginning late. To make matters more difficult, we sometimes distrust the science that helps explain the dilemma we face, since it often conflicts with our previously held views and expectations regarding lifestyle, population growth, climate change, and many other factors.

Our rapidly emerging imperative to care for the landscape, and to do so over the long term, has been with us for too short a time to become established in our collective psyche. As a consequence, even though it is becoming increasingly apparent that our survival depends on it, we cannot easily or quickly change to a new way of understanding the environment or behaving appropriately in our relationships with it. To do so will require creative change in how we think as well as how we behave. But, as Leo Tolstoy said, "Everyone thinks of changing the world, but no one thinks of changing himself." Perhaps the first thing designers must change is not the landscape, but themselves. Or at least how they think about the landscape.

Ecosystem Health

Regardless of the extent of global climate-change influences, it is critically important that design and management of the landscape become more responsive to prevailing and projected environmental conditions, and that design approaches institute safeguards to increase landscape resilience. Providing favorable microclimates within the urban environment, while simultaneously precluding the unnecessary consumption of water and energy for transportation, climate control, or inappropriate plant introductions, needs to become a design priority.

In addition to urbanization, utilitarian extractive processes such as agriculture and forestry explicitly reduce the complexity and diversity of ecosystems in order to increase the productivity of selected species, such as corn or pine, in the lower trophic levels. This is normally accomplished by the displacement of a complex indigenous species composition by a few selected indigenous or exotic species. Even the number of domestic crop species is being diminished. Of the 300 species of corn planted in the United States at the turn of the twentieth century, only a dozen are now cultivated. This simplified industrial process—which prevails in both urban and agricultural landscapes—is facilitated through the transfer of significant water and energy inputs from sources outside the ecosystem into the production and management system. In mechanized agriculture, this is accomplished by the subsidy of petroleum energy, thereby exhausting nonrenewable resources in order to extract renewable ones (Lyle 1994), with the result being increases (perhaps only short-term increases) to the environment's human carrying capacity—increases beyond the level that can be sustained by local or regional resources. When ecosystem simplification becomes too extensive, the stability of the system on which production relies is threatened.

If we are to design the landscape in ways that protect and maintain the basic workings of the system rather than to focus only on efficiency in satisfying direct, narrowly defined human needs, and if we are to employ planning and design processes to break the cycle of resource depletion and ecosystem simplification, fragmentation, and deterioration, then new practices will have to be introduced based on a better understanding of the conditions to be changed and a more comprehensive array of intended performance outcomes. Contemporary motives for changing the landscape tend to focus on the extraction of environmental goods, often at the expense of diminishing environmental services. These goods are extracted to meet our immediate needs, but we will also continue to require the uninterrupted benefit of environmental processes and services. Long-term life-support benefits are being threatened for short-term gains.

Only when the protection of the environment *as an ecosystem* becomes a standard practice of landscape development will designers begin to address these problems at the level and on the scale that they exist. We have not yet adopted this level of concern as a comprehensive professional responsibility, but we have recognized that it is necessary to do so. Now the design professions must learn *how* to do so.

Designers can begin by understanding that each act to change the landscape has a cumulative effect on the system as a whole. If we acknowledge that one of the most common attributes of ecological health is the interconnectedness of natural systems (Dramstad et al. 1996) and its effect on their sustained viability, we may begin to design in ways that assure the continued robustness of these interconnections. Designs for the landscape must assure that development is organized to minimize the disruption of natural systems, just as the natural systems must be managed to avoid disruption of development. By meeting both of these goals, sustainable development becomes a realistic possibility.

Urban Development

Most of the doubling of the world population during the last half of the twentieth century—growing from 3 billion in 1960 to 6 billion by 2000 (US Bureau of the Census 2004, 11)—has taken place in urban areas. It is estimated that, by the year 2020, 75 percent of the world's population will live in urban areas. For the design disciplines, the implications of this growth are profound.

The pattern of urban development in the United States has been particularly influential, not only on the character of the urban environment but also on the character of our evolving cultural experience. During the next quarter century, the living environment for almost half of the urban population will be established. Whether that pattern is one that protects the vitality and diversity of landscape and urban ecosystems, and promotes the physical, social, and emotional health of those who live in those communities, will depend to a significant extent on how well designers are able to keep themselves informed about the changing needs of people and the environment in order to respond appropriately through design innovation.

During the decades following World War II, the landscape was transformed by urbanization through the development of sprawling, fragmented cities with uncontrolled, low-density housing areas that were distant from work, schools, shopping, and community facilities. To achieve this type of development, valuable agricultural land and natural areas were appropriated with little consideration for the effects on environmental quality. Unfortunately, the low-density, suburban character of most contemporary development has maximized its negative impact on the landscape, much of it being irreplaceable, highly productive agricultural land.

In the view of ecologist Eugene Odum (1994), contemporary cities function as parasites that, unlike their successful counterparts in nature, have not evolved mutually beneficial relationships with their life-support host organism (the landscape) that would prevent its destruction and thereby themselves. Contemporary cities draw resources from the landscape but lack the mechanisms to return waste products for recycling and reuse, breaking the ecological cycles on which life relies. While exhausting their landscape base through increasing demands for space and resources, cities are simultaneously diminishing the quality of their air, water, and soil with the mounting accumulation of wastes, hastening urban degeneration—particularly in nonindustrial countries (Lyle 1994). Of greatest concern is that these conditions are the systemic results of the way we currently comprehend, plan, design, and manage the landscape environment; that is, they result from what and how we think about the landscape. Our decision making does not reflect a basic awareness of the way the landscape works or an awareness of our absolute reliance on these systems—an awareness that must change soon if knowledge is to make its way into design decision making in time to prevent the drastic deterioration of the landscape's potential to support society (Yang et al. 2010). But supporting society requires more than the protection of critical resources.

It is particularly important that future design interventions are more efficient and economical in reducing demands on the landscape. Development must require less extensive and costly management and maintenance, encouraging the processes of nature to perform the work of development wherever possible—as when streams are left undeveloped in order to serve as urban drainage ways for storm water runoff and recreation venues. If we better understand the way the landscape functions, we may begin to model development on the successful examples provided by nature. To assure that design changes integrate harmoniously into the landscape, it is necessary to understand the specific conditions into which new designs must fit. To gain this understanding, a number of landscape factors are routinely investigated prior to the formulation of landscape designs. Typical design considerations regarding these factors, such as geology, climate, vegetation, etc., are listed in the online Appendix A at: http://islandpress.org.

Because the biophysical factors of the landscape are dynamic and ever-changing, the principal challenge for the designer is not just to respond to conditions of natural processes as they currently exist and the way different systems interrelate, but to determine their long-term trends and to establish landscape settings that will bring about improvement in conditions as they emerge in the future. In addition to consideration of the landscape's biophysical features and systems, there are equally important social and psychological considerations that, when understood, may be used to inform landscape change. Chapter 4 introduces these human factors in design.

CHAPTER FOUR

The Human Landscape

> *Our looking enters as one of the determinants in the reality event that we see. . . . We know now that our concepts, our notions or basic assumptions, actively direct our percepts. . . . Our mind directs our sensory apparatus every bit as much as our sensory apparatus informs the mind.*
>
> *—Joseph Chilton Pearce*

The designer must understand not only the natural systems of the landscape to be changed, but also the people to be designed for. Although the most pressing reason for designing the landscape is to satisfy people's basic needs—to provide sustenance, shelter, security, and community—design is concerned with more than just the provision of direct needs. It also is concerned with the way in which they are provided. The quality of the landscape and our experience of it are as important as the goods and services it provides to meet the needs of the whole person. The challenge of design is to reshape the landscape to satisfy these direct and indirect needs in ways that are both appropriate and authentic for those who are to use and occupy it. But the human condition presents many obstacles to achieving these objectives.

Until fairly recently, cities in different parts of the world, or even different parts of the country, had a distinctly local and culturally unique character, physically and socially different from those in other places, where people had distinctive values, histories, and traditions of their own. Contemporary cities throughout the United States, and even in Asia or

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Africa, however, are, to a significant extent and in spite of their historical traditions, becoming almost indistinguishable from their counterparts in Europe or other American countries. To design in more culturally appropriate ways, landscape architects need to be closely attuned and responsive to the uniqueness of the people and social groups for whom they design.

The world population, increasing at some 75 million people per year (US Census Bureau 2004), presents one of the most difficult problems to be addressed over the next fifty years. During the twentieth century, the nations of the world, and in particular the Third World, experienced a rapid drop in death rates without a corresponding decrease in birth rates. People are living longer, while increases due to births continue to add to their numbers (Lappe et al. 1995). The global population increase is staggering and, for far too many, basic survival may be the most they can hope for (see fig 2-2). Nearly half the people on Earth live on less than $2 a day (UN Food and Agriculture Organization 2010).

Human Needs

The primary purpose of design is to satisfy people's needs. Unfortunately, the contemporary urban landscape often leaves much to be desired. It is well known that some of our most basic human needs—a safe place to live, or access to services or clean drinking water—go unmet in many urban environments.

Almost without thinking about it, people engage with one another and the environment to satisfy their needs and desires. And to a significant extent, these needs are the same for everyone, even though people may meet them in differet ways. For designers to serve the basic interests of the people being designed for, they should understand the needs common to all people. Psychologist Abraham Maslow formulated a general theory of human motivation to describe how behavior is driven to satisfy fundamental human needs (Maslow 1970) that are the underlying reasons for people's actions. Maslow's theory describes how people strive to meet their needs in a hierarchical series of motivational categories, satisfying their most basic needs first; then, as each successive category becomes satisfied, attention is shifted to address those in the next tier in the hierarchy, one that is relatively less urgent for immediate survival. The pattern of the hierarchy is described as a pyramid of human needs with the opportunity to satisfy the demands in each tier being based on the relative satisfaction of the level immediately below it (see fig. 4-1).

Conative Needs

One category of these needs is described as *conative* needs—the needs we are instinctively driven to fulfill. From the most basic or universal to the most individual, they include:

- **Physiological needs** to assure survival and health, which are driven by hunger and thirst as well as the needs for sleep, shelter, and procreation. These factors represent the highest priorities in human motivation and behavior.
- **Safety and security** needs for shelter and protection, which include physical safety and stability, as well as psychological protection from fear and uncertainty. These basic drives represent a need for physical and psychological order in the environment to improve predictability and sense of security.
- **Belonging** needs, which include people's drive for involvement with others, to be loved and accepted within their community or social group through expressions of approval from interpersonal interaction. Belonging provides order and predictability on a social level.
- **Esteem** needs include people's drive to achieve self-esteem and to gain the esteem of others in order to attain status within their community. People are motivated to engage with their community to provide a level of psychological security and sense of belonging.
- **Self-actualization** describes the desire for self-fulfillment, creative engagement in life, making the most of one's abilities and opportunities, and, in sum, becoming all that we are capable of being in life.

Cognitive Needs

In addition to meeting their conative needs, people are also motivated by intellectual drives to satisfy the *cognitive* needs that influence behavior. These are defined as the requirements for life that are satisfied through perception, intellect, and learning as adjustment tools to be used in

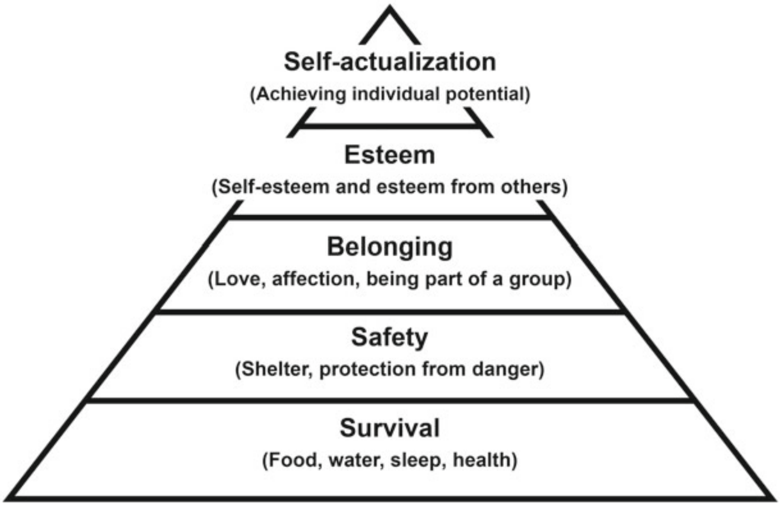

Figure 4-1. *Maslow's pyramid of human needs.*

meeting the conative needs (Stokels et al. 1987). For example, as people observe and interpret the urban landscape, they learn when and where to cross streets safely or what places to avoid after dark.

Optimizing the capacity to address cognitive needs improves people's ability to satisfy their conative needs. Learning continually is necessary to survive and thrive in a changing environment. But people demonstrate a drive to know and understand that extends beyond mere utility. The things that most clearly distinguish us as human are our self-awareness, curiosity, and creativity: to look at the environment and ask not only what is there, but why, and to take pleasure in knowing and creating. Cognitive factors that motivate human behavior include:

- **The need to know and understand**, which includes the ability to acquire knowledge and to gain insight about the world. Learning reflects the need to explore and apply knowledge: to create. To satisfy this need to know, people place two demands on the environment: first, it needs to make perceptual and associational sense if it is to provide useful insight about the conditions in which people find themselves. Second, it should offer interest and engagement, the potential for pleasurable experience through continued exploration, learning, and attraction

(Kaplan et al. 1998; Feynman 1999). Acting together, the processes of exploration and understanding address the need to gain new information about the environment and to organize that information to resolve uncertainty and improve survival through behavioral choices.

- **Aesthetic needs**, which include a person's need to experience pleasure and satisfaction with their perception of the conditions of life (e.g., the experience of beauty) and, where they are found lacking, to create these conditions. (The concept of aesthetics is discussed in chapter 6.)

Transcendental Needs

A final area of human aspiration, described as the quest for experience beyond the boundaries of self, is a powerful motivator of human behavior. This motivator is identified as the need for self-transcendence (Maslow 1969).

- **Self-transcendence** is described as a search for experience beyond self-actualization. Satisfying this spiritual need leads to self-fulfillment as a peak experience and does not appear to compete with any of the other needs. Moreover, the satisfaction of other needs does not have to precede behavior motivated by the need for self-transcendence.

These factors motivate human behavior to the extent that, if they are unsatisfied by current circumstances, people feel uncomfortable and are driven to actions intended to satisfy them—typically by changing the environment. The design considerations regarding these human needs may be found in the online Appendix B at: http://islandpress.org.

Building on Maslow's theory, economist Manfred Max-Neef developed a heterarchical (non-hierarchical) theory of human needs (Max-Neef et al. 1989). This theory describes an expanded range of human needs that extends deeper into the intricacies of the human condition than do the motivational factors formulated by Maslow; they include, for example, the identification of leisure as a human need to be accommodated. These satiable human "needs" for which design must make provision (as opposed to human "wants" that are both infinite and insatiable), are described in table 4-1. In the table, "Being" describes the desired qualities needed to satisfy an identified need and "Having" indicates the people or things being sought to bring about that satisfaction.

Table 4-1
Max-Neef's Taxonomy of Human Needs

Need	Being (qualities)	Having (things)
Subsistence	Physical and mental health	Food, shelter, work
Protection	Care, adaptability, autonomy	Work, social security, healthcare
Affection	Respect, generosity, sensuality	Friendship, family, relationships
Understanding	Criticality, curiosity, intuition	Literature, teachers, schools
Participation	Receptiveness, dedication	Responsibilities, work, rights
Leisure	Imagination, spontaneity	Games, parties, peace of mind
Creation	Imagination, boldness, curiosity	Abilities, skills, techniques
Identity	Sense of belonging, self-esteem	Religions, work, customs, values
Freedom	Autonomy, passion, self-esteem	Equal rights

Although Maslow and Max-Neef describe essentially the same basic human needs, Max-Neef's identification of the settings in which these needs may be met provides guidance in determining where design has the greatest potential for satisfying human needs. Hence, the **settings** in which these human needs may be met include:

- **For subsistence**—living environments, work environments, social settings;
- **For protection**—dwellings, streets, parks, public and social environments;
- **For affection**—privacy, intimate spaces of togetherness;
- **For understanding**—families, schools, universities, communities;
- **For participation**—public space, recreation areas, churches, neighborhoods;
- **For leisure**—landscapes, parks, natural areas, intimate spaces, places for solitude;
- **For creation**—spaces for expression, workshops/studios, places of reflection;

- **For identity**—everyday settings, workplaces, places one belongs to;
- **For freedom**—public spaces, parks, social settings.

In addition to interactions with the specific settings to satisfy their basic needs, people also respond to the *quality* of those interactions. Several key psychological and physiological responses are thought to influence people's ability to satisfy their needs (Stokels et al. 1987). These factors—*arousal*, *overload*, and *stress*—describe experiences that can be assessed as a measure of the quality of people's interactions with a setting and may be understood as indicators of its success in accommodating human behavior and activity.

- **Arousal** refers to a person's general level of sensory awareness—psychological or physiological alertness—and relates to their extent of mental engagement in an activity, experience, or place. A well-designed setting attracts people's engagement and provides them with opportunities to regulate stimulation in response to the variable optimal arousal levels they may seek.
- **Overload** refers to the temporary loss of focus and engagement caused by excessive sensory stimulation stemming from too many simultaneous demands for attention or from distractions in the environment. Environments that contribute to extended periods of overload can lead to stress. Settings that give people choices in regulating sensory information provide opportunities for managing stress.
- **Stress** refers to the psychological and physiological response to threat, demand, or challenge; this includes high levels of arousal and active attempts to cope. Stress can occur in response to many factors in the environment, especially adverse conditions that are unpredictable or uncontrollable and in which there is a realistic likelihood of injury or loss, associated with an inability to interpret environmental cues correctly and respond appropriately. Stress may occur in environments that fail to assure safety (such as areas known for street crime) or to satisfy routine needs (such as predictable and convenient transportation systems like bus routes to get people to work).

These descriptions of human motivation and response mechanisms attempt to identify and explain some of the universal human needs for which design is intended. One of the fundamental questions for design is: How may design make the human experience more secure, creative, and enjoyable?

In many parts of the world, it is becoming increasingly difficult for people to satisfy their most basic needs. As the world becomes more urbanized and people seeking greater opportunities move into unfamiliar environments, their ability to satisfy their security, socialization, and esteem needs becomes increasingly problematic, while for a growing majority of the world's population, self-actualization is only a distant hope. Transforming the urban landscape of the future into a healthy and satisfying behavioral setting will require a significant level of understanding and creative insight about people and behavior, as well as new ways of approaching design.

Health Needs

One of the highest priorities in design is the protection of human health. One of the most prevalent threats to health is stress. Among the significant problem areas for which designers must find solutions are the environmental stresses to which society is exposed, stresses that originate from a variety of sources, many of which are beyond the reach of the design professions. But because these issues are intricately interrelated, they must become a part of design thinking if any are to be addressed in integrated, although often indirect, ways. Several areas of stress are thought to be critical to the way the environment is to be developed in the future (Homer-Dixon 2006).

- **Energy stress**—At the same time that urban growth requires increasing energy to sustain development, sources are becoming more expensive. Over the last several decades, the ratio of return on investment for energy production in the United States has dropped from about 25 : 1 to 15 : 1 as dwindling or difficult-to-reach supplies become more costly to extract.
- **Economic stress**—The gap between rich and poor is growing, placing increasing stress on those who are being bypassed by the benefits of the global economy. To maintain lifestyles at current levels will require increasing reliance on economic efficiencies and shared facilities, such

as increased urban densities, public transportation, and social services infrastructure that includes green infrastructure: open space, parks, and recreation areas. Providing these, in turn, will require radically altered patterns of urban organization and behavior to prevent the stresses associated with a new pattern of living.

- **Demographic stress**—The differences between developed and developing nations are widening, in particular due to differences in growth rates between those in rich and those in poor countries. Similar disparities are observed among people of different economic levels within the developed countries. Inevitably, these differences in opportunity will cause demographic shifts along national and continental lines. Increasing complexity of urban populations will require new ways of organizing and sharing the benefits of the urban landscape.
- **Environmental stress**—All aspects of the global ecosystem are under increasing pressure as populations grow and change and as we increase pressure on the environment to supply food and shelter. Changing the way we view the environment and sustain its productive capacity will require altered expectations as well as stringent performance requirements if we are to maintain the environment as a viable human habitat (Harrison 1992).
- **Climate stress**—As our use of energy increases the emission of greenhouse gases and climate change becomes more pronounced, all countries will experience new challenges as they change from the status quo. Reducing energy consumption and carbon output will require profound shifts in primary energy sources and use patterns, and in how manufacturing and transport systems are organized and operated. Altered climate will require changing from established patterns of urbanism, industry, agriculture, and forestry, but in ways that cannot be predicted. Water consumption will become a major focus.

These stresses are not new in human experience. History records the efforts of individuals and societies to address these challenges and improve quality of life. And as life continues to confront people with stressful conditions, they will continue to seek ways to cope. Design and technology are the intellectual responses to determine how these stresses are to be addressed, not just on an individual basis, but through the organization of society and the landscape.

The notion that contact with nature provides stress-relieving benefits is a longstanding belief in both Eastern and Western cultures (Ulrich et al. 1992). Over the last quarter century, there has been mounting evidence of the therapeutic benefits of access to the natural landscape. While most of the research regarding these benefits has been directed toward nature's effects on hospital patients, there is no reason to believe that access to nature would not be just as beneficial to others (Horsburgh 1995; Gierlach-Spriggs et al. 1998).

Because natural settings have been found to sustain people's interest and attention, and serve as a pleasant distraction, they appear to lower stress. Viewing nature has been found to produce health recovery and restoration more rapidly and more completely than when patients are exposed to settings lacking in natural content. Significantly, these benefits have been found to occur within minutes, as indicated by positive changes in patients' blood pressure, heart activity, muscle tension, and brain activity, as well as lower levels of fear and anger, and reported higher levels of positive feelings (Ulrich 1981; Hartig 1991; Ulrich et al. 1991; Nakamura et al. 1992). Patients also have been found to require shorter hospital stays with fewer postsurgical complications (Ulrich 1984). Mood improvement and restoration from stress among hospitalized patients have been identified as the primary benefits of exposure to natural scenery (Cooper-Marcus et al. 1995; Whitehouse et al. 2001), in part, by providing them with a positive sense of mental escape and control.

Although the evidence to date is limited, it suggests that therapeutic landscape settings are more likely to ameliorate stress if they contain green foliage, flowering plants, calm water, harmonious natural sounds (birdsong, breezes, moving water), and visible wildlife (butterflies, birds, squirrels) (Ulrich 1999). Visual access to natural settings with savanna or park-like qualities, such as open lawns with scattered trees, may be most effective in fostering restoration of the spirit (Cooper-Marcus et al. 1995, 1999). Characteristics that seem to diminish the therapeutic effects of landscapes include a predominance of paving or other starkly built urban structures (Ulrich 1999; Whitehouse et al. 2001), or the presence of ambiguous art and design features (Ulrich 1991).

Among the most significant conclusions of these findings is confirmation of the importance of verdant landscape settings as an integral component of psychological health. To make complex natural conditions of the landscape physically and visually available to all segments of society—at residential areas, schools, shopping areas, office parks, public streets—could contribute significantly to improving the health and resilience of both people and the landscape. For society at large to have routine access to the benefits of a stress-relieving and contemplative environment holds the potential for being one of our most beneficial achievements in improving the quality and health of contemporary urban life.

Behavioral Dimensions of Space

In addition to satisfying people's direct needs, designers also are concerned with the spatial dimensions of people's interactions. These represent demands people place on the environment that may be amplified or diminished by the character of the physical setting. Two broad concepts describe these spatial factors. One is highly personal and individual: *personal space* (Sommer 1959; Hall 1968). The other describes a group-oriented process: *territory* (Ardrey 1966; Sommer 1969). Territoriality and personal space represent important characteristics of the spatial interdependency between people and the environment.

- **Personal space** is the portable "bubble" of space surrounding each person, into which others may intrude without trespass only by permission. It is an interpersonal distance regulator that functions to determine how closely we interact with others. Personal space is carried with us wherever we go, and it may expand or contract depending on the circumstances of familiarity, expanding in formal or threatening situations or contracting during intimate interaction with loved ones.

- **Territory** is a spatially defined area, often with visible boundaries, that is controlled by an individual or group (Greenbie 1981). Territory functions to determine who may enter and interact, and prompts specific behaviors based on perceived rights of possession. Territory is relatively stationary and bound to place.

The extent of personal space, the distance at which people feel comfortable interacting with others, is culturally determined. People in southern Europe or South America, for example, tend to be comfortable in closer physical proximity to others than people in northern Europe or North America. Thus, the English and the Italians have distinctively different personal-space preferences. Consequently, the design of places for public interaction should make allowance for different people with different concepts of personal space. This becomes problematic for designers when people from different cultural backgrounds, and different concepts of spatial behavior, must be accommodated in the same space.

Personal space is a form of social control and privacy. People have a threshold requirement for privacy as a prerequisite for psychological health—for reflection, grooming, intimacy, or social control—that is dependent on their personal and cultural expectations (Margulis 2003; Altman 1975). Conversely, people have a strong motivation toward community affiliation: the need for social interaction to satisfy the desire for belonging to a social group (Baumeister et al. 1995), but that, too, is culturally influenced. Much of our behavior is devoted to balancing the competing needs for privacy and community. Although interaction with others is desirable, people want to be able to exercise individual choice regarding when and under what circumstances control is surrendered.

Territorial behavior, one of the most common behavioral characteristics in nature, is apparent in human interactions ranging from enthusiasm for local neighborhoods and support for home teams to the defense of nations (Ardrey 1963; Wilson 2012). It is one of the most powerful instinctive drives in nature and accounts for our profound tendency to exhibit empathy for those belonging within and enmity for those from outside a group's established territorial boundary, even when there are no other definable differences between those who are cherished and those reviled, such as members of rival baseball teams or schools.

There are different types of territories within which people are prompted by their understanding of the environment to make different choices and behave differently. The boundary between Texas and Mexico is clearly a territorial limit that prompts different behaviors on opposite sides of the border. But not all territories have political or cultural demarcations, and it is often the less visible territories that are of greatest concern to designers. In general, three types of territories have been defined (Lyman et al. 1967; Sommer 1969):

- **Public territory**—places that provide people with freedom of access, but not necessarily freedom of action, such as city streets or public parks where behavior is controlled and policed by law.
- **Home territory**—spaces taken over by groups or individuals where regular users or patrons have a sense of familiarity and exercise social control, such as gang turf, college bars, or children's makeshift clubhouses on vacant lots.
- **Interaction territory**—transient and mobile territories where social gatherings can occur; they are often public areas, such as street markets or fairgrounds, with clearly marked boundaries and rules of access.

People may be expected to respond differently in each of these distinctive territorial types, patterning their behavior specifically to the nature of each one. The more intimate and personal the space, and the greater people's control of it, the greater their freedom of action within it. The more the territory is deemed public, or under the control of others, the more restricted the individual's freedom of action. Some territories may be unmarked, understood only by those in a position of assumed ownership, such as gang turf in a city, while other territories are clearly demarcated, such as college campuses or gated communities. When territories are poorly understood, their owners may design ways to reveal their limits, such as gang graffiti on building walls or personalized entry treatments in public housing developments. Territory, and our association with it, appears to be an important way for people to meet their conative needs, such as gaining esteem by having residence at a prestigious address or attending a respected university.

Settings with visible identity and with clearly articulated transitions, from public domain to semi-private territory to personal territory, afford the legibility needed for effective communication that one is moving from a public domain into territory reserved for the use of others. When territorial limits are both clear and clearly understood, people assume a sense of belonging and responsibility within them. People have also been found to integrate more successfully with others who share the territory and assume increased responsibility for its protection and maintenance (Newman 1973).

People's understanding of territory affects their daily choices about where to go and how to interact. Different settings prompt different responses: behavior at a fairground is expected to be different from behavior at a cemetery. In public space, people read cues and pattern their behavior according to cultural spatial norms (Motloch 1991). In private space, people are able to avoid unwanted interaction through psychological means (withdrawal), rules (manners), behavioral cues (gestures), spatial separation (distance), or physical devices (walls) to control contact or filter the flow of information between themselves and others, and by structuring the timing of activities to avoid coincidental interaction (Rapoport 1977).

Invasion of one's personal space can occur simply by inappropriate touching, possibly due to differences in the scale of culturally determined interpersonal distances. Violation of a neighborhood park could occur by being taken over by outsiders for an impromptu football game or jam session. Under extreme conditions, perceived invasions or violations of territory, such as intrusion of gang territory in public housing projects or vulgar displays at a patriotic or religious ceremony, can lead to violent responses. Reducing the potential for this type of confrontation in public open space is a challenging aspect of urban landscape design.

Making provision for territorial demands seems to require that the spatial definition of a setting is consistent with established human behavior for a particular activity. Providing for personal space requires that the environment provide opportunities for people to establish their individual personal boundaries. For example, public benches large enough to accommodate three people, if used by more than two strangers, will often prompt one to leave. The limits of their personal space may have been exceeded. The design for an activity is strengthened when the boundary of the setting is physically explicit or where opportunities for inappropriate or conflicting activities are limited. This may be seen in multi-family housing developments where children's active play areas are located to avoid proximity with the living or sleeping areas of the units, limiting the potential for conflict among neighbors.

Cultural Diversity

Mobility is enabling an increase in cultural and ethnic diversity worldwide. Recent research indicates that a quarter of the US population is currently either foreign-born or first-generation American (Cohn 2015). Different social groups reach different understandings regarding the nature of the world and, as a consequence, hold culturally distinct perceptions and concepts of reality, differences that present opportunities for creativity and innovation in society (Wilson 2012). Population diversity, although valuable from an ecological perspective, poses a number of obstacles in the provision of open-space design. Different social groups also differ in their socio-spatial organization. In public spaces, people cannot predictably control their interactions with others and are generally expected to follow the rules of the resident culture by, for example, respecting their behavioral norms or engaging in appropriate activities. However, in many urban settings, multiple resident cultures must coexist in the same public spaces, and so the rules of behavior within a common culture that facilitate the interaction of strangers in public space are no longer available. When people with different cultural norms interact, their differences in behavior may be interpreted as lacking in respect or courtesy, even when no disrespect has been intended or even understood to have occurred. Settings that thrust people with different values and expectations into contact with one another can create tension and stress.

People are thought to share two kinds of cultural space. One of these is referred to as *proxemic space* (Hall 1966; 1971), which is shared with those who hold similar cultural paradigms, and in which culturally specific behavior is allowed. The other type is described as *distemic space* (Greenbie 1981; 1982), which is that shared by those who hold culturally diverse values, perceptions, or behavioral norms.

Proxemic space is occupied by homogeneous groups with highly consistent spatial behavior. Examples of proxemic spaces include sports clubs, fraternity houses, and places of worship. Both the social interactions and the physical environment can be extremely complex, because the rules of social engagement are largely taken for granted due to the users' high degree of familiarity with them. And because people choose to be a part of the group, there is incentive to uphold its social norms. Proxemic spaces are usually high in associational meaning, and the policing of behavior is accomplished by internal social pressure. As a consequence, there are few interpersonal conflicts and little need for behavioral cues to prompt appropriate interaction.

Distemic space, on the other hand, is shared by people who are culturally diverse and who hold different values, codes of conduct, myths, symbols, and cognitive attitudes. Examples of distemic settings include festivals such as Mardi Gras, or the departure lounges of international airports. Behavior by one group may be expected to infringe on that of another. To avoid this, behavior is overtly controlled by the imposition of explicit spatial settings, behavioral rules, cues, ordinances, and external policing. The advantage of a distemic setting is that cultural differences are allowed and people interact and express themselves as individuals rather than as members of a social group whose individual differences are subsumed by the overriding limitations of the group. This allows greater cultural exchange and social evolution than might be possible within the confines of a proxemic setting, where the rules are never examined or open to discussion. The exuberant behavior of patrons at a sports bar, for example, which might not be tolerated at their place of residence or work, is never questioned, since those in attendance want to conform to the group norms. Each setting—a sports bar or a workplace—is a different but internally consistent proxemic setting.

The basic problem for landscape designers is to provide a shared public setting that avoids both intrusion and exclusion. Cultural diversity poses a challenge in the design of public space to provide a setting that is equally available to all members of the public. In designing for people who are culturally, socially, or economically uniform, it may be reasonably easy to establish settings that can be comprehended, used, and appreciated in relatively predictable and satisfying ways. However, in designing for culturally diverse users, some of whom may be acting to address survival-level needs while others are addressing needs on a higher social or aesthetic level, it becomes difficult for designers to either understand such complex behavioral needs or to provide appropriate settings for them.

We are beginning to understand that while cultural or aesthetic preferences may differ, they are not necessarily better or worse, simply different, based on divergent values and experiences. The elitist view of designers as being society's arbiters of "good taste" has become discredited as we learn, and learn to appreciate, more about the inherent value of diversity within society.

Of the basic human needs, aesthetic experience is certainly one of the most important to be addressed by design and the one most universally agreed upon among designers of all stripes as their point of common interest. However, it is difficult to argue that, just because it is the value most commonly shared by designers, they therefore must agree on aesthetic preferences, or that it has greater priority than any of the other considerations on which design quality depends. Addressing the full range of human needs for a community is a minimal requirement for advancing the human condition. Providing shared landscapes that are understood, deeply satisfying, and respected across cultural lines within an increasingly pluralistic society will be necessary if these landscapes are to be sustained by the populations using and living in them. This is a task few designers have been prepared for in the past but one for which all must assume some level of responsibility in the future.

Urban Development

To use the urban environment successfully, people need to be able to understand it and move through it freely. To do this, people form cognitive maps of the urban environment that serve to guide their decisions about what the environment holds in terms of places and opportunities, and to aid navigation through it to gain access to them (Kitchin 1994). Cognitive mapping is facilitated when the urban environment is organized to convey the kinds of information people seek in order to achieve better understanding and engagement with the environment.

To organize the urban environment in ways that convey these kinds of information—that is, so they make perceptual sense—designers need to arrange not just the functional but also the perceptual building blocks of the city—the physical and symbolic aspects of the environment that people perceive as the defining features of the urban environment, the features on which they rely for information to guide decisions and behavior.

Architect and site planner Kevin Lynch described five categories of urban features that facilitate cognitive mapping (Lynch 1960). The features he found people using to comprehend and describe the environment, as well as some recent additions, include:

- **Paths**—shared travel corridors through the environment, such as highways, rail lines, streets, pedestrian paths, and canals (Kaplan et al. 1998).
- **Districts**—large areas of the urban environment that have common characteristics, such as campuses, industrial areas, residential neighborhoods, shopping areas, or entertainment districts.
- **Edges**—linear features, not typically used as paths, that form the boundaries of or enclose areas. These include features such as topographic restrictions, rail yards, limited access thoroughfares, walls, or shorelines (Kaplan et al. 1998).
- **Nodes**—major points of interaction where activity is concentrated or focused, typically associated with the intersection of major paths or places where they terminate, such as a central market, transit station, or major street intersection.
- **Landmarks**—distinctive features of the environment, usually visible from a distance, that people use as reference points, such as tall buildings, mountains, water towers, or monuments (Kaplan et al. 1998).
- **Portals**—entryways by which a sense of arrival to an urban environment or district is expressed, such as the formal gateway to a residential area or campus, and more rarely, to a city itself (Brooks 2004).
- **Environmental corridors**—natural systems, cutting through the urban environment, that remain more or less intact, such as a river valley, urban greenway, or topographic ridge (Dee 2001).

Design attention to these features not only makes places more recognizable, but also more meaningful to their inhabitants. In addition to these traditional elements of urban structure, features such as ecological corridors or edges provide distinctive form and identity to the built environment. Under ideal circumstances, ecological corridors are retained as beneficial additions to the urban environment, adding richness and diversity beyond the contributions of conventional urban systems. More commonly, these natural systems have been degraded to the point of basic utility, sometimes operating more as piped or open concrete-lined storm sewers than functioning stream systems or ecological habitats. But where they have been protected and enhanced, in places such as the River Walk in San Antonio, Texas, they provide unique and cherished additions to the urban setting, enriching its character and place identity.

Clearly expressed urban environments, places that facilitate people's ability to understand and cognitively map them, promote effective access and use, increasing their potential for improving quality of life. The extent to which environments reveal themselves and facilitate people's

Figure 4-2. *Riparian environment along the San Antonio River Walk, located in the heart of San Antonio, Texas. (Source: Wikimedia Commons.)*

comprehension and formation of clear mental images is referred to as **design legibility**: the ease with which the parts of the environment "can be recognized and organized into a coherent pattern" (Lynch 1960, 3). As a consequence, legibility also facilitates people's ability to form attachments to place, an important indicator of their satisfaction with the environment.

These considerations are illustrated by people's choice of residential environments, the most common of which are low-density, single-family housing areas—suburbs. Indeed, such places hold many attractions for people who desire to live in their own home, on their own land, among those whose values they share (Greenbie 1981). But as contemporary suburban environments become more expansive and homogeneous, they tend to become less legible and distinctive, and as a consequence, less satisfying. In most suburban residential areas, the characteristics that facilitate environmental decoding and understanding tend to be absent or obscured, making comprehension, cognitive mapping, wayfinding, and place attachment difficult.

Society is the organization of people in definable groups—by shared history, language, culture, religion, values, or place of origin. One of the traditional ways of providing for people in groups (particularly, but not limited to, groups in densely populated cities) is through the development of public gathering space. There is a great deal of open space (space not occupied by buildings) in our cities, but little of it has been consciously designed to meet people's need for social interaction (Whyte 1980). Rather, much of it is simply space left over after building. Public places need to be purposefully designed to facilitate comprehension and social interaction opportunities if they are to meet the needs of individuals and groups. The public open spaces that people find most attractive are places that are easily accessible and occupied by other people.

Desirable places also provide amenities, such as comfortable places to sit or congregate; interesting and engaging views, particularly of other people; and the availability of food and beverages (Whyte 1980; 1989). Urban sociologists Clare Cooper-Marcus and Carolyn Francis developed a set of design performance criteria based on decades of research in San Francisco

Figure 4-3. *Extreme uniformity of many contemporary residential subdivisions. (Source: Wikimedia Commons.)*

and Berkeley, California (1998). They conclude that successful public open spaces are, among other things, accessible, secure, comfortable, and beautiful. A detailed list of their design performance criteria for urban open space is found in the online Appendix C at: http://islandpress.org.

Performance criteria for public space in housing developments, formulated from research by Clare Cooper-Marcus and Wendy Sarkissian (1986), address the need to balance community and privacy interests, safety, territoriality, and psychological health. These criteria include guidelines to promote inclusiveness and foster a sense of community by providing community services and recreation, and by other settings that enhance opportunities for social interaction. For example, they suggest that designs for low-density and medium-density housing areas should include community meeting spaces as well as considerations for function, health, and safety. These criteria are listed in online Appendix D at: http://islandpress.org.

These performance criteria may appear to be common sense, particularly in view of our understanding of people's basic human needs. In some respects, such as safety and universal access, the law requires such design performance. But even these criteria have not always been well understood. They were developed only after many years of systematic research, and they resulted from observations of many settings, both successful and unsuccessful.

Much of the problem with poorly designed public settings may lie with the researchers' observation that the design approach should always be "balanced." That is, the design should satisfy the values of the users as well as the designers. Designers in the past have tended to place overriding emphasis on the artistic and aesthetic aspects of design. For example, studies of public housing areas revealed that detailed attention to façade and color variation to improve aesthetic quality went largely unnoticed by residents, while design arrangements that limited privacy choices—choices that were sacrificed in favor of refinements in façade detail—were more clearly understood to have an impact on people's lives (Cooper 1965). Cooper-Marcus and Sarkissian encourage the provision of some degree of architectural complexity. However, they caution that unless residents perceive it, attention to aesthetic considerations may not improve design quality when measured by comparison to improvements in people's quality of life. Nevertheless, until we provide evidence that other criteria are equally beneficial, it should not be surprising if designers remain committed to what they already know—or think they know—about what constitutes good design. The evidence, however, about how people and setting interrelate in response to perceptual and behavioral needs and how that evidence may be used to inform design decisions is accumulating steadily in the literature.

Designers' intuition is not necessarily wrong. One of the most important aspects of a healthy living environment is the reduction of stress—as noted, a common aspect of contemporary urban life. In reaction, people have long acted on a felt need to escape the city and repair to the parks or countryside for the therapeutic benefits of nature. We are now beginning to learn that the designer's intuitive feelings were accurate, that contact with nature is indeed restorative and healthful (Ulrich et al. 1991) and environments that provide routine exposure to natural features, lawns, and trees can be stress relieving and health giving (Ulrich 1984). This has significant implications for the way urban environments are to be designed and built in the future.

It is also important to note that people express a universal desire for autonomy (Dworkin 1988, 1989), to exercise freedom of choice in their lives. Autonomy is an important indicator of quality of life. Designers in particular seem to express this desire for autonomy in their own work. If there are any universal human preferences beyond the desire for love and belonging, the desire for freedom must certainly be one of them. If people are to be genuinely free to make individual choices, they must find opportunities in the environment to act on these choices.

Providing options for people's activities may be one of the most important characteristics of a successful urban environment, and perhaps one of the most difficult to provide. This is particularly so if the options are to be provided such that they reveal themselves and their comparative advantages or disadvantages in enough detail to permit the user to make informed choices, such as choosing between two paths to a destination or alternative activities in a park.

Access and Circulation

The environment is useful only if we are able to gain access to it. The best-understood and most-used urban system is the public roadway, designed to provide that access (Eisner 1993).

The road has long been recognized as a major element of human use and domination of the landscape; dating from the Roman era, the Appian Way, which served to sustain Rome's military domination, today remains intact with original paving in many parts of southern Italy.

The road is one of the most extensive expressions of human activity in the landscape. The traditional pattern of routine movement through the landscape was revealed as a trace worn onto the ground. By following the trace, the traveler was guided to an intended destination. According to landscape historian and theorist J. B. Jackson, one of the "significant aspects of the road was how it affected the landscape; how it started out as a wavering line between fields and houses and hills and then took over

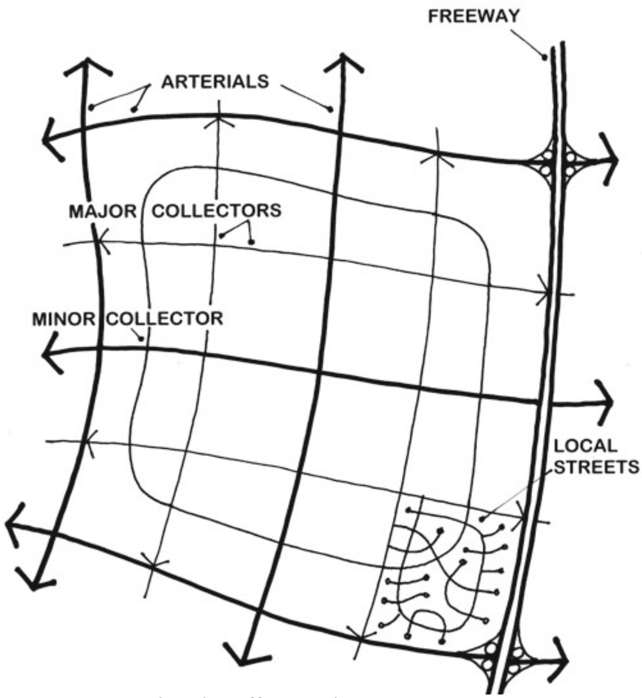

Figure 4-4. *Hierarchical traffic circulation system.*

more and more land, influenced and changed a wider and wider environment, until the map of the United States seemed nothing but a web of roads and railroads and highways" (1980, 122).

Another traditionally important aspect of the public road was its function as a place of social interaction and exchange within towns and cities. Before people began to share streets with motor vehicles, the road was the primary place of meeting and commerce. Historically, a town's main street—the widest and best-paved—concentrated traffic in the center of the community, where the market and other public events took place (see fig. 4-6). But this was primarily pedestrian traffic.

In many older cities, in Europe, for example, the street still serves as a continuous urban space for socializing, commerce, and recreation. Places that attract many people have been widened to form public squares, often with specific design attention to improve their beauty, comfort, and convenience for market activity, public events, or social interaction. But

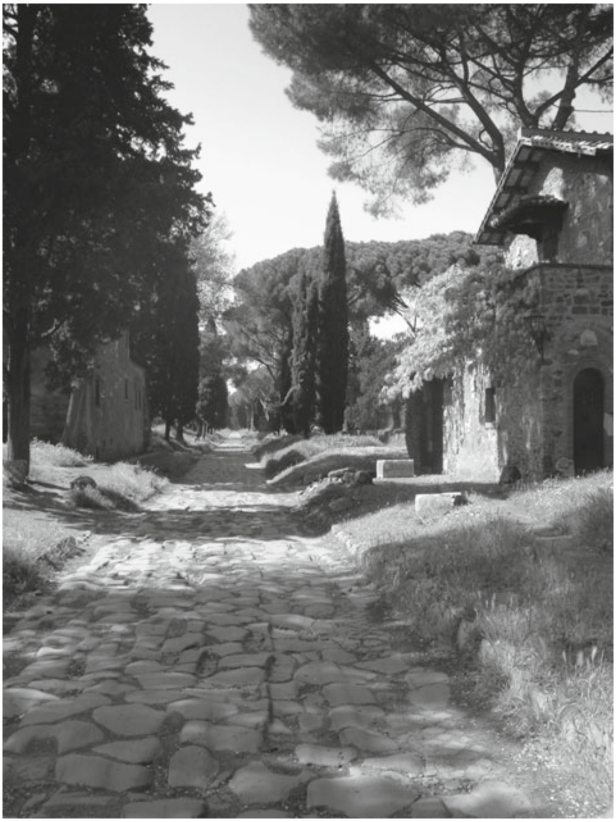

Figure 4-5. *The Via Appia, connecting ancient Rome to the southern port of Brindisi on the Adriatic, still has remains of Roman-era paving and is an enduring example of the road as an element of human domination in the landscape. (Source: Wikimedia Commons.)*

modern cities reflect little of this historic behavioral pattern. Human interaction has been driven from the street. Today, the widened places on the street are used mostly for parking cars, which serve to further separate people and interfere with social interaction. It is amazing to see how aggressively cars have taken over the contemporary urban environment, in much the same way that the introduction of invasive species can result in their domination of natural environments. But there have been some encouraging recent initiatives to reclaim the space of the street for people. Noteworthy among these has been the recent transformation of Times

Square in New York City, where traffic has been removed and the space turned over to pedestrians and cyclists, with the effect of creating a more vibrant urban civic space for people as well as improved economic activity (Sadik-Kahn et al. 2016; Shoup 1997).

Today, we understand the introduction of the freeway as the precipitating event that ushered in urban (more often suburban) development of the landscape. The hinterland of American cities may be mapped as an extension of development following major circulation routes radiating out from city centers. The form of the urban environment that once could be mapped as a compact circle of development is now an open web with tentacles extending out along lengthening lines of movement, connecting outlying residential areas with the city center.

Traffic circulation represents one of modern society's most significant design advances and at the same time, one of its most difficult problems. The efficient urban thoroughfare systems, in addition to handling high volumes of urban traffic, also change vast areas of landscape through the promotion of inefficient development patterns. As these freeway systems consume increasingly larger amounts of open land, they fragment and

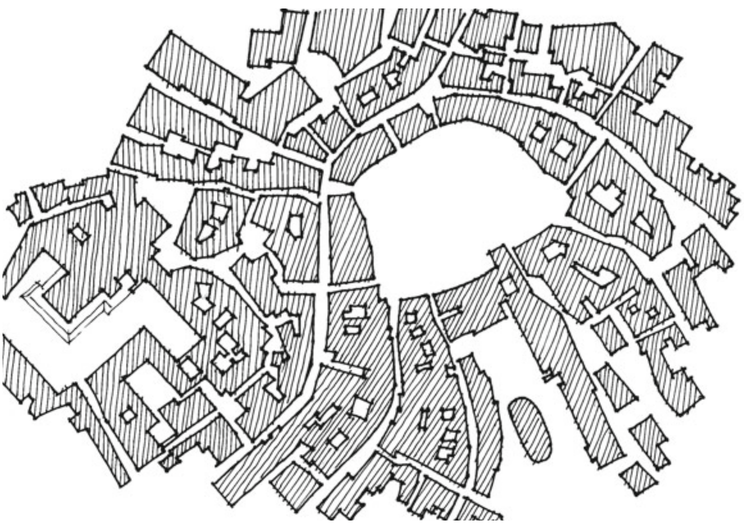

Figure 4-6. *Plan view of the pattern of streets converging on the Piazza del Campo in the heart of Siena, Italy.*

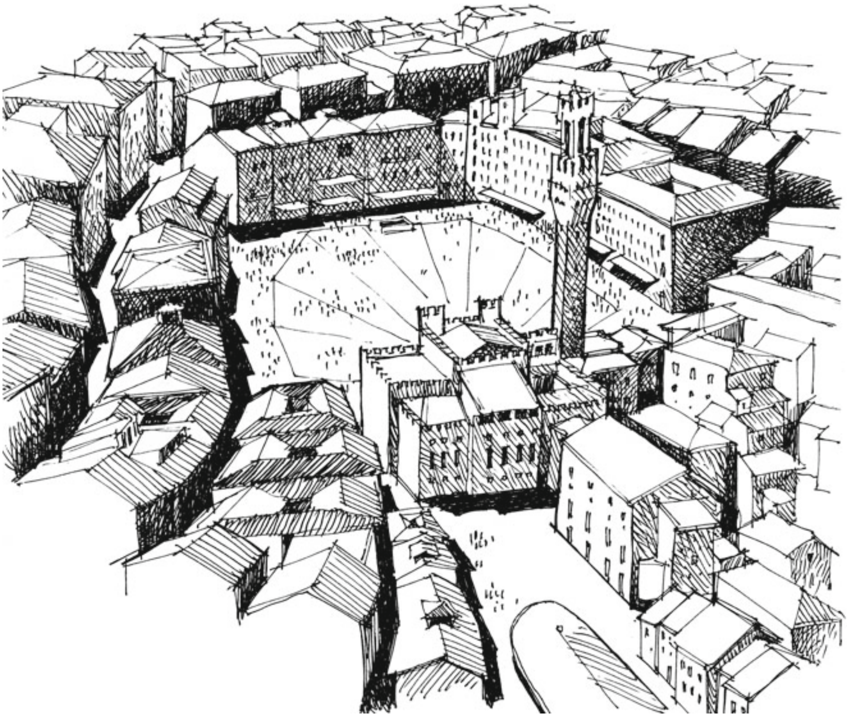

***Figure** 4-7. Aerial view of Piazza del Campo in Siena, Italy.*

subdivide the urban and suburban environment in ways that interfere with the development of established social and ecological patterns. Highways are employed to connect remote housing areas to central cities, requiring that people expend large amounts of time and resources in commuting, so they will be able to more economically occupy large amounts of land for housing (Wynberg 1993; Lang 1994).

The land-use patterns and urban forms of contemporary cities are shaped fundamentally by priorities in transportation (Newman et al. 1999). The freeway-dominated transport system promotes low-density land utilization that is antithetical to the compact development patterns recommended by urban planners for several reasons (Kannenberg 1994):

- High densities in a compact urban form are necessary for efficient public transportation systems such as buses, trams, and subways. It also makes possible greater use of pedestrian movement as a principal form of circulation.

- Non-vehicular infrastructure and social services can be more efficiently and economically delivered.
- Higher economic thresholds are created where population and movement patterns are concentrated to stimulate commercial activity.
- The nearer agriculture production areas are to the urban centers they serve, the more economically produce can be transported to end users.
- The nearer production areas are to consumption centers, the greater the potential for organizing and returning waste materials to the landscape for recycling.

The low-density suburban developments that have come to characterize the contemporary American city provide many benefits. People choose to live there because of the genuine advantages they offer, such as greater privacy, the availability of newer, larger houses and lots at lower purchase prices. Because these areas are largely homogeneous environments, there is little social conflict. Living in the suburbs also provides access to services such as newer schools that provide better education than those typically found in older inner-city neighborhoods. They also provide homeowners with reduced tax responsibilities, because new areas are not burdened by the aging infrastructure and social systems of inner cities.

But there are costs as well as benefits to be considered with this form of development. As early as 1974, the US Department of Housing and Urban Development calculated that compact development would cost only 40 percent as much as the low-density suburban pattern. Widely dispersed development with longer driving distances requires not only a more extensive road system but also greater energy consumption and its accompanying increase in noise and air pollution (Duany et al. 2000).

In addition to concerns for economy and traffic flow in the circulation system, there is the consideration of how street patterns influence people's interpersonal relationships. Streets have a significant, although largely unrecognized, impact on people's physical and social interactions, particularly in residential areas. In a typical suburban residential neighborhood, because the houses are oriented toward the street, residents are oriented toward the street as well. In what may appear an obvious finding, residents in a suburban neighborhood have been found, on average, to know up to ten times as many of their neighbors who live along their street as they know those living in closer physical proximity but directly behind their back fence, and thus on another street. People living on the same street may be physically more distant, but in closer functional proximity regarding their opportunities for casual access to one another.

Obviously, distance is a determining factor in the likelihood of people interacting; people living or working in close proximity are more likely to become acquainted than those too far removed for passive social encounters, which are characterized as occurrences beyond the control or intentions of the people involved, such as people sharing neighborhoods, workspaces, routine paths, or bus stops. In addition to physical distance, functional distance is just as determinative of passive social contact. Functional distance is determined by whether the people involved are present at the same time of day or share a common route, origin, or destination. The contemporary street is no longer designed as a place for human interaction. But it could be.

Casual interpersonal contacts are determined more by the form of the environment than by individual choices. And there has been longstanding awareness that friendships are determined primarily by casual interpersonal contacts, as determined by close functional proximity (Merton 1948; Whyte 1957). The design of the physical setting is the primary determining agent regarding whether casual interpersonal contact will or will not occur. For some populations, such as preschool-aged children or university students, social contacts and compatible acquaintances can be an important determinant in their social and psychological adjustment. On college campuses, the ease of establishing social contacts and friendships is critical to a new student's rapid assimilation into campus life, which can be major factor in their satisfaction and academic success in these sometimes-stressful, transient communities.

Functional distance is established by design decisions about the arrangement between houses or apartments, required paths to parking areas, laundry facilities, or trash collection, or access to service facilities such as recreation areas, day care, or mail boxes. The presence of these common functional connections increases the probability of people using them to make passive contact. In this way, the physical arrangement of the site, the design and orientation of dwellings, and the physical distances between people have a significant influence on their resultant patterns of social contact, the development of acquaintances, and possible friendship formation. In studies of planned communities, friendship groups have been found to be determined by two variables: proximity to neighbors and the orientation of dwellings. People in these communities seem to select their neighborhood friends primarily from those who live nearby and those whom their homes face (Whyte 1957; Rosow 1961).

But choice always needs to be a consideration in design. In addition to the advantages of interpersonal contacts, the designer must also be aware of the possibility of unwanted contacts that may be imposed by settings offering the users insufficient options. For example, in housing areas where adjoining residents have no option but to share the same paths, hallways, mailbox areas, or driveways, the environment can present circumstances where people with personality conflicts or differences in behavior or values are forced to interact, even when they would prefer not to (Murphy 1968). In these circumstances, residents may become isolated or have their behavior shaped by the movements of others in order to avoid unwanted interaction. These unavoidable contacts can create stress as a consequence of the design of their shared landscape.

Although designers have long been aware of their responsibility to create living environments of improved function, safety, economy, and aesthetics, they also need to provide people with possibilities for desired social interaction, and just as importantly, options regarding how these opportunities may, or may not, be acted upon. Settings that fail to offer opportunities for social contact can lead to isolation for people who lack the means to initiate contacts on their own. Social isolation has been recognized as a major risk factor for morbidity and mortality, and can be a significant liability for some members of the population, such as the elderly or physically impaired (Rubin et al. 1988; Tomaka et al. 2006), significantly impacting not only their psychological well-being and adjustment, but their physical health as well (Cacioppo et al. 2009). The physical and mental health of the people being designed for should be a consideration of primary concern in design, and the public street is a feature of significant influence in helping to bring it about.

If we consider cities as organisms and compare their circulatory systems to those of living creatures that convey water and nutrients to and remove wastes from cells, we may anticipate that vehicular circulation systems will remain one of the most vital and most influential systems in urban landscape design. However, the broader and more serious considerations of integrating circulation into the fabric of the living environment have only begun to affect the thinking of transportation planners and designers, which at present, is heavily focused on the movement of goods and people, rather than circulation in support of community activities, energy conservation, health, and social interaction.

The circulation systems that so dominate the urban environment are actually intended as supporting infrastructure for the land uses and human activities they so commonly disrupt through neighborhood dispersal, community fragmentation, energy inefficiency, air pollution, traffic congestion, and noise. In living organisms, the circulation system never interferes with the function it serves; an artery does not disrupt the function of an organ. But for urban design to achieve this level of integration is a slow process. Our collective demand for unrestricted, independent movement in private cars has slowly shifted design emphasis from circulation as a supporting activity to vehicle movement as the primary purpose of street design, with the predictable consequences of misplaced priorities. A more balanced approach to redress these discrepancies may be observed in many recent attempts to reduce and slow traffic through the imposition of fewer, narrower lanes in congested areas; this is a radical departure from the traditional approach of constantly widening and adding traffic lanes to accommodate ever-increasing traffic demand. Typical traffic and circulation, as well as other cultural factors of design consideration, are listed in online Appendix E at: http://islandpress.org.

Pedestrian Circulation

Notwithstanding the dominance of vehicular circulation in contemporary cities, one of the primary design concerns in landscape architecture is with pedestrian and, increasingly, bicycle movement. Although most pedestrian and bicycle circulation follows the same route as other vehicular traffic, there are many situations where the systems are segregated, such as a path or bike system through a park or college campus. And even when following the same route, vehicular and pedestrian circulation systems often require separate pathways and accommodation. This is a successful, long-standing concept, first introduced at New York City's Central Park by Olmsted and Vaux. The design of pedestrian circulation is based on many of the same principles as vehicular systems, with some notable exceptions.

One of the paramount concerns in the design of pedestrian circulation is to create settings that are not only functional but also desirable: settings so engaging that they capture the pedestrian's attention, causing the user to enjoy the experience of the place being traveled through rather than simply hurry on as quickly as possible in order to leave an inhospitable environment and reach a desired destination. Along well-designed pedestrian routes, the experience of the journey is as important as the destination. The main requirements of a successful pedestrian circulation system include:

- **safety**
- **convenience**
- **comfort**
- **universal access**
- **attractiveness**
- **wayfinding.**

Traffic safety for pedestrians, particularly for the elderly, the infirm, or the young, is necessary for providing reliable access to other people as well as schools, shopping, recreation, and community facilities. Pedestrian systems also need to be designed to preclude the appearance of personal threat along the route, particularly during times of limited visibility. Conditions such as heavy vegetation, potential hiding places, or poorly lighted sections along a pedestrian route present a threat to users during times of poor visibility (Michael et al. 1994). When conditions appear unsafe, the most common response is to avoid using the path, further contributing to the level of risk for anyone who does use it because there is no one else present to observe the area. The potential threat presented by an isolated pathway would likely preclude its safe use, even under conditions of good visibility. As journalist and urban theorist Jane Jacobs so eloquently put it, there must be "eyes upon the street" to accommodate pedestrians safely (Jacobs 1961).

Another critical consideration for pedestrian traffic is convenience. Often, a pedestrian path is superimposed onto the preexisting vehicular pattern rather than designed as an integral component of a complex system. One consequence of this is that, for reasons of safety, the pedestrian path is commonly located along a longer rather than the shorter route. But while it might take a driver only a minute to follow the longer route, it may take a pedestrian as much as half an hour of additional walking time to follow a route that does not conflict with vehicular traffic. Convenience means not only providing the most direct route, but also providing one that follows the easiest gradient. An obviously indirect or inconvenient route will often be circumvented by pedestrians choosing to take a shorter or easier path, resulting in maintenance problems, on the one hand, and unused pathways, on the other. Footpaths worn across lawns are a common expression of pedestrians' unwillingness to accept an indirect route.

Pedestrians also tend to ignore overpasses at busy street and rail-line crossings due to the perceived inconvenience of climbing lengthy ramps or steps. In these cases, pedestrians can often be seen crossing high-speed lanes to avoid the safer but less direct route. In a situation where a rail line crosses a university campus, pedestrians and sometimes bicyclists have crossed between cars stopped on a siding rather than use an overpass. Pedestrians and cyclists will have to be given a preferential route if these forms of travel are to become modes of choice in the urban environment. And although steep slopes can sometimes be accommodated by steps, they present obstacles to cyclists or those without the strength or ability to negotiate them conveniently.

Universal access for handicapped pedestrians or those in wheelchairs has become required by law in most public settings, and the specific requirements for ease of gradients, traction and firmness of surface materials, length and steepness of ramps, and specifications for steps, landings, and handrails, while varying slightly from state to state, are nominally uniform throughout the United States due to federal regulation by the Americans with Disabilities Act.

Navigation of the environment is facilitated by the knowledge we gather about existing conditions and the possibilities for moving through them. Finding one's way—**wayfinding**—requires that we correctly interpret the setting to make appropriate choices of movement. This is a mental process requiring the ability and the information needed to cognitively map a setting, as well as the ability to formulate a plan of action and the decision-making capacity to translate plans into behavioral choices and actions.

Wayfinding, based on the processes of learning and decision making, involves two main activities (McCormick 1996):

- **Orientation**—extracting clues from the environment to establish one's position in the landscape and determine the options available for moving through it;
- **Navigation**—making decisions about the best route to take in moving through the environment toward an intended destination.

As environments become more complex, wayfinding becomes more difficult (O'Neill 1991a). Difficulty in wayfinding is a source of stress from the environment (Carpman et al. 1984), and environmental stress, in turn, makes wayfinding more difficult (Zimring 1981; Evans et al. 1984). Improved wayfinding improves access to the landscape and reduces environmental stress. Wayfinding is facilitated by appropriate design. Molly McCormick identifies four design considerations to facilitate wayfinding:

- **Vistas** are openings in the environment that provide visual access to route information and path choices between nodes or decision points (Garling et al. 1983; Kaplan et al. 1998). Open vistas reveal information about available routes and the conditions between nodes or decision points.
- **Landmarks** are distinctive features in the environment that serve as reference points for orientation (Kaplan et al. 1998). Landmarks serve as guides to navigation because they are spatially distinctive and

visually separated from their background environment (Lynch 1960; Appleyard 1969). Visible landmarks at nodes and decision points define destinations and clarify route choices.

- **Simple design organization** eliminates unnecessary complexity and limit the difficulty of mapping out a movement strategy. A coherent central path or primary route to promote the formation of sufficient traffic volume serves as a cue to appropriate movement behavior.
- **Other traffic** is another important cue to wayfinding. People moving alone, or on paths with little traffic, have significantly greater difficulty in wayfinding than those following a crowd (McCormick 1996).

For information about the environment to improve people's understanding of possible destinations and the conditions to be navigated in order to reach them, these characteristics need to be legibly displayed in a form that conveys the information needed to make appropriate movement choices—as, for example, when path form is consistent with the user's expectations based on remembered prototypes or conventional experience. Information such as distinctive entry points, recognizable path forms, and familiar surfacing materials provide guidance to appropriate behavioral choices. In the absence of these environmental cues, signs are used to inform users. But while signage may help with wayfinding (Wener et al. 1983; O'Neill 1991b), it cannot overcome misleading cues (Carpman et al. 1985) or the difficulty of interpreting ambiguity or excessive complexity. For example, a primary footpath that is perceived as being too narrow may misguide the pedestrian trying to interpret whether it leads to a principal destination. A path that appears too wide or lacking in amenity may be misinterpreted as a vehicular route rather than one intended for pedestrians.

An example of this is a campus situation where broad walkways connect at right angles to a street intersection, seemingly inviting campus visitors to drive into the midst of pedestrian traffic. Providing for orientation and navigation in the urban landscape is becoming increasingly important as cities become more extensive and complex, and as people travel for work or leisure to new or unfamiliar settings that may present potential risks (Passini 1984; Golledge 1999).

In addition to obvious concerns for safety, convenience, universal access and wayfinding, the designer is also concerned with the route as a pleasurable experience: a sequence of spatial settings through which the traveler is attracted to move. Designers must pay attention to the creation of an engaging and varied setting; the visual, aural, or tactile characteristics of materials; the light and heat reflectivity of surfaces; and the variety of sounds and other sensual experiences provided by different spatial and ground patterns, textures, colors, sounds, and smells. Shade needs to be provided in summer and shelter from wind and rain in winter. The experience of the atmosphere, the play of shadows, the textures of plants, the movement of nearby water, and the activity of birds or animals or other people are just as important to a satisfying pedestrian experience as the convenient connection to an intended destination. All these are considered in the orchestration of a safe, clear, comfortable, aesthetically rich, total experience: walking or biking to be experienced as much for the pleasure of being in the landscape as for circulation as a necessary activity.

CHAPTER FIVE

Design Purpose

Design can be good only insofar as it does good.

—Norman T. Newton

The underlying purpose of landscape design, to borrow ecologist Barry Commoner's phrase, is to create a "finely sculptured fit between life and its surroundings." But life and its surroundings cover a lot of territory. Many factors must be considered in creating a finely sculpted fit among them. Design is often described as creating space—for example, the space that did not exist before boundaries, such as edges or enclosures, contained and defined it. Space is "created" by design to make "place" for desired activities and shaped to facilitate their functions. Clearly defined space enables the users of a setting to recognize the place being allocated for a particular activity. The space, of course, was always there. But, by design, space is redefined and shaped to suit some intended purpose, such as recreation or social interaction.

The features and patterns of the landscape are recomposed through design to facilitate desired human response and more fitting interpersonal and environmental processes. For designers, creation means thinking up innovative ways to integrate the parts into a purposeful whole; materials and space are arranged to identify, facilitate, and characterize a setting. When design renders a site meaningful as well as useful, it is *place* that is created.

Michael D. Murphy, *Landscape Architecture Theory: An Ecological Approach*,
DOI 10.5822/ 978-1-61091-751-3_5,

Place Making

Place refers to the circumstantial meaning situated in a locale. It is based on a location's physical attributes, the social interactions taking place there, people's shared experiences, and their perceptions of the relationships between them. Place, as a concept, describes an existential property of a setting based on its social relations and the subjective associations of memory that integrate to form its identity (Relph 1996). In addition to its character, function, and associated meanings, the place identity of a site is defined by its relationships with adjacent sites or landscapes by, for example, conforming or contrasting with them. Geographer Edward Relph describes place as the "persistent sameness and unity" that differentiates one location from another as determined by three factors:

- **The physical setting;**
- **The activities, situations, and events taking place;**
- **The individual and group meanings created by people's intentions and experiences of the place.** (Relph 1976, 45)

A more conceptual way of describing place is as an "assemblage of dialectic processes" (Dovey 2008, 56) rather than a geographic location or a unique socio-spatial setting. Place may be defined as the meaning associated with the whole of a site assemblage whose properties emerge from the interactions of its parts. For example, the place identity for the San Antonio River Walk derives from its unique combination of a confined, tree-lined riverside setting, walkways filled with pleasure seekers, the sounds of laughter and banter from diners at sidewalk café tables, the aromas of food, and the music of wandering *mariachi* bands, all set in the heart of the city but isolated from the normal activity and traffic passing unseen overhead on street and pedestrian bridges. The systemic interactions among these people, settings, and activities result in the emergent properties of a synthesized whole that is greater than the sum of the properties of its individual components.

A place identity becomes stabilized through repeated activity. Or, alternatively, it may be destabilized through activities that contradict the established identity. Meaning arises as a consequence of the social valuation of

Figure 5-1. *The San Antonio River Walk with its sense of place centered on its unique landscape setting. (Source: Billy Hathorn via Wikimedia Commons.)*

the assemblage in both its internal composition and in its relation to other places. It is the intensity of experience and heightened concentration of human perception, interactions, and intentions that set a place apart from its context and from other places. The more stable the meaning of a place, the greater its resilience against disturbance and destabilization.

Because people are an inextricable part of the landscape context, they also are an integral part of a place identity as it is experienced, understood, and recalled (Cresswell 2004). Through their activities over time, people may alter a place identity by changing its constituent components or their performance capacity, and in so doing, they themselves become constituents of the place (Kjerrgren 2015). A loss of safety, for example, can both reduce a recreation area's capacity to perform and create its new place identity.

An intense sense of place can also be an aspect of a person's identity. In addition to culture and language, people derive their individual identity from their understanding of place and their relationships with it. Landscape architect Lovisa Kjerrgren argues that this is an important reason why people identify themselves on the basis of geographic belonging: "To say that I am a Swede or a Stockholmer is not merely to point to the location of my home, but to hint of my identity by virtue of my belonging to these particular places" (Kjerrgren 2015, 40).

Although the designer has a central role in bringing it about, place is not so much a quality established by design as a shared understanding of what a setting is as a consequence of people's everyday relationships with it. If place identity stems from its natural essence or historical precedent, the designer may only protect or enhance it. If place is based mainly on experience, the designer may have a greater role in determining how it is used or experienced, and consequently perceived and understood. Alternatively, if place is based on a social construct, the meaning may depend on the interpretations of different social groups (Kjerrgren 2015). The meanings of different sites vary depending on which of these factors is the dominant influence, or may result from some combination of them.

Settings with a unique sense of place, such as Yellowstone National Park or the French Quarter in New Orleans, are sometimes described as possessing "placeness." Settings that are indistinguishable from others, such as conventional shopping malls or suburban residential areas, are often characterized as being "placeless." As Gertrude Stein once said of her hometown (Oakland, California), "there is no there there." For designers to invest a stable sense of placeness in a site requires that they provide the means to sustain both the character and the intended human–environmental interactions in a way that amplifies the meanings that shape people's experience of place over time (Massey 2005, 130).

In addition to facilitating a unique web of social and biophysical processes, place-specific landscapes also provide the perceptual experiences that define and convey authentic place identity through congruence of setting, activity, and experience. The design challenge is to assure that when a person is in a place, they know it, and what they know is consistent with the meaning intended.

Well-designed places satisfy people's needs beyond the provision of specific activities or amenities. Such places are also experiential and behavioral opportunities that enable the people who use them to engage

Figure 5-2. *The French Quarter of New Orleans with its sense of place centered on its unique cultural heritage. (Source: Wikimedia Commons.)*

in activities that they themselves determine. Settings create possibilities; and users, through their own initiative and creative engagement, establish how these possibilities are realized. Under the best of circumstances, the designer enters into a collaboration with the users of a setting to facilitate interactive behaviors, many of which cannot be anticipated when the design is formulated and implemented. As industrial designer William Moggridge said of his design of the laptop computer, "We are designing verbs, not nouns" (Brown 2009, 134).

The designed landscape is not only a physical setting, a noun—such as a park or campus; it is often also an opportunity for a yet-to-be-determined action, a verb—to re-create, to reflect, to explore—that describes a relationship between person and place. Design is the establishment of an interactive process.

Improving System Performance

To assure that the changes imposed on a site satisfy all their intended purposes, designers need comprehensive performance standards to guide and then evaluate their formation. As Norman Newton suggests: in design, performance is the final arbiter of success. Our definition of what constitutes "good design" changes constantly as our knowledge of society and the landscape evolves toward increasing sophistication and integration. Consequently, our concepts of aesthetics, form, function, and environmental fit also evolve toward greater complexity and process definition. As methods for producing and evaluating changes in the landscape evolve in response to increasing knowledge of the relationships we seek to improve, the standards for design success continue to expand and improve as well. In landscape design, this entails the reorganization of a system's cultural and ecological subsystems.

Conceiving design as an integrative process of systems learning and change, rather than an exercise in the creation of unique, isolated artifacts, transforms the traditional definition of design as a professional activity. We no longer rely solely on how we feel about designs—in particular, how we respond to the way they look—as a reliable indicator of design quality.

If designers focus on the purpose, processes, and context of design to achieve comprehensive and demonstrable performance outcomes, landscape architecture may be seen as an indispensable service to society. Giving attention to both the practical and the experiential aspects of landscape is important as designers, working at site as well as regional scales, improve their ability to integrate a wider spectrum of considerations for both near-term and long-term benefits into design thinking. By requiring broad, performance-based demonstration that the design modifications proposed are likely to bring about systemic improvement of existing conditions—in both satisfying human needs and incorporating the resilience required to sustain healthy and vibrant landscapes—designers will not only be designing "with nature" as McHarg suggests, but they will also begin to design "like nature." To do this, designers must begin to learn more, not just *about* the landscape, but more importantly, *from* the landscape.

Designers have many lessons to learn from nature about designing and managing the landscape. Contrary to the way designs tend to simplify the array of plant species of a setting, for example, natural landscapes reflect a survival strategy for life that has evolved over many millions of years to increase plant diversity. To reduce the energy required to maintain unnecessarily pure plant forms and arrangements—particularly for areas other than sites such as sports fields that, for function and safety, require a highly uniform playing surface that wears evenly—a more complex way of approaching design would be more successful at satisfying our purposes over the long term.

Designers in the past seem to have been on the right track when they began to create designs that looked "natural": the more closely a design conforms to its context, the less likely it is to conflict with its context. Today, designers must learn how to create designs that perform ecosystemic functions as well as reflecting their forms.

Contemporary designers need to learn how to pay closer attention, to let nature teach these lessons. If designers can learn from these models, through approaches such as biomimicry, and begin to create settings in closer harmony with the systems nature has evolved, designed landscapes and the societies that occupy them have a greater chance of becoming more successful (Benyus 1997; Bruges 2004). Confronting or ignoring these successful systems has shown little promise of sustainability.

If our intentions are to make life more sustainable as well as more successful and pleasurable through design innovation, the design community will need to learn more about how nature works if it to apply that knowledge to inform design innovation. The science of the landscape exists, but for far too long, it has resided in the disciplinary silos of other fields such as social science, geology, meteorology, and ecology, isolated from the mainstream of design thought. Designs for the future need to be based more completely on the understanding that science provides.

To design landscapes from an ecological perspective requires that they be conserved or reformed, and also managed over the long term to retain the vitality of their biochemical-physical systems that, acting together, carry out their interrelated life-sustaining functions. To successfully build a new or reformed landscape requires that they be constructed, literally, from the ground up. For example, one of the first orders of design might be to assure the complexity and vitality of the life of the soil. It is a living soil on which the plants and, as a consequence, all other organisms in the landscape, rely. And any planting arrangements that are retained or introduced also must conform to the landscape's existing climatic and hydrologic regimes that establish their potential for survival. Orchestrating a site's ecological and cultural systems to be mutually supportive and regenerative—that it, sustainable—is a fundamental purpose of landscape design.

From an evidence-based approach, knowledge of existing conditions is employed to shape design ideas in the same way that the conditions this knowledge represents shape organisms and landscapes. When designs are successful, they may achieve Norman Newton's definition of *being* good because they *do* good. This brings us to the question of design intentions and performance: how are designs to be created and evaluated to determine if the new form will "do good"?

Design Intent

One of the reasons that people engage in design is because they take pleasure in the creative process. The satisfaction that comes from resolving complex and demanding problems is one of the charms of being a designer. But satisfaction in the challenge of design is only a fringe benefit—a personal, not a professional concern. Those who engage the designer's services do so to meet their particular needs. Clients, in addition to their requirement to change the environment to meet some unmet need, also need to be able to evaluate the quality of the recommendations that designers propose.

On a professional service basis, the most equitable way to evaluate design proposals is by measuring probable results relative to design intent. This, however, is different from evaluating resulting environmental quality: the condition that the design ultimately brings into reality.

The first consideration evaluates the merits of the design proposal on the basis of how likely it is to facilitate the intended performance outcomes before actions to change the landscape are undertaken. The second evaluates the quality of the changed condition relative to the realities of the environment—in both the short and the long term. Both of these considerations deserve attention, but a proposed course of action will only be pursued if it appears likely to achieve its intended purpose. The clearer the purpose of design, the more successful the designer is likely to be in achieving it (Peña et al. 1987).

To satisfy the intention of bringing about improvement in system performance for both landscape function and human experience, designers must address a range of specific human and environmental relationships. Although a design must ultimately resolve as a whole, the whole is constituted as an integration of parts. The parts describe the individual requirements of design—the design questions dealing with issues such as human activities or safety concerns. Posed as a series of design questions, these intentions cover a broad range of issues as seen from a number of different perspectives, and they direct attention in the search for the most-appropriate design answers. Each design undertaking is unique and will have a different range of intentions based on user or client requirements, the context of the site and the information available about it, and the limitations of resources and the decision-making process. A comprehensive outline of universal design intentions is found in online Appendix G at: http://islandpress.org.

If the altered form of the landscape leads to the satisfaction of these requirements, we may reasonably consider that it is a "good" design, or at least a successful one. But this is only likely to happen if the design intentions are clearly understood by designer and client alike. To demonstrate that a proposed design intervention has the potential to bring about meaningful landscape improvement, designers need to provide evidence that an envisioned landscape change is likely to satisfy the immediate and long-term requirements of clients, users, and members of the general public. Competence in delivering evidence-based design service is considered the central thrust of contemporary professional practice and the basis of educational preparation and research.

There are two broad categories of design performance. These include considerations to address the integrated requirements of *quality of life* and the *quality of environment* on which it depends.

Quality of Life

The underlying purpose of design change is to improve the quality of life for the people who are to invest in and benefit from the resultant environments. No matter how important other considerations may be, unless these issues are addressed, the others are unlikely to be appreciated or, perhaps, undertaken. To focus on characteristics that directly improve the human condition, some of the performance requirements that any design change should endeavor to satisfy are outlined below. Although these are not the only important issues to be resolved by design, they are those most clearly understood to apply in nearly all circumstances when the setting is intended for active human use.

Quality of Life Design Criteria

Landscape conditions that contribute directly to enhanced quality of life include:

- **Human needs**—The landscape setting is organized to satisfy the full range of basic physiological and psychological needs for the user populations. Although provisions for safety and shelter are commonly addressed, other considerations, such as public toilets or drinking water, are often lacking in landscape settings, even though they are universally desired.
- **Human activities**—The organization of the landscape is functionally appropriate with regard to convenient, non-conflicting relationships within and among adjacent activities. This helps eliminate much of the difficulty and stress that negatively impacts people's daily lives.
- **Aesthetic experience**—The landscape expresses a unity of form that incorporates sufficient novelty and complexity into a harmonious setting that stimulates a compelling sensual response and enriches users' aesthetic experience. The aesthetic preferences catered to are those most accessible to the anticipated users.
- **Access**—Use of the environment is dependent upon access to it. Access to the landscape, including universal access, and circulation within it are provided to improve people's physical and visual contact with the environment, while at the same time the landscape is arranged to protect it from deterioration due to abuse, uncontrolled use, or overuse.
- **Comfort**—Activity in the landscape depends on the level of shelter it affords to those using or accessing it. Protection from predictably uncomfortable elements such as summer sun or winter wind, through

features such as sheltered bus stops and shaded sidewalks, is a basic element of design provision.

- **Convenience**—Use of the landscape is dependent on the level of convenience available in accessing or using it for the activities provided. Arranging spaces for activity without conflict in access, function, or relationships with adjacent uses is a basic level of design accommodation.
- **Health, safety, and welfare**—The organization of activities and design features promotes society's general welfare by providing conditions and relationships that protect people's safety and security, and enhance their health and sense of well-being.
- **Social interaction**—The landscape is arranged as a behavioral setting to facilitate desired levels of social interaction among homogeneous social groups, and to afford choices to users that avoid forced contacts with heterogeneous groups, through the development of public spaces appropriate to a range of users' activities and values.
- **Accommodation of diversity**—The landscape is arranged to enhance opportunities for harmonious interactions among heterogeneous social groups and individuals through the development of public spaces respectful of people's diverse economic, social, and cultural backgrounds as well as their desires for community interaction.
- **Availability of choice**—The landscape presents users with options for appropriate interaction with the setting and with others based on individual preferences. It should provide opportunities for activities other than those anticipated. The public landscape needs to be based on individual and community opportunities to actively participate in controlling and shaping their shared living environment.
- **Sense of community**—The landscape needs to be arranged to facilitate the formation and maintenance of community. People are a social species, with many of their human needs being satisfied by participation in a community setting, and consequently much of their behavior is devoted to community interaction and cooperation.
- **Cultural sense of place**—The landscape setting expresses a culturally specific sense of place that is symbolic of, and responsive to, the unique

characteristics of local cultural conditions and traditions, and thereby enhances opportunities for community interaction and attachment to place.

- **Legibility and wayfinding**—The landscape provides sufficient order and clarity to satisfy people's cognitive need for environments to make associational sense by revealing the organization of the setting and how it might be used and navigated. The setting reveals itself as a repository of critical activities, processes, and features; it facilitates users' comprehension of the physical environment; and it provides understandable cues to appropriate behavioral choices and movement.
- **Historic precedent**—The landscape incorporates, protects, and celebrates historically and culturally significant features and settings of the local and regional environment in order to preserve cultural identity, maintain a narrative record of cultural heritage, and enrich people's knowledge and experience of place.
- **Equity**—The publicly shared landscape is designed as a setting to foster human interaction, social equity, and cultural evolution. It avoids creating opportunities for some at the expense of others.

Quality of Environment Design Criteria

In addition to direct criteria, there are design requirements that indirectly satisfy quality-of-life criteria. These are the criteria that establish the quality of the shared living environment and represent basic performance requirements for most landscape settings.

- **Environmental fit**—The landscape is arranged to reduce conflicts between human activities and natural processes. The landscape integrates human activity into the landscape in ways that insure its continuing vitality and provide benefits such as habitat maintenance, biological diversity, clean air, clean water, and healthful living conditions. The landscape setting employs existing ecological and geomorphic processes to satisfy human use and management functions, such as site drainage, climate amelioration, plant selection, and maintenance.
- **Environmental health**—The landscape is organized to maintain and enhance the health, diversity, and stability of existing ecosystems. The

setting protects critically important environmental processes such as succession, habitat complexity, soil genesis, groundwater recharge, and erosion control.

- **Biological diversity**—The biological diversity of the landscape is retained and protected in order to sustain community health and dynamics. Exotic species are eliminated or avoided in order to prevent the deterioration of the ecological interrelationships necessary for the health of the community.
- **Resilience**—Landscape complexity and diversity are retained and facilitated to impart resistance to ecosystem disturbance and to provide the capacity for recovery needed to respond to perturbation and adapt to long-term change.
- **Resource management**—The landscape is arranged to manage systems such as the hydrologic regime in order to maintain groundwater recharge and stream flow in waterways. Planting selections are made to reduce requirements for supplemental irrigation and mechanical maintenance. Urban and agricultural practices are managed to reduce or eliminate fertilizer and pesticide runoff into ground- and surface water resources.
- **Resource conservation**—The landscape is organized to maintain the continuing availability of renewable environmental resources, both on- and off-site, and promote their management to ensure the ongoing provision of food, fiber, shelter, and fuel. The landscape is organized to be sustained by locally available resources.
- **Energy efficiency**—The landscape is organized and maintained to engage local energy opportunities, and it avoids placing an undue burden regarding long-range energy consumption and carbon-emission pollution for routine operation. Strategies such as orientation and wind or solar energy systems are used to reduce reliance on fossil fuels.
- **Flexibility**—The modified landscape condition retains sufficient flexibility and resilience to accommodate future change and evolution without undue disruption of ongoing human activities or natural processes.

- **Sustainability**—The design enhances ecological complexity, diversity, and vitality, and it reduces dependence of resource consumption. Ecological services and processes are protected and employed in order to maintain the health and continued regeneration and evolution of the natural system.
- **Environmental sense of place**—The landscape expresses an environmentally specific sense of place that is responsive to, and integrated with, the unique characteristics of local ecological and geomorphic conditions and processes.

The design considerations outlined above describe the specific intentions or goals of a design. But design quality depends on *how* the goals are provided as much as on *whether* they are provided. The defining feature of a design is how well the parts from which it is constituted have been integrated into a unique, coherent whole. While it might be unrealistic to expect any design to satisfy all the performance categories outlined above, it would be equally unrealistic to ignore many of these issues and still expect a design to bring about comprehensive and beneficial change in the landscape.

Lifestyle and Health

Quality of life depends on many aspects of the living condition. One of the most important of these is health. In addition to concerns for social and psychological health, as discussed in the previous chapter, it also is concerned with physical health.

One of the most prevalent public health problems in the United States today is obesity: more than a third of adults and 17 percent of children are obese (Ogden et al. 2014), with the inevitable influence this has on general fitness and health. This is only partly related to diet. It is also due to our increasingly sedentary lifestyle (Lopez 2004); a quarter of Americans are estimated to get no exercise at all.

One of the reasons for our sedentary lifestyle has to do with the design of our living environment. Contemporary designers and developers have not created urban environments to facilitate safe and convenient walking or biking as an integral part of life (Levy 2003). In fact, we have designed them, perhaps inadvertently, to discourage it, and in so doing, we have denied for many the opportunity to keep themselves in good physical condition as a normal outcome of everyday life experience. Americans take only about 5 percent of their routine trips on foot. Europeans and Japanese, by comparison, take between 20 and 50 percent of their trips on foot (Kay 1997; Ewing et al. 2003).

Without fully realizing that we are doing it, we have designed our cities to create an unhealthy environment that is expensive to maintain. Designs to place greater reliance on pedestrian movement would be a major step in the direction of correcting some of the disadvantages that have been built into the contemporary urban environment. But effective reliance on pedestrian movement would require more than the provision of additional or more-convenient and accommodating sidewalks. The entire pattern of urban development, with emphasis on density, proximity,

Figure 5-3. *An example of utilities integrated harmoniously into the design of the street in a residential subdivision, designed by Chris Mulder Associates Inc. (Source: Michael Murphy.)*

safety, convenience, comfort, and aesthetic experience, would have to be reconsidered (Frank et al. 2003; Cawley et al. 2012).

The form of our contemporary living environment has not been the result of an integrated consideration of the myriad factors that intersect in the systems of the urban environment and its landscape setting or how they unite to improve design performance. Urban form in the United States is difficult to fault as "urban design" at all, since it is really the almost-accidental result of a wide array of highly segregated, single-purpose decisions for the development of different subsystems, such as land use, utilities, transportation, or green infrastructure. Rather than a comprehensive approach to the design of the city as a whole entity with overriding criteria for the health, welfare, and enjoyment of people and the health of the environment, it is an amalgamation of a host of different and largely unrelated systems designs, each operating with its own funding, values, and political interests.

Perhaps in the future, landscape architects will be able to become more holistic and collaborative in their work and begin to leave the urban landscape in a better condition than they have inherited. Designs of the future are almost certain to be evaluated on the basis of what might have been possible through greater integration and collaboration to more imaginatively apply the knowledge now at our disposal. But creating such a condition will require innovative thinking that begins with asking the right questions about what is to be achieved and how to respond to future challenges.

CHAPTER SIX

Design Form

Design is poetry—from the Greek, "to create"—insofar as it associates forms into new meanings.

—Paul Jacques Grillo

I believe that even philosophers interested in aesthetics find it difficult to explain the origin of our feelings toward forms which are dictated by the laws of statics or dynamics, since these laws are not intuitively understood nor can be explained by the experience of our ancestors. But there is no doubt that any product of high efficiency is always aesthetically satisfying.

—Pier Luigi Nervi

The role of design is to impose new order on the environment. In landscape architecture, order is imposed by altering the form of the landscape. Form and, in particular, the sensual and emotional attraction it elicits, have been the explicit focus of design for many centuries. Unfortunately, longstanding attention has brought us little closer to a thorough understanding of how the perception of form influences the people who experience it. The consideration of form is a matter of nuance and subtlety.

The fine distinctions in form relationships that discriminate between the aesthetically remarkable and the ordinary do not lend themselves to easy analysis or to the formulation of straightforward guidelines for

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creating them. In general, the salient considerations of form relate to *uniqueness*, *coherence*, and *proportional harmony*:

- **Uniqueness**—the distinctiveness of form relative to its particular function, materials of composition, and context.
- **Coherence**—the extent to which a form's consistency of its external boundary and its internal organization are clearly integrated.
- **Harmony**—the extent to which form is comprehensible as a pleasing, orderly, and congruent arrangement of parts relative to the whole.

Harmony between the parts and the whole of a design, as well as, particularly, how an observer perceives these relationships, appears to have a greater influence on an aesthetically satisfying form than the "correctness" of the form of its parts individually. Well-formed parts may, or may not, cohere to create a well-integrated whole. This, among other considerations, makes it difficult to explain form relationships; it is the arrangement of the parts—their interrelationships with one another and with the whole—that is most important to the resolution of form.

Further, each situation is unique, so the conditions accounting for the beauty of a landscape may be completely unlike those accounting for the beauty of a painting or a sunset. The challenge for the designer, no matter how disparate the parts or varied the circumstances, is to compose them into an elegantly formed whole.

Relating Design Quality to Form

The overarching goal of the designer, no matter what the style of expression, is to impose forms that integrate functional utility, social relevance, and aesthetic quality with environmental context. Design form, as an abbreviated or "shorthand" reference, is one of our primary ways of evaluating design quality.

Our ideas about design quality and form have a long history, developed continuously since design became a conscious aspect of human thought—which anthropologists describe as the beginning of human culture (Johanson et al. 1989). Science writer Robert Ardrey explains: "A pebble-tool is the simplest of all stone implements, consisting of nothing but a fair-sized pebble usually smaller than one's hand and chipped at one end to achieve a cutting edge. Crude though pebble-tools may be, they mark the beginning of the human capacity to create—to take something found in nature and fashion from it an object the design of which exists only in the mind of the maker" (Ardrey 1963, 272).

Over the course of human history, design and culture have coevolved as an integral aspect of who people are, what technology they possess, and how they live. People from different cultures and time periods have developed different styles of forming the material aspects of their lives. And paralleling these styles in form has been a corresponding evolution of aesthetic sensibilities and preferences, which, over time, have continued to evolve. Contemporarily, design styles seem to mirror the changing views of what is considered important about form. For most of the history of design, visible form has been our primary source of information in making these determinations. Because visual expression constitutes our primary, and most immediate, source of information about the world, it seems natural that visible form remains our most common means of comprehension and evaluation. What we think is determined as much by what we see as what we know. And from a holistic perspective, the quality of a landscape is also influenced by what we hear and smell and feel. There are many aspects of the landscape that we might find aesthetically attractive or unattractive.

Because traditional design approaches placed primary emphasis on physical form, most of our modeling techniques have been based on showing what a future condition would look like. Physical form became a preoccupation that doesn't focus the emphasis of design on shaping the quality of people's relationships to one another or the landscape, but instead on shaping the quality of the form intended to establish those relationships—as determined by the preferences of the client or the values of the designer as the expert on form, with attention focused on visualizing conditions such as proportion, pattern, scale, and color. When viewed from this perspective, design quality has been judged largely by technical and aesthetic considerations, not by the performance characteristics of improved human and ecological relationships—that is, of sustainability.

But the purpose of design is not just to create new physical forms. Innovations in form are introduced for the purpose of creating new and improved relationships between people and the landscape. The perception of form, and one's satisfaction with it, is only one of these critical relationships. Design form has taken on new and more integrated meaning. And just as importantly, form must also express these relationships if it is to communicate that meaning to users.

The question for theory is: What makes form meaningful? One thing we understand is that the form of a thing or place needs to facilitate the function it is intended to perform. The handle of a tool, for example, must fit the hand in an ergonomically appropriate way relative to the force the hand is intended to apply. If the tool is a spade, for example, it should also facilitate optimum leverage in the penetration and movement of the soil with minimal effort from the user and without stress on the bone structure or musculature of the limb applying that force. The form of an object or place should also convey information about what it is that is being perceived. The user of a spade should be able to intuitively understand which end to grasp and which end to push into the soil for the greatest effect.

To make form comprehensible, the designer attempts to clarify and distinguish the form being created. This is facilitated by making form distinctive from its background or from the form of other objects in proximity to it, which is often achieved through techniques such as employing novel structural arrangements, methods of connections, or heightened texture, color, or value contrasts, thus enabling a designed form to be clearly distinguished from other forms or its surrounding environment: to express itself for what it is.

At the same time, to avoid an expression that is discordant or distracting, the designer may employ form taxonomies or color variations that conform to a coherent suite of forms or colors in order to simultaneously separate and harmonize a distinct form with its surrounding context. One of the primary aspects of form is its relationship to context.

Architect and design theorist Christopher Alexander emphasizes three interrelated considerations for assessing design quality: *form*, *context*, and *fitness* (Alexander 1964). He considers form and context as indivisible—one cannot be understood without considering its relationship with the other. Environment-behavior researcher John Zeisel proposes different, somewhat more descriptive terms for these considerations: *internal* *coherence*, *external responsiveness*, and *acceptability*, but these terms address, essentially, the same issues (Zeisel 1988). These integrated considerations for evaluating design quality are summarized as follows:

- **Form/Internal Coherence**—an expression of the organizational relationships between an entity's parts and its whole. If the form is a bench, for example, it needs to be constructed of materials that are composed in such a way that the bench will be able to hold together and support the intended load without failure under conditions of normal use. The parts also should be visually perceptible as constituting an integrated whole that conveys its integrity of form.
- **Context/External Responsiveness**—how form relates to the external conditions to which it responds: the forces of the environment, to include users that place demands on form. If it is an outdoor bench, it must have the structural capacity to support a person in a comfortable position and to withstand the forces of sun or rain or moist ground without excessive deterioration that might weaken these relationships.
- **Fitness/Acceptability**—the mutual satisfaction among the relationships between form and context. Design is a process of satisfying the performance demands that form and context place on one another. The form of a bench must convey its appropriateness for the intended use, fulfill that purpose to the satisfaction of the user, and express itself in a way that users will find appropriate relative to their expectations and values.

Explaining the reasons why a form might be considered beautiful or aesthetically satisfying can be especially challenging; it is difficult for designers to provide an understandable explanation of how they arrived at some specific form recommendation. Because most clients have spent little time considering the nuances of form, their lack of preparation for understanding abstract explanations of the designer's rationale can make the discussion of form frustrating for both designer and client.

And the more time designers spend thinking about form, the greater the separation between their understanding and that of the people for whom a design is intended. (This same kind of frustration is common in discussions between beginning design students and their instructors.)

People can discriminate between what they prefer and what they do not, or what they consider beautiful or ugly, even if they are unable to say why. But verbal language, the common medium of communication, is ill suited to an explanation of why or how the designer reaches a physical form resolution. Graphic communication—visual display of form relationships—is the most reliable language for a discussion of the form of objects or places. For now, we will examine several approaches to form, providing a foundation for the visual thinking and graphic communication discussed in chapter 10.

Classical Form

The search for perfect harmony in form reached a zenith when the ancient Greeks invented geometry and applied mathematical proportional relationships to art and architecture (Murphy et al. 1972). The golden section (attributed to Pythagoras, ca. 500 BC), also called the golden ratio or the divine proportion, with a ratio of 1 : 1.618 (see fig. 6-1), was considered an ideal for many centuries. It represented harmonious relationships in both physical and mathematical properties. The "divine proportion" can be "expressed in the equation form: $A : B = B : (A+B)$. This is the formula of the celebrated golden section, a uniquely reciprocal relationship between two unequal parts of a whole, in which the small part stands in the same proportion to the large part as the large part stands to the whole" (Doczi 1981, 2).

By the fifth century BC—before art and science were thought to fall into different categories of thought—Athenians were applying these sophisticated, mathematically derived proportional relationships to create aesthetically and intellectually satisfying forms in art and architecture. In their search for perfection in form, the façade of the Parthenon (see fig. 6-2) was designed to conform to golden-rectangle proportions (Van Mersbergen 1998). The Romans later adopted these models of art and architecture more or less directly and incorporated them into their own culture. Through their extensive imperial reach, the Romans distributed these forms of expression throughout the Levant and Western Europe.

Mathematically proportional relationships similar to the golden section reached Europe during the Middle Ages. In 1202, the mathematician

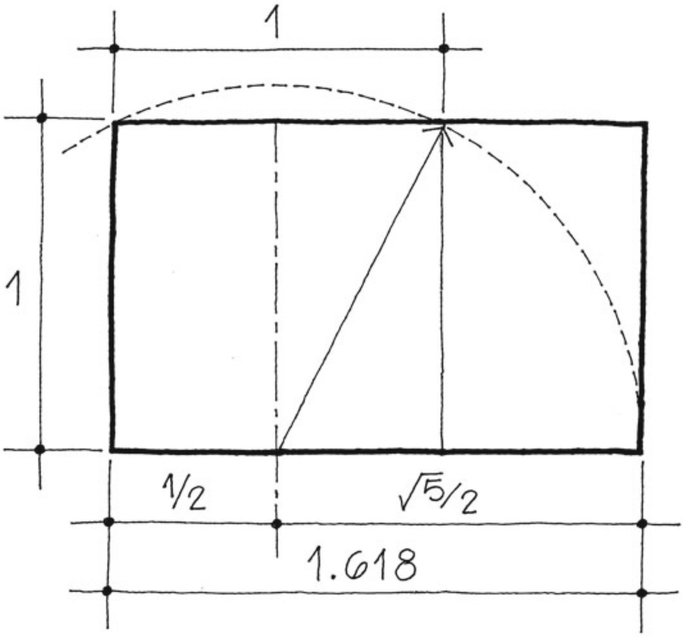

Figure 6-1. *Proportional relationships of the golden rectangle.*

Leonardo Bogollo, known as Fibonacci, published a number series that had originated four centuries earlier, probably with the Muslim scholar Al-Kwarizmi from his work on Hindu-Arabic numbers (Scott et al. 2014). The series established relationships closely approximating those of the golden section (Sigler 2002). The sequence, known today as the Fibonacci series, begins with 0. The second number in the series is 1, then, these two numbers are added to produce the third number in the series. Thereafter the last two numbers in the series are added to yield the next, thus: 0, 1, 1, 2, 3, 5, 8, 13, 21 . . . and so forth. The division of two adjacent series numbers produces a ratio nearly identical to the 1 : 1.618 of the golden section. A Fibonacci spiral (see fig. 6-3) is created by quarter-circle arcs connecting the corners of joined squares with the dimensions of Fibonacci numbers as the basis for a spiral; the sizes of the adjoining squares being formed by the dimensions 1, 1, 2, 3, 5, 8, 13, 21, 34 . . . etc.

These proportions are common among the patterns of nature—in the spiral of a nautilus shell, for example. Other examples of these

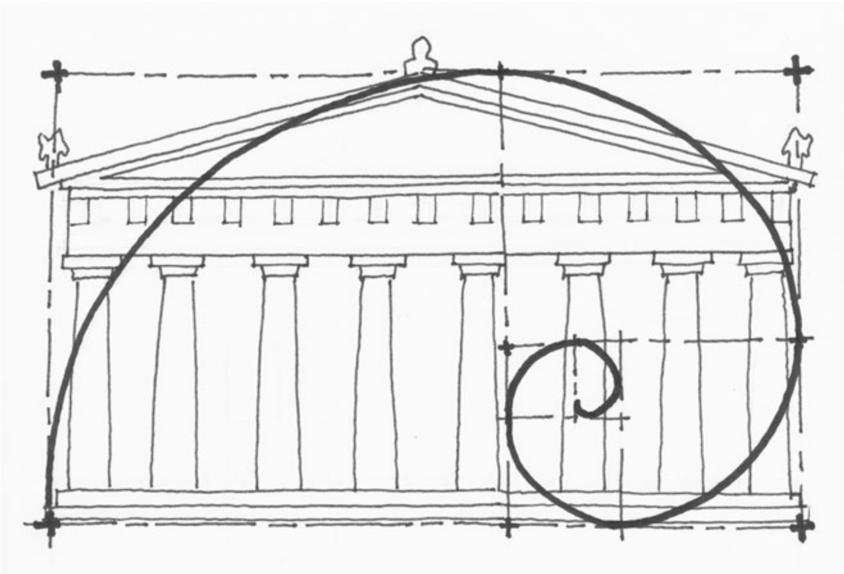

Figure 6-2. *Golden section proportions of the Parthenon.*

proportional relationships are illustrated by the phyllotactic spirals of florets at the center of a daisy flower or the unfolding fronds of a fern. Daisy florets are arranged in a pattern of intersecting sets of clockwise and counterclockwise spirals; each set of florets has a predetermined number of spirals: 21 clockwise and 34 counterclockwise—two adjacent Fibonacci numbers. The sunflower displays florets in intersecting spirals of 34 and 55 (Vogel 1979). Many flowers have 3, 5, 8, 13, 21, or 34 petals. The golden section and Fibonacci relationships were held to possess an almost magical capacity to yield perfection in the union of mathematical and visual harmony. Although it is unknown why these relationships are found in nature, speculation has focused on their biological efficiency, lending support to Nervi's contention that efficient forms also are aesthetically appealing.

It was later, during the Renaissance, with its focus on rationality, reason, and "man as the measure of all things"—a comment originally attributed to Protagoras, ca. 450 (Jowett 1948)—that designers began to impose precise geometric forms on the plan organization of the landscape.

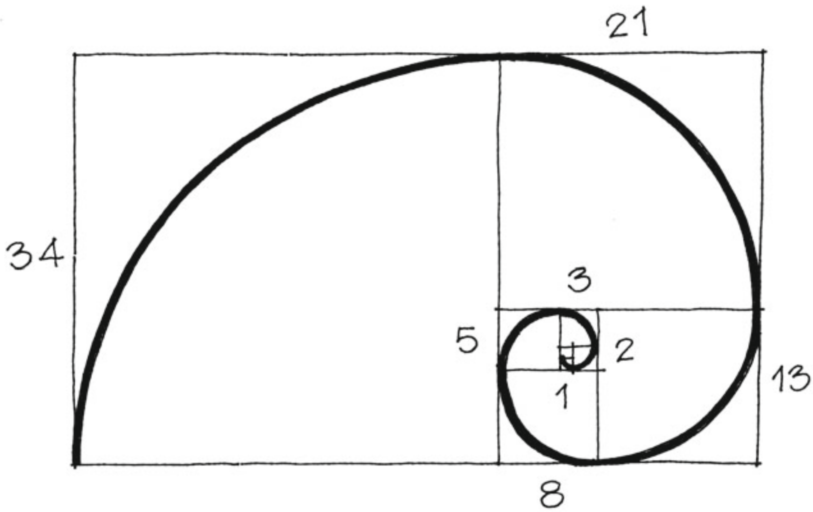

Figure 6-3. *Fibonacci spiral.*

Geometry provided the rationale for organizing the landscape to conform to the notion of mankind's position of superiority in the world.

The designers of places such as the palace gardens of Versailles (see fig. 1.3) in France (designed by André Le Nôtre in 1661) and Herrenhausen in Germany (designed by Martín Charbonnier in 1666) sought to "humanize" the form of the landscape by the imposition of rational geometric order. During the Renaissance, the application of regular geometric relationships to order the planned form of the landscape became a trend that lasted for centuries. We still see these applications today. One may assume that these form relationships persist because people continue to find them satisfying, and perhaps because they satisfy a need for reassuring and predictable order in the environment.

Inevitably, designers began to change their concepts of form and the appropriateness of geometric determinism. The application of geometric proportional relationships, while easily adapted to architecture (e.g., the proportions of façades, windows, and doors) and paper products (e.g., the proportions of business cards, index cards, and currency), proved less relevant to the form of the landscape, and then only by way of a long-term commitment of resources to maintain these inflexibly static forms. Reconciling the irregularity of the landscape's dynamic topographic condition with geometric precision presents intractable problems, not only for design and construction but also for the long-term maintenance required to sustain such rigid proportional relationships. The formal basis for widespread change in landscape design appeared with the eighteenth-century English Romantic movement (see fig. 6-4). Popular landscape paintings of the time commonly depicted an earthly "paradise" with harmony between mankind and nature. This painting style influenced a shift from geometric to naturalistic form in the design of gardens (Howett 1987).

During this period, designers such as William Kent and Lancelot "Capability" Brown began to compose landscape form as a "natural" scene or "portrait" of the landscape, meant to be viewed from a particular vantage point. Formal entry drives often set the stage by leading to the primary viewing position with an image of a residence's point of grand arrival (Grese 1992). Features such as axial views and vistas to presage arrival became accepted as the basic structure of a landscape composition. Inevitably, these "rules" for formal design composition, like the earlier "rules" of geometric proportionality, were rejected and replaced with new innovations over time. Today, even architecture itself no longer follows the

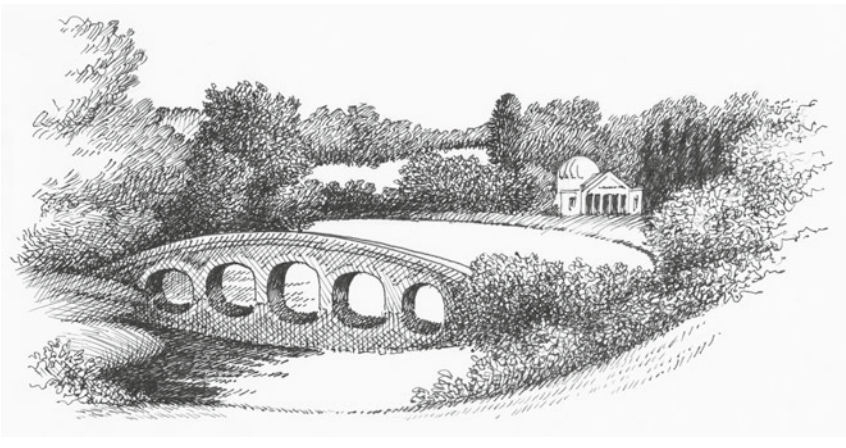

Figure 6-4. *Romantic-era English garden at Stourhead, designed by Henry Hoare II.*

classical "rules" of geometric proportional harmony; consider a modern building, such as Frank Gehry's Walt Disney Concert Hall in Los Angeles (see fig. 6-5).

Design thinking about form has evolved continuously over the last half century. Through the first three-quarters of the twentieth century, the design disciplines increasingly followed the admonition that "form follows function" (Sullivan 1896). By the mid-twentieth century, American landscape architects began to break from formal design traditions—as well as from a purposefully informal or naturalistic style—and the limitations they imposed. Under the leadership of innovative young landscape architects such as Garrett Eckbo, Dan Kiley, and James Rose, influenced by the abstract painting of the early twentieth century, there were concerted efforts to explore and expand the freedom and possibilities of form. Again, design style was being influenced by the art form of the period. The formality of both geometric regularity and naturalistically contrived form were rejected in favor of a fresh approach. These young modernist designers sought more expressive and artistic forms that were free and unrestrained in response to the problems they hoped to address and as a more accurate reflection of the dynamic contemporary society for whom they designed (Eckbo 1950; 1964). These often geometrically

Figure 6-5. *Walt Disney Concert Hall in Los Angeles, designed by Frank Gehry. (Source: Wikimedia Commons.)*

irregular designs combined angles, arcs, and tangents to shape the features of the landscape into unpredictable and novel patterns (see fig. 6-6). This modernist style became a dominant theme in the organization of landscape form that lasted for many decades, and it remains common. But by the mid-twentieth century, the influences of abstract art, in reaction to modernism, reasserted themselves once again in the landscape forms of designers such as architect and engineer Luis Barragán and landscape architect Peter Walker with the adoption of minimalist approaches to eliminate the redundancy and ornamentation that interfered with the clarity of form, while postmodernism reintroduced and reinterpreted it shortly thereafter. The relationships between art and design have remained close for many centuries and are likely to continue.

The landscape, however, is not a canvas to be viewed from above. The fascination with the plan image of design as a composition on the surface of the Earth took on an importance among designers that, for a time, shifted the emphasis in form from the normal eye-level view to the pattern of design as seen in *plan view*—that is, the bird's-eye view from above, a perspective rarely seen by users (Booth 1990). This preoccupation with plan composition had the unfortunate effect of shifting the designer's attention away from considerations of landscape form as it is normally experienced.

On the other hand, focusing on the compositional aspects of the plan as an abstract design arrangement had the benefit of directing the designers' attention to the interrelationships of form and pattern in a more conceptual and objective way. The plan view provided the most dimensionally accurate way of organizing the juxtaposition of adjacent relationships and their context. It also made the form of each piece of the composition more explicit as a discrete entity, regardless of its function or the material of its construction; further, this perspective revealed how each piece served to hold the others together in the formation of a tightly integrated composition (see fig. 6-7). Moreover, because these new forms were so intricately composed, they resulted in designs that were no less rigid and inflexible than those from the previous formal traditions they sought to replace.

To be perceptually effective, design forms for the landscape must be

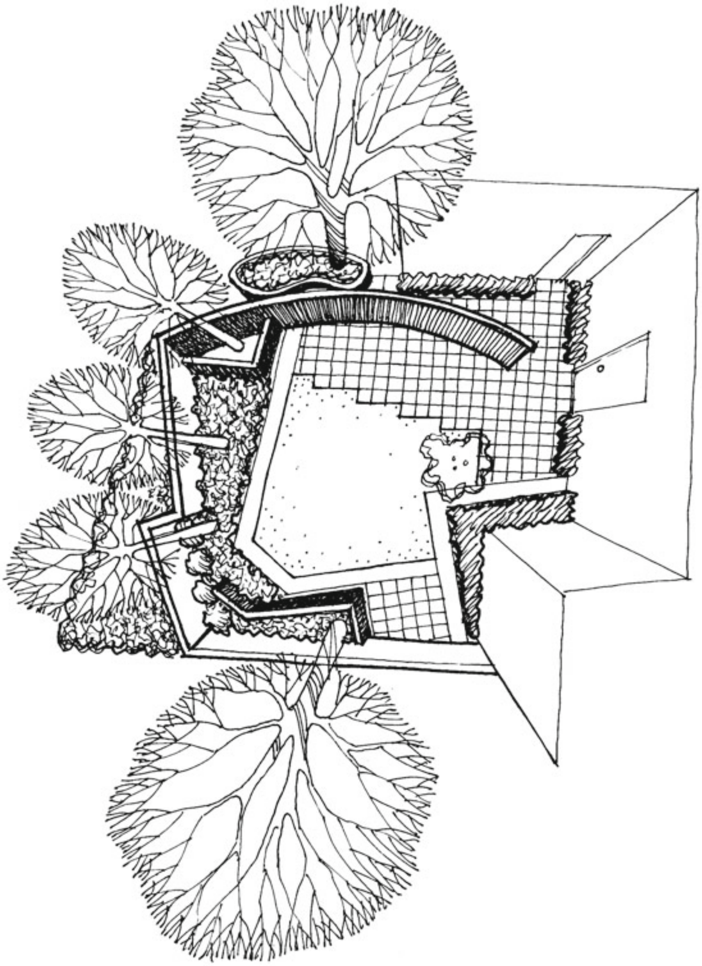

Figure 6-6. *Plan perspective view of a small garden designed by Robert Royston, ca. 1946. (Image based on Treib et al. 1997.)*

considered in three dimensions. In fact, the fourth dimension, time, is just as essential, since these compositions rely heavily on living and dynamic materials that change and mature over time. As a consequence of these dynamic materials, as well as that of the nature of the landscape itself, design is equally dependent on the maintenance it receives to sustain the desired form. From the 1940s through the 1970s, it was commonly thought

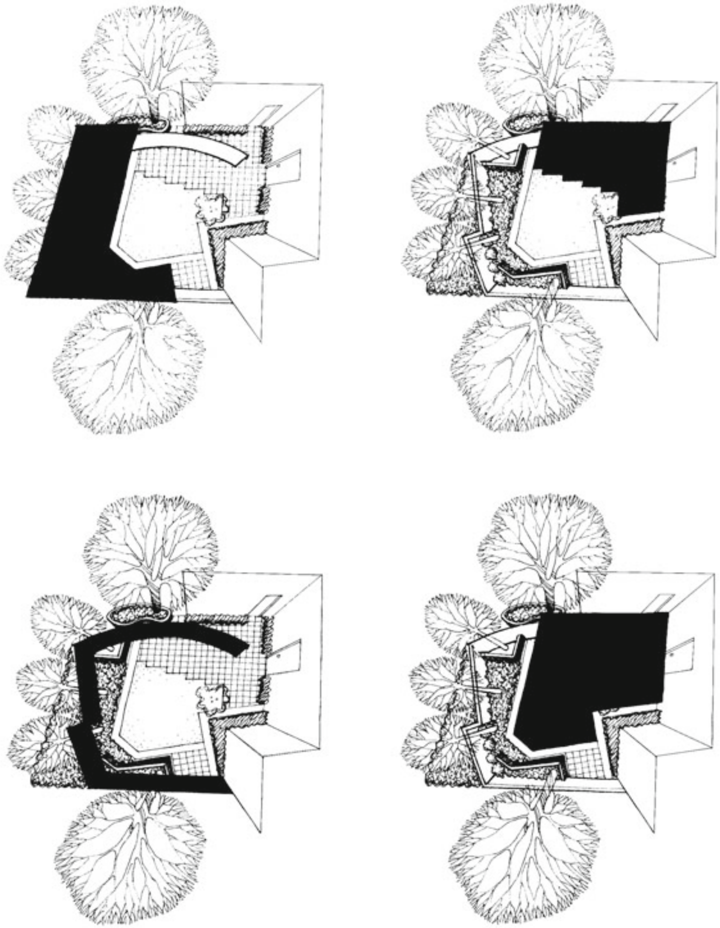

Figure 6-7. *Abstract analysis of the plan-form relationships of different elements of Robert Royston's garden design composition.*

that the functional aspects of the landscape could be improved by controlling the aesthetic (primarily visual and spatial) characteristics of landform, to a large extent, as seen from plan view.

In reaction to the limitations of plan composition, as well as more pragmatic considerations, attention to design form changed once again. The plan became relied upon as an important organizational tool, but the image of space and form as beheld by an observer within the landscape reemerged as a principal influence on design form decisions. By the 1970s, many designers began to accept the notion that the aesthetic aspects of landscape form could be improved by the integration of functional and ecological relationships. Responding to Sullivan's admonition that form follows function, Ian McHarg insisted: "Form follows nothing—it is integral with all processes" (1969, 173).

McHarg introduced a radically new way of looking at the form of the landscape, and our design responsibilities in shaping it, with the publication of *Design with Nature* in 1969. He contended that the form of a thing should be an expression of what it is. The form of the landscape is determined by the interrelationships between people and the environment. Today, at the beginning of the twenty-first century, landscape architects have begun to assume a more comprehensive view: that functional, ecological, social, technical, and aesthetic issues represent different—*but equally important*—dimensions of design meaning and, as a consequence, the different demands that coalesce to influence design form.

An ecological approach assumes that these issues represent multiple ways of examining the possibilities for forming the landscape—different forces or value sets, each of which must be integrated by design into a comprehensive whole. In practice, each of these values is driven by the designer's knowledge of it. And as the designer's knowledge of these issues increases, the meaning of form is expanded and enriched. Today, we have reached a point at which it becomes difficult to support the proposition that good design decisions rest primarily on the visible form or style of the landscape: essentially, what it looks like. *Form must now perform*. Although design must provide a satisfying visual appearance, it must do more. In particular, design must be *informed* by evidence from a broad array of disciplinary perspectives.

Natural Form

The forms of living organisms are instructive in an examination of design theory, since all natural forms may be thought of as meaningful responses to context. In the landscape, the forms of hills and valleys are the result of long-term processes of erosion and deposition. In plants, the shape of leaves optimizes the opportunity to receive radiation for conversion by photosynthesis into carbohydrates. In animals, ears protrude like shells to capture sound, and eyes are binocular, the better to perceive objects and their precise spatial relationships. These seemingly purposeful adaptations appear to be formed specifically to perform these functions. To the extent that we understand them, natural forms represent precise responses to the forces acting on them. It is the specific forms of natural organisms that enable them to perform their roles in life, without which they could not survive and thrive. Form reveals the process of integration between an organism and its environment over time. Examining the conditions and life forms in nature helps us to understand the relationships between form and context, a consideration central to the development of theory, since it is the role of the designer to establish and sustain such relationships.

There is enormous diversity among the life forms in nature. Each species is unique in its form. It is through this individuality of form that we recognize and classify organisms—we know that something is a horse because it looks like a horse; that is, we see that it has the characteristics of a horse. This uniqueness in form is due to the different environments that organisms inhabit and the precise relationships they have established over time with the array of conditions in which they live.

Over time, the form of organisms seems to be continuously "redesigned" by the evolutionary process to improve their fitness for survival in a dynamic environment. But this is not strictly true. *Design* has prior intent. *Evolution* does not. That is, evolution, although directional, is thought to proceed according to chance opportunities for change, rather than along a preordained path to a specific predetermined conclusion. As far as we can know, there is no *final* form in nature.

Because geological and ecological processes are continuous, the form of the landscape continues to unfold. In the same way that these processes modify the form *of* the landscape, they also precipitate change in the life forms resident *in* the landscape. The resulting form of the environment and the elements that comprise it represent the most fitting expression of their integrated relationships *at a particular moment*—and this form will continue to change over time.

Undue emphasis on form as the *purpose* of design misses the point. Form is not the purpose but the *medium* of design, just as form is not the purpose but the *strategy* for life. Each organism is uniquely formed to facilitate a nearly perfect point-in-time relationship with that part of the environment (the ecological niche) which it inhabits and on which it depends for survival and must continually adapt to as evolving conditions require.

Designed landscape form needs to be more than functional and physically attractive. It should also be amenable to change, and perhaps more importantly, it should *promote* change. To fit appropriately into its dynamic context, landscape needs to facilitate the continued elaboration of new and more-appropriate systemic relationships. One of the most important considerations in design is to create connections that improve our ability to perceive complex relationships and facilitate deeper understanding of the dynamic meaning of form. Deeper understanding improves our ability to enable system change toward increasing fitness of form. Each beautiful thing we find in nature—whether an animal, a snowflake, or a landscape—is only a physical manifestation of itself, an expression of what it is and how it relates to its external environment, how it has been formed by relationships as they currently exist (McHarg 1969). The more we understand these relationships, the more we are able to appreciate the deeper beauty that landscape form represents. If designed forms were shaped to improve our understanding of the complex relationships we hope to address, and improve our understanding of the processes that create them, they would do much to advance not only beauty in the form of the landscape, but also its more appreciative and informed use—and its continued evolution.

Designed Form

The creation of form is the designer's means of bringing everything together, of integrating what we know and what we want to improve about the landscape, and expressing how it is to be organized in the future. The search to create meaningful form begins with the identification of design influences. The critical issues that influence form may be thought of as *design forces*. These forces may reflect the values and priorities of the designer, the client, the user, the community, or the environment. Preferably, all these interests are systemically integrated to produce a balanced set of influences acting in concert to determine landscape form. When these forces are in a balanced relationship, the form may be thought of as being holistically derived (see fig. 6-8).

When influences are expressed with greater or lesser emphasis, their relative effect on design decisions may be read from the resultant form. A common criticism of designs considered to be of inferior quality is that too much emphasis has been placed on reducing the initial cost of construction, or perhaps too little value has been placed on the user's functional requirements or the quality of the user's aesthetic experience. In contrast to a balanced influence of forces, altered priorities shape design form to reflect either an exaggeration or a diminution of the value we place on particular influences (see fig. 6-9), and thus they result in a distortion of the design form. Emphasizing different values or forces produces different forms.

It is important to understand that the landscape is an artifact that expresses us as a culture (Meinig 1979; Jackson 1984). But the landscape is more than just an artifact. It also is an environment that sustains us, makes

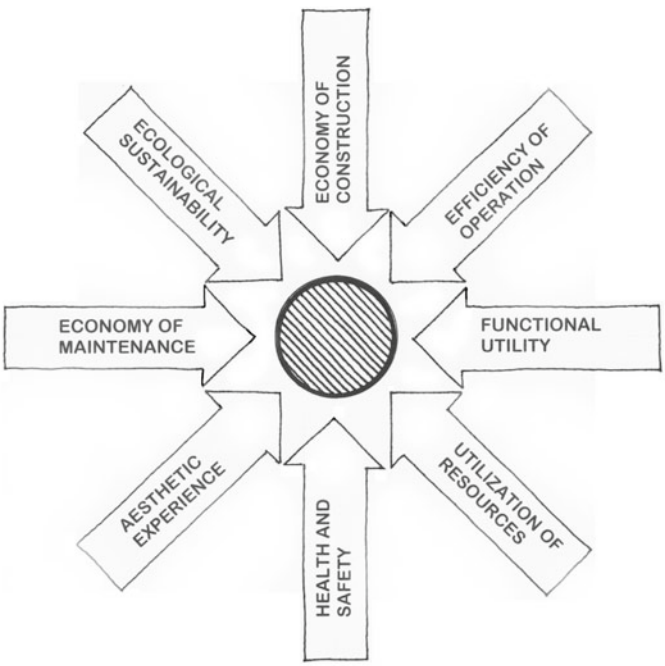

Figure 6-8. *Balanced or equal forces shaping design form.*

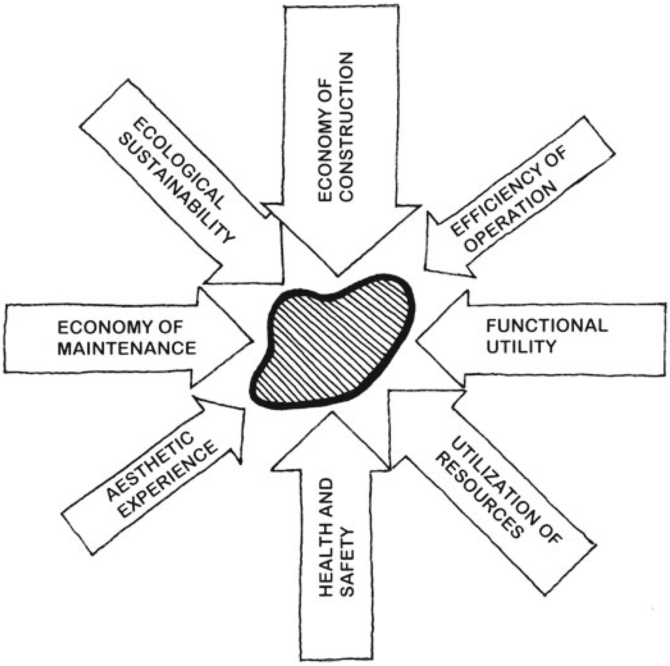

Figure 6-9. *Unbalanced or unequal forces shaping design form.*

our activities convenient or difficult, affects our comfort, influences our sense of well-being, provides expressions of personal or group identity, and improves human satisfaction. For example, a worn or poorly maintained environment to which people are strongly attached (in the way that the citizens of New Orleans are attached to their city despite economic disparities, destruction from hurricanes, and other pressures) may be highly successful as a living environment (Altman et al. 1992). Conversely, an elegantly designed and well-maintained suburban community, where people reside but feel no compelling sense of attachment or community, may prove unsuccessful. The extent to which the living environment is perceived as a territory to which we belong is an important aspect of our relationship with place. It is the *form* of the urban landscape—as an expression of the processes of history, group formation, activity, and territoriality—that establishes the nature of a successful environment with regard to a sense of shared belonging.

The search for appropriate form in design should address at least three basic considerations. Interestingly, these are the same issues that must be addressed when the goal is to understand the landscape. From a systems perspective, these are the fundamental characteristics of design form:

- **Structure**—what are the salient physical relationships to be established in the landscape, and how do they relate to the context of the environment?
- **Function**—how are the activities that we design for, and their relationship with the context of the environment, to satisfy our needs and activities?
- **Context**—how might the changed form integrate into the existing landscape to accommodate prevailing processes, as well as to satisfy current needs and, in the future, accept further modification to meet new processes and needs?

The ongoing modification of landscape form is an essential response to evolving conditions and human needs. These are the design problems to be resolved. An associated challenge for the designer is how to promote change to meet current needs while preserving other site characteristics—some of which are dynamic—that have value; and how to determine which aspects of the landscape should change and which should not as the setting evolves.

While it is necessary that some features of the landscape be retained in their essential form, this should not be the case for the overall form of the landscape. It would be a tragedy if we were to lose places such as Yosemite Valley, about which John Muir once declared: "Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul alike" (Muir 1912, 14). Or the gardens of Versailles (see fig. 6-10), where architects first began to extend design change over the broad sweep of the landscape. Or Washington, DC (see fig. 6-11), where those same principles of form were used—paradoxically, since at Versailles the diagonal *allees* were superimposed on the grid to display the power of monarchy, while in Washington they were meant to express the formal establishment of a democratic republic—governance by the consent of the governed.

Designers need to form the matrix of the built landscape in ways that accommodate and facilitate, rather than obstruct, continuous evolution

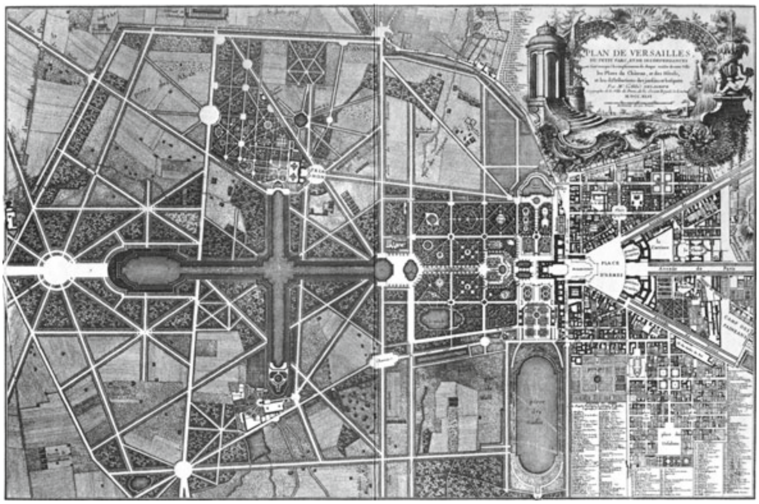

Figure 6-10. *Plan of Versailles showing the diagonal* allees *overlying the rectilinear street grid. Engraving by Abbe Delagrive, 1746. (Source: Wikimedia Commons.)*

Figure 6-11. *Plan of Washington, DC, showing Andrew Ellicott's 1792 revision of Pierre L'Enfant's plan using the same grid with overlying diagonal street pattern, as seen at Versailles. (Source: Library of Congress, http://hdl.loc.gov/loc.gmd/g3850.ct000509.)*

in landscape form. We may not have matured as a design discipline or as a society to the extent that we are yet capable of guiding this type of dynamic development of the landscape. We do not have answers to these questions because they have not yet been seriously posed. There are, however, promising signs of progress as contemporary designers begin to expand the reach of design influence with innovations such as urban wetland reclamation that cleanses runoff and restores ecosystems, greenway systems linking urban and regional environments to preserve habitats and wildlife, and storm water management and water-harvesting schemes to reduce urban flooding, improve aquifer recharge, and sustain ecosystem vitality (Fabos et al. 1995; Galatas et al. 2004).

The process of design, driven by values as well as knowledge, shapes the outcome of landscape form. And, in response, the form of the setting shapes human processes. As Winston Churchill once remarked, "We shape our buildings, thereafter they shape us." The same, of course, is true of the landscape. Thus, the contemporary designer may be thought of as more of a manager of evolutionary process than a creator of permanent landscape form.

One of the most obvious reasons that landscape form is transitional is that the materials of design, such as plants and water, are by nature dynamic. In addition to their functional and ecological roles, plants are an important component in the compositional aspects of the landscape. Because they are living organisms, they are perpetually changing—by season, for example, or life stage. Plant selection is made as much on the basis of plants' unique characteristics of form as their fitness for a particular environment. Plants are found in a wide variety of forms, sizes, colors, and textures, so choosing the species most appropriate to the envisioned composition must be based on a number of considerations. To use plants in an honest expression of their true nature, every possibility should be given to express them in their typical growth characteristics without over-reliance on intensive maintenance to sustain a desired form or compositional effect. Furthermore, as landscape architect Robert White cautions:

> Perhaps the most challenging aspect of planting composition is the fact that most landscape scenes may be viewed from an indefinite

> number of positions. In other words, as one moves about in any outdoor space, the composition is in motion as well. Although the designer cannot hope to realize the final results of a plant composition from every point of view, such compositions must be studied from several obvious vantage points if they are to be ultimately successful. (White 1966, 23)

Because plants may be expected to grow, change, and eventually die in any landscape situation, maintenance of their compositional role over time further complicates the need for careful consideration in their selection and use. Creating planting compositions with a capacity for regeneration, and thereby for sustaining their form and pattern over time, is a particular challenge for the designer.

The search for new and more appropriate form in design need not lead to yet another new and soon-to-be-replaced innovation in style. For inspiration, designers have only to look to the people to be accommodated, the activities to be facilitated, and the landscape to be changed or preserved. Determining the interrelationships between people and place, as well as the opportunities for addressing them more successfully, provides ample opportunities for innovation in design form.

Since each landscape has its own unique mix of climate, relief, geology, soils, plants, animals, history, people, and activities—and, significantly, the processes in which they are engaged—any design that deals with these issues holistically will inevitably be unique in its form. And since each designer's approach is also unique, the individual contributions of each one will result in a different expression, revealing the designer's capacity for understanding and innovation to integrate human activity into the context of the landscape. In this respect, André Le Nôtre's design for Versailles may be thought of as a masterpiece of design form. It expressed, explicitly, the power that Louis XIV held over people and the land. But the resources expended to maintain that form since the seventeenth century are an expense that can be afforded only by those with control over vast resources. Le Nôtre's landscape form is one that may never again find opportunity for expression.

It is primarily when we have preconceived notions of what the form of design "should be" that we fail to learn about or address the issues of design form appropriately. Landscape architect Catherine Howett (1987) argues that there has been a long-standing preference among landscape architects for the picturesque park landscape form, dating from at least the time of the English Romantic movement and introduced in the United States by Frederick Law Olmsted and Andrew Jackson Downing (Downing 1841). Before engaging himself in design, Olmsted spent several years walking and riding through the landscapes in England and the United States, which he described in his writings as beautiful and inspiring (Olmsted 1857). If this bias prevails, unquestioned acceptance of this inherited cultural model of an idyllic pastoral setting as the appropriate image of a beautiful landscape, just as with the geometric formalism of Versailles, would constitute an obstacle to objective evaluation and continued innovation in landscape form.

Aesthetics

The most compelling aspect of form is its aesthetic appeal: the extent to which one is attracted by the beauty and emotional impact of sensual experience. A fundamental concern in design is to make a thing or place beautiful so that it will be enjoyed and appreciated for the sensory pleasure it provides. The search for and appreciation of beauty and aesthetic experience is so ingrained in our thinking that it occupies a central position in our judgment and decision making about design, as it does in so many other aspects of life (Huntley 1970).

Aesthetic experience is held to be intrinsically gratifying, not because of any utilitarian benefit, but from the emotional satisfaction to be derived from it. The quest for beauty is a universal human trait. Its enduring importance has led to the development of the field of **aesthetics**, the branch of philosophy that deals with beauty or the beautiful—what might be described as the science of beauty and art. The study of aesthetics includes the psychology, sociology, ethnology, and history of the arts and their related fields. This formal definition suggests that there is congruence between art and beauty, a presumption that may or may not be borne out by many types of contemporary artistic expression, some of which reject formal concepts of beauty as the basis for meaningful aesthetic experience.

But even with traditional concepts of beauty and aesthetics, description is difficult. "Like all philosophy, aesthetics is a process, not a product, an inquiry, not an almanac" (Stolnitz 1965, 1). Our primary concern with aesthetics is to determine what characteristics of designs make them sensually attractive so we can apply that knowledge to improve design quality. People may be attracted by some essential quality of design, or simply by novel or skillfully executed forms of expression.

Affinity for the natural landscape is often described as an aesthetic attraction. But there may be an underlying reason for this attraction that goes beyond sensual appeal or sentimental attachment. The concept of **biophilia**, as described by evolutionary biologist E. O. Wilson, suggests that people possess an innate "urge to affiliate with other forms of life" (Wilson 1984, 85). In Wilson's view, this attraction explains the "connections that human beings subconsciously seek with the rest of life" and is a product of biological evolution. Indeed, this subliminal urge may "be evident in our preference for certain landscapes such as savannas or in the fact that we heal more quickly in the presence of sunlight, trees, and flowers than in biologically sterile, artificially lit, utilitarian settings" (Orr 2002, 25).

Attraction to certain landscapes may be indelibly encoded in our collective psyche as a consequence of our evolutionary history. Parks, for example, are typically developed as open grasslands with trees, possibly revealing an underlying preference for the form of the savanna as the most appropriate prospect-and-refuge setting (Appleton 1996). When we refer to a landscape as being "beautiful," it is an attempt to express not just its visual or other sensual qualities, but also the pleasure we derive from our experience of it and the compelling sense of attraction it holds for us. Although the judgments we make on the basis of aesthetic preference are among the most common aspects of everyday life, they are also, unfortunately, made subjectively or unconsciously, as well as individually. This makes understanding the basis for aesthetic attraction difficult. Since aesthetic preferences originate as a subconscious emotional response, we rarely think about them or discuss them in an objective or analytical way.

Sensual preferences become integrated into our thinking from the earliest moments of life. For the very young, sensual experience—awareness of when they are wet or cold or hungry—is essentially all there is before contact with the outside world provides experiences that accumulate in memory. As we expand our experiences and develop an awareness of the world around us, we begin to take pleasure from other sensual experiences, such as delighting in the sounds of a voice or the appearance of a familiar face, and, later, from the scent or color of a flower or the sound of a melody. Memory begins to influence our sensual pleasures. This awareness progressively moves us to make choices that are more related to pleasure and enrichment than utility.

Throughout our lives, as we take pleasure from sensual experience we expand and refine our individual tastes and preferences—a complex experience that changes and develops with learning. As we mature, our accumulated experiences alter our tastes in all areas of sensual perception: the music we listen to, the foods we acquire a taste for, the clothing we wear, the cars we drive, the movies we see, and the books we read. It is well understood, for example, that tastes in music or literature among the young are usually different from those of adults.

Taking direct pleasure from the landscape can also be a complex experience. Enjoying a spectacular sunset or the colors of autumn foliage seems to be a universally shared pleasure. But this pleasure is more than just visual stimulation. There may be other, more subtle aspects involved, such as feeling the changing temperature of the air and smelling its freshness, or simply understanding the difference between the novel image before us and ordinary experience. Through memory, our appreciation of the environment takes on growing complexity and meaning, as when we anticipate the approaching season and the changes it brings when temperatures begin to fall. The more we know about the landscape, or the music we listen to, the more we are able to appreciate its aesthetic qualities in increasingly complex and anticipatory ways. This does not mean, however, that we cannot experience aesthetic satisfaction with the landscape or music or painting unless we understand it fully. We need not understand the processes of nature to feel an aesthetic attraction to its beauty (Bell 1928). Indeed, we need only to experience the form of the landscape to have an appreciation of its features or characteristics. The more we know about the landscape, however, just as with music or painting, the more complex and profound our experience of the form may become.

Although aesthetic experience is based on *how* a thing is formed rather than *why* it is formed to produce the desired effect, the why and how must be addressed together. The designer cannot separate form and substance into distinctive categories and address them separately. Both *why* we design and *how* are equally significant and must be united in the designer's handling of them. Successful designs satisfy the intended purpose in such a way that both purpose and experience are brought together into a unified and compelling effect. Heightened aesthetic experience is not just the way we design; it also is one of our intended purposes in doing so.

Aesthetic Qualities

Despite our imperfect understanding of aesthetics, we have some useful insights about what contributes to an aesthetically satisfying experience. The qualities we understand a beautiful object or place to possess may be understood as the criteria by which we evaluate sensual phenomena. In evaluating aesthetic quality, there are a few general attributes—unrelated to issues of purpose or function—that we expect to find in an aesthetically satisfying experience. They describe the conditions designers hope to create that will lead to a meaningful experience for others. Significantly, it is when these qualities are united into a set of tightly integrated characteristics that aesthetic experience appears greatest. These qualities include:

- **Novelty**—the degree to which an experience is unusual or exceptional and achieves a level of perceptual significance that exceeds the expectations of ordinary experience. The perception of beauty conveys an unexpected and compelling sense of delight to the beholder (Maddi et al. 1961).

- **Complexity**—the extent to which phenomena express variety and diversity. The more complex a phenomenon, the richer and more engaging it tends to be. People's brains seem most aroused by patterns in which there is about 20 percent redundancy (Smets 1973; Wilson 2012). The simpler, less varied the phenomenon, the less potential it has to sensually engage or psychologically arouse and hold the audience's attention. However, complexity should not be perceived as sensually chaotic; variety and diversity must be balanced and integrated into a congruent whole.

- **Unity**—the extent to which the richness and variety of complex phenomena are integrated into a coherent and satisfying pattern of relationships (Bronowski 1964). Complexity and unity occupy opposing positions along a continuum of consideration. A very simple condition may be highly unified but lack diversity. Highly diverse conditions may be excessively complex or lack unified coherence. Neither great complexity nor great unity contributes to an elevated aesthetic experience in the absence of the other.
- **Harmony**—the extent to which the parts of the whole are perceived as being integrated in a logical, mutually reinforcing, and comprehensible way. Harmony exists when there is a unity of the parts to the whole that is perceived as highly appropriate and satisfying as a total experience, including harmony with setting.
- **Clarity**—the extent to which there is sufficient strength of form that it is easily grasped by the observer (Ulrich 1986). Unless the person engaged is readily able to apprehend the form, structure, and complexity of the experience, it is unlikely that the encounter will stimulate a pleasurable aesthetic response.
- **Intensity**—the extent to which one is attracted to become, and to remain, perceptually engaged in an experience and be sensually aroused by it. Unless the experience is emotionally compelling, there is limited aesthetic response. The more deeply felt the experience, the greater its aesthetic quality. Compellingly intense attraction may require an intellectual or cultural awareness of the relationships it expresses.
- **Security**—the extent to which a phenomenon or condition allows a person to engage in an experience without being preoccupied by concerns for personal safety (Ulrich 1986). Aesthetic response requires a perception of security.

There is some question about the suggestion that security is a qualification for aesthetic experience. Although a sense of danger can provide a thrilling sensual experience, that may be different from an aesthetically satisfying one. But then, perhaps none of these criteria apply universally. These are not so much the rules for achieving artistic or aesthetic success as they are clues to the type of conditions we may expect to result in an aesthetically compelling experience. In fact, these qualities may be more representative of the aesthetic criteria for *evaluating* design expression than for *producing* it. They may be best thought of as design objectives to be employed in order to achieve the goal of a satisfying aesthetic experience.

Although the terms are often used synonymously, there is a distinction between *aesthetics* and *beauty*. **Aesthetic experience** is an emotional response based on the awareness, selection, and understanding of the order produced by the objects, places, or experiences we admire for their beauty (Berleant 1992). **Beauty** is a quality that, when perceived, brings pleasure to the senses and charms the intellect (Huntley 1970). The perception of beauty is generally, but not necessarily, described as visual or aural perception—the images we see or the music we hear. Perception of the quality of beauty stimulates an aesthetic experience.

Access to beauty may, to some extent, be intellectually or culturally preconditioned. What is deemed to be pleasing or beautiful may be restricted to those conditioned by prior knowledge to appreciate a certain form of experience as being beautiful. A thing considered beautiful may be familiar but it cannot be ordinary. Compellingly beautiful things are rare rather than ordinary occurrences. Beauty has both sensual and intellectual aspects, even though it must be sensorially perceived to be experienced. Although a great deal can be learned from the description of a painting in a museum catalogue, or of a musical compositon on the dust jacket of a record, such learning cannot provide the aesthetic experience of seeing the painting or hearing the music.

It is important to discriminate between the quality of beauty and the object possessing that quality. For the designer, the question is not so much, *What is beautiful?* but rather, *What is beauty?* What conditions or characteristics do we identify when we experience a thing or place as beautiful? If aesthetics is the "science" of beauty, there must be a body of knowledge about what constitutes beauty. But as we see, this knowledge is difficult to define. Claude Monet, who spent much of his life communicating the beauty of the French landscape through painting, commented on beauty as being contextual and transitory: "For me, a landscape does not exist in its own right, since its appearance changes at every moment; but the surrounding atmosphere brings it to life—the light and the air, which vary continually. For me, it is only the surrounding atmosphere which gives subjects their true value" (Friedenthal 1963).

The experience of beauty is determined by the perceived qualities a beautiful thing possesses and the relationships it exhibits regarding its parts to one another and to their context. If we are unaware of these qualities, it is difficult to appreciate a condition as being beautiful, and thus it is to that extent that knowledge is required for aesthetic experience. When we are able to fully understand the relationships and thereby experience the emotions they engender, knowledge provides access to an elevated level of appreciation and aesthetic satisfaction. A person may be able to enjoy viewing the interior workings of a fine watch, but only a watchmaker would be able to fully appreciate the elegance of their forms and the intricacy of their movements. One of the designer's challenges is to clearly reveal the qualities possessed by form in order that the viewer can understand, and thus appreciate and enjoy, the experience of them.

Design, as opposed to art, has a utilitarian purpose and is executed for the benefit of others. Therefore, it is important that, in regard to beauty, greater priority should be given to the aesthetic values and preferences of the clients or users of the designed environment than to the values and self-expression of the designer.

Preferences regarding people's responses to the landscape have been found to depend on a range of factors, to include a setting's visual coherence, complexity, and legibility. In addition to visual considerations, aural factors also have been found to be critical to landscape assessment, in some cases playing a greater role than visual factors in determining a preference (Anderson et al. 1983; Gan et al. 2014). To further complicate aesthetic understanding, assessment—because it is based on a subjective psychological appraisal—also depends on personal concerns such as mood or satisfaction, which are difficult to assess objectively (Hull et al. 1995). The complexity of aesthetic evaluation makes our understanding of it tenuous.

During the course of evolutionary development, humans appear to have relied for their survival on a number of factors, including a high degree of visual acuity and the ability to process large amounts of visual information about the landscape. As a consequence, people seem to have inherited some pronounced biases regarding perception and landscape preference. One such bias is that people tend to prefer landscapes with visual qualities that facilitate their making sense of the information presented (Ulrich 1977).

Aesthetic preferences depend on many factors. One has to do with landscape complexity, which has been shown to be an important predictor of landscape preference (Schutte et al. 1986). Geographer Roger Ulrich found a general preference for moderate levels of complexity, with preference levels dropping if the complexity became either too low or too high. Conversely, he found that perception is characterized by a bias for patterned information, which might also include conditions with high complexity (Ulrich 1977). But because people prefer landscapes that appear orderly—meeting conventional expectations—this can be problematic for ecologically managed landscapes. If the users of a setting consider it to be disorderly or messy, they may bring pressure for conformance with conventional maintenance practices—despite ecological intentions (Ulrich 1986; Nassauer 1995; Galatas et al. 2004). However, a degree of ambiguity, which could include high complexity, also contributes to landscape preference when a setting presents a sense of mystery.

Mystery, or the extent to which information is concealed rather than revealed, is characterized by a condition where the viewer can gain additional information only by proceeding further into the scene (Lynch et al. 1992), which prompts more-intense engagement. Mystery has consistently been shown to be a dominant factor in landscape preference (Ulrich 1977). Ulrich developed a landscape preference model that predicted high preference for scenes with attributes that aid in perception and comprehension or convey an explicit suggestion that there is further information to be gained. The legibility attributes that his model determined as preferred traits include:

- **Complexity**—The scene contains a number of different perceptible elements.

- **Focus**—The visual order is patterned on a dominant feature or space.
- **Depth**—The scene permits clearly defined, moderate-to-deep visual penetration.
- **Ground plane**—The ground surface is uniformly smooth with even textures.
- **Curving sight line**—There is a suggestion that new landscape information lies beyond view.

Among these variables, mystery was found to be the single most powerful predictor of landscape preference; contradictory to the viewer's need to understand and make sense of the information presented, mystery actually heightens landscape attractiveness, irrespective of the other variables. It appears that the tension between opposing propositions—in this case, between understanding and ambiguity—provides a principal clue to aesthetic attraction.

Context is always relevant with regard to perception and aesthetic judgment. And unlike the artist, who can confine the aesthetic experience to the limits of a canvas or a concert hall, the landscape designer can rarely limit the influence of the broader landscape context in shaping the viewers' perceptions and framing their aesthetic experience. The landscape is formed by processes, such as geology or climate or economics, over which designers exercise little control and, as a consequence, which limit designers' influence over many aspects of the landscape as others might perceive it. This makes the concern for beauty no less important, but it certainly makes the creation of beautiful environments a challenge for the designer.

A common strategy for controlling the aesthetic experience of a landscape is to confine the influences on it, such as enclosing a garden within screening walls to limit disruptive influences from the surrounding landscape. An alternative effect is created by arranging designs to take selective visual advantage of adjacent conditions—"borrowed" landscapes—by including or enhancing desirable views of the landscape beyond the limits of design control, such as a view of mountains or the sea. However we try to achieve it, we know intuitively that the aesthetic characteristics of the landscape are an important aspect of people's experience and satisfaction with the environment.

As we can see, there are many aspects of form to be considered in design: ecological, functional, cultural, technical, economic, and perceptual. As a principle of design, all these considerations need to be integrated into a coherent concept of form and experience. The form of an object or environment needs to be a clear and straightforward expression of what it is, relative to the forces to which it responds. The better the arrangement, the more satisfying the form. As Texas A&M President Robert Gates once said of a university, it is "not what it claims to be, or what it strives to be. It is what it does" (Gates 2005). The same may be said of the landscape. Its form is an expression of what it does as well as what it is. The challenge for the designer is, first, to determine what it *does*: to recognize the human and environmental forces shaping form; and, second, to create form that responds appropriately to what it *is*: to compose the features of the landscape in a way that serves, delights, and sustains those who are to live with the results.

PART III

Procedural Theory

CHAPTER SEVEN

Design Process

Some people consider it noble to have some method, others consider it equally noble to have no method. To have no method is bad. To adhere strictly to method is worse still. It is necessary at first to observe a strict rule, then to penetrate intelligently into all the transformations. The possession of method liberates us from the necessity of possessing method.

—Lao Tzu

Design is a process of determining how to transform existing conditions into preferred ones. The designer—or design team—must determine needs, formulate a strategy to meet them, then select materials and compose them into patterns to achieve some desired objective, typically within the limits of available time and resources. In landscape architecture, the process of design is complicated by the need to coordinate a series of tasks to be performed by a number of people over an extended period of time. Landscape architects also contend with the variety of competing interests to be resolved by the participating parties, as well as the fact that many of the materials used in their designs have a life of their own. Given the complexity of the challenge, procedural theories have been developed to facilitate the process of design and improve the predictability of outcomes. The next four chapters address different aspects of procedural theory.

Procedural theory deals with the mechanics of designing. It is based on the notion that *how* knowledge is applied is as important to a successful

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outcome as *what* knowledge is applied. Evidence-based design process is intended to link knowledge to design form. By this approach, problems are framed in relation to what is known about the design intentions and the context in which they occur—essentially a process of research, reflection, and decision management. It is a learning as well as a thinking process. To a significant extent, *what* we think depends on *how* we think (Regal 1990). How we think depends on the kind of thinking process we employ. Two kinds of thinking are essential in the formulation of a design: intuitive thinking and rational thinking. Design can never be completely intuitive because there are too many things that we know and cannot ignore. It can never be completely rational because there are too many things that we do not know. Thus, design process is intended to assist the designer in applying the most effective kinds of thinking and the most relevant information at the most appropriate times to promote efficiencies in the creation of imaginative and successful design ideas (Lawson 1994).

Design process takes place under conditions of uncertainty. It requires decision making in the present based on data gathered in the past to affect conditions in the future regarding issues that are imperfectly understood (Couclelis 2005). Although the need for improvement may be clear, the underlying causes that create that need may not be. As a consequence, the possible solution to meet the design need—to solve the design problem—also may be unclear.

Designers need to understand the problem correctly before they can determine what kind of solution is likely to lead to the improved conditions they seek. But because the situation to be resolved continues to evolve, the designer cannot be certain that the conditions being created will solve the problem once a design has been executed and the landscape has been changed. And even when the problem is clear, simply understanding it does not lead directly to the formulation of an effective design solution. In the provision of intellectually defensible design services, two basic responsibilities are assumed (Peña et al. 1987; Gardner 2004):

- **Define the problem correctly**—based mainly on rational thinking.
- **Formulate an appropriate solution**—based mainly on intuitive thinking.

Reducing uncertainty about design outcomes depends as much on designers' ability to correctly define the problem as on their capacity to devise an effective design response. The more design thinking relies on evidence of existing conditions and probable performance outcomes, the greater the predictability of a proposed design change. To fulfill these responsibilities requires a comprehensive approach to the identification and resolution of a network of related problems.

Effective design decisions are based on a thorough understanding of the issues affecting a successful outcome, which begins with asking the right questions. In general terms, there are three basic questions in design (McGraw 1966):

- **What do we have?** What existing conditions are inadequate to meet our needs or interfere with our goals and aspirations, and what resources are available to address them?
- **What do we want?** What conditions or relationships have to exist if we are to meet those needs or achieve our goals and aspirations?
- **How do we get it?** What physical arrangement will provide the desired conditions and relationships, and what resources must be committed to realize this arrangement?

Taken together, these questions constitute the problem to be resolved by design. Most design thinking is focused on the third question, "How do we get it?" But each of these questions needs to be considered as part of an integrated set if designers are to improve the way they think about a problematic situation and, as a consequence, create an effective response to it. Procedural theory provides an integrated approach to addressing these questions.

Design Process

Design process encompasses the sequence of activities extending from the time when a condition requiring design intervention is detected, through the deliberation of factors influencing the final determination of a course of action (Broadbent 1973). In the process of formulating design ideas, three types of mental activity are involved (Zeisel 1988):

- **Envisioning**—forming a mental image of the new condition that resolves the relevant problems and reduces the limitations of the environment.
- **Representing**—depicting the imagined condition through some representational medium, such as drawings or models, to illustrate the idea that has been formed.
- **Evaluating**—determining if the envisioned concept satisfies the desired conditions being sought within the limitations of time, resources, and context.

People have been successful at shaping the environment because of their ability to master these activities. The *envisioning* process is effective because it enables us "to represent the outer world symbolically, to think conceptually, and to communicate our symbols, concepts, and ideas" (Capra 1982, 295). Using symbols to *represent* thoughts enables us to examine and elaborate ideas before implementing them. But before they can formulate and *evaluate* the usefulness of a form innovation, designers must establish some standard by which its success is to be measured. And each design situation requires its own unique standard.

To further complicate the process, in addition to the mental skills of envisioning, representing, and evaluating, the designer must master the knowledge and technology needed to understand the problem, and in particular, the conditions that cause it. Design process is intended to organize and integrate the application of resources in the form of knowledge, skill, and time to improve the quality of design thinking and design results. Design thinking and design training come to us through a tradition originating in the fine and applied arts. Each design discipline has its own definition of purpose and function. Architecture is oriented toward the provision of structures, landscape architecture toward the making of place, and engineering toward the application of technology to solve human problems. Each discipline has a slightly different process. The mainstream approach to architecture and landscape architecture has been described as the "grand tradition" of design—designs produced by professional designers—in contrast to "vernacular" design—designs based on local traditions, materials, and technology (Rapoport 1977, 5).

Grand-tradition design expression tends to be a formalized representation of some intellectual trend (such as smart growth), movement (energy conservation), or stylistic design model (minimalism). Designers are educated to think about design in relatively uniform ways, even though the forms they develop in order to express these ideas may be novel. This uniformity in approach is reinforced by professional literature that directs attention to respected models of design thinking. Because they are imposed from outside the system, these design forms offer limited opportunity for self-expression or influence from users, and, as is often the case with vernacular designs, they seldom express in an organic way the uniqueness of the cultural or biophysical environments in which they arise.

The recent history of design methods has evolved from a highly individualized, intuitive process where designers were concerned largely with artistic self-expression, toward methods that apply rational goals and objective evidence as the basis for decision making. By the mid-twentieth century, thoughtful designers began to develop a rationale for design that went beyond individual preference or intuition.

Innovations in design thinking have advanced considerably over the last half-century, but serious analysis of the process began about a century ago. As early as 1926, social psychologist Graham Wallas developed a procedural model for critical thinking and problem solving that, while applicable in many fields, is particularly useful for approaching the complexities of landscape design.

Wallas recognized that effective thinking occurs at both conscious and subconscious levels and that both were important to the formulation of a creative outcome. His model identifies four key steps in the creation of new ideas or the resolution of complex problems (Wallas 1926, 80). These stages operate sequentially as follows:

1. **Preparation**—assembling and assessing relevant information and preparing the mind by focusing attention on the salient features of the problem.
2. **Incubation**—internalizing the relevant information and allowing the mind to work through the problem via subconscious awareness.
3. **Illumination**—discovering new relationships, often described as

coming in a "flash" of inspiration as new patterns and relationships become recognized.

4. **Verification**—determining whether a new idea is likely to be successful, and, through refinement and elaboration, bringing it to a final form.

The Wallas model stresses that good ideas emerge from a deep understanding of context and intentions that form the basis for reflection and introspection, eventually leading to an innovative conclusion. While design requires knowledge to guide informed change, creative inspiration remains critical to success. When design was thought to be based more on creative inspiration than evidence-based predictability, immersion in the problem to facilitate incubation was considered necessary to enable designers to focus the mind and "create" effective ideas. Inspiration, it was suggested, would naturally "result" when the designer became deeply immersed in the problem. Today, the preparation stage of the process is intended to assure that the new relationships and ideas "discovered" are based on a thorough understanding of the most important considerations. (Creative thinking processes are discussed further in chapter 10.)

Design as a Rational Process

One of the first to describe design as a comprehensive process was landscape architect Norman Newton. In *An Approach to Design*, he described the process as a series of practical steps to facilitate the creation of "form to develop organically in the straightforward solving of . . . human needs" (1950, 72). He outlined design process as having three phases: a programming phase, a creative phase, and a construction phase—"all three, seen and taken as a whole" (1950, 14). These phases he described as follows:

- **Programming phase**—defining the design problem to be solved through research and analysis and determining what sort of action is needed to solve it.
- **Creative phase**—solving the design problem by establishing specific form and relationships among the features of a solution through design speculation and evaluation.
- **Construction phase**—implementing the design idea by building the new conditions into the landscape.

Unique to Newton's description was the close relation of these phases to the provision of professional design services, as opposed to the more academic treatment of intellectual activities described by other mid-twentieth-century writers. Landscape architect Hideo Sasaki described design as an intellectual process involving three types of thinking (Sasaki 1950):

- **Research**—investigate in order to understand the context and factors to be considered.
- **Analysis**—determine the ideal relationships among the factors and their context.
- **Synthesis**—integrate the complex of relationships into a spatial organization.

A decade later, engineer John Chris Jones used some of these same elements to frame a modified three-stage process that he described as a systematic design method (Jones et al. 1963). This method was intended to have two benefits: it would reduce design errors, time spent on redesign, and the resulting delays, and it would facilitate more imaginative and advanced design results. The three stages of the process include:

- **Analysis**—describe the design requirements as a set of logically related performance specifications.
- **Synthesis**—discover possible solutions to each performance requirement and develop complete designs by combining them with the least amount of compromise.
- **Evaluation**—determine how well a proposal meets performance requirements before deciding on a final design form (Jones 1984).

Although he failed to identify the need for research, Jones's major contribution was to recognize the importance of evaluation as a critical step in the process. And reflection is as critical to determining the effectiveness of an idea as is its development. In all these descriptions of design process, thinking is informed by relevant information before the formulation of useful ideas can take place.

Research is necessary to ensure that proposals are based on reliable evidence rather than on personal opinion or preference of existing conditions as well as likely conditions. Evaluation is necessary in order to verify that the ideas produced are based on the evidence and conform to design intentions. Designers must do more than simply recognize that a problem exists. Most importantly, they must verify that they understand the problem correctly—systemically—as a set of interactive relationships.

A decade later, architect Geoffrey Broadbent formulated a design process that included steps to recognize and *define* the problem, *describe* the conditions needed to resolve it, *formulate* a solution that solves the problem, and, importantly, *implement* this solution, with implementation understood as an integral part of the design process (Broadbent 1973). He recognized that because thinking about design is continuous, so is the learning that accompanies it—even after a design decision has been reached and implementation is underway.

In the conduct of design process, investigation to understand the relationships to be altered gets the process moving but it does not lead to a design conclusion; the designer has to create it. Eventually, the designer is confronted with the question of how to produce tangible design form—how to go about the actual formulation of a design idea. In outlining a procedure for producing a design form idea, regional planner and landscape theorist Carl Steinitz broadly describes the process:

> There are two fundamentally different ways to make a design. (I am purposely making this contrast, fully aware that the two ways are frequently combined.) The first way is anticipatory and deductive. You are sitting in the middle of the night, at your table, and you have an idea. And you see the future. You see the future, and then you have to figure out how to get there. Every designer has had this experience, likely many times. You have thought about the problem and you see the solution, and then you have to figure out how you get there, and you almost always fail. It's hard!
>
> The other way is explorative and inductive. You basically put together a set of issues and choices—a scenario. A scenario is a set of assumptions and policies that guide you into the future. There are basically two ways to navigate this scenario chain. In the first and typical way for designers, one goes out as far as one can, and recycles back when confronted with a design problem. You decide

> to do this and this and this, etc. The second way is to simultaneously test several different scenario combinations and systematically compare them before proposing a solution. . . .
>
> And either way, you almost always fail, because a typical large plan might have a sequence of twenty to fifty important decisions. And if you can make twenty correct decisions in a row, you should be a gambler in Las Vegas. (Steinitz 2008)

Deductive and inductive reasoning approach the determination of a conclusion from opposite directions. **Deductive** reasoning proceeds from the general to the specific. It begins with a general statement, held to be true, and examines the possibilities for reaching a logical conclusion about its application to a specific situation. By applying general rules, options are winnowed down until a conclusion of some certainty remains. **Inductive** reasoning takes the opposite approach: it proceeds from a specific to the general. Induction reaches broad generalizations about an answer based on specific information. A conclusion is reached by extrapolating from specific supporting evidence to demonstrate the probability of a correct conclusion.

Creating an original idea is a demanding task, particularly when there are multiple dimensions to its success. Designers need to apply a rational decision–analysis process to help frame the complex problem they're trying to solve in order to provide the evidence on which a logical and defensible conclusion may be based. A multiple-scenario decision–analysis process to resolve the problem may be presented as a progression of tasks as follows (Partidario et al. 2000; Seip et al. 2007):

1. **Specify** the problem.
2. **Formulate** the decision objective.
3. **Develop** alternative concepts for solving the problem.
4. **Assess** the impacts and consequences of the different alternatives.
5. **Choose** the preferred concept.
6. **Refine** the chosen concept.
7. **Implement** the solution.

This approach is sometimes referred to as the "choice model" of design

(Rapoport 1977; Zeisel 1988). System scientist Russell Ackoff argues that since people cannot predict the future, they choose the future by design: choices are created by the alternative futures they envision (1974). To make the most appropriate choice, the designer needs to proceed on the basis of a comprehensive knowledge base—objective understanding of environmental performance—to determine the best among possible choices.

A Consolidated Design Process

When integrated into a comprehensive set, these rational design activities have an implicit logic that can be described as a comprehensive design process sequence:

1. **Recognize and Describe the Problem**
   - **Research** to understand the context and factors to be considered.
   - **Analyze** to determine the ideal relationships among the factors and their context.
   - **Describe** the design requirements to be met in resolving the problem as a set of logically related performance specifications.
2. **Formulate Alternative Solutions**
   - **Discover** possible solutions to each performance requirement.
   - **Develop** alternative concepts by combining the different solutions with the least amount of compromise needed to satisfy the overall design requirements.
   - **Select** the best concept.
   - **Formulate** the solution into a spatial organization.
3. **Evaluate the Alternatives**
   - **Determine** how well a proposed design is likely to meets performance requirements before deciding on a final design form.
   - **Choose** the best alternative.
   - **Redesign** and reevaluate as necessary.
4. **Develop the Final Design**
   - **Establish** a final design form based on feedback and refinement.
   - **Document** the final design scheme to guide implementation.

5. Implement the Design

- **Construct** the new condition in the landscape.
- **Report** project progress and completion to the client.

When described as a logical progression, the rational decision–analysis process demonstrates the probability of arriving at an effective design conclusion. But certainty can never be assured regarding a design outcome. This rational approach implies that the most appropriate design scenario exists within the options examined. This, however, may or may not be the case, and there is no mechanism for making that determination. We will return to this issue under the Phases of Design Evolution subsection, below, where I will attempt to show that a combination of the anticipatory and the exploratory—deductive and inductive—approaches provides the most effective and predictable process for creating and evaluating design possibilities. But first we need to consider the performance requirements for an effective design process.

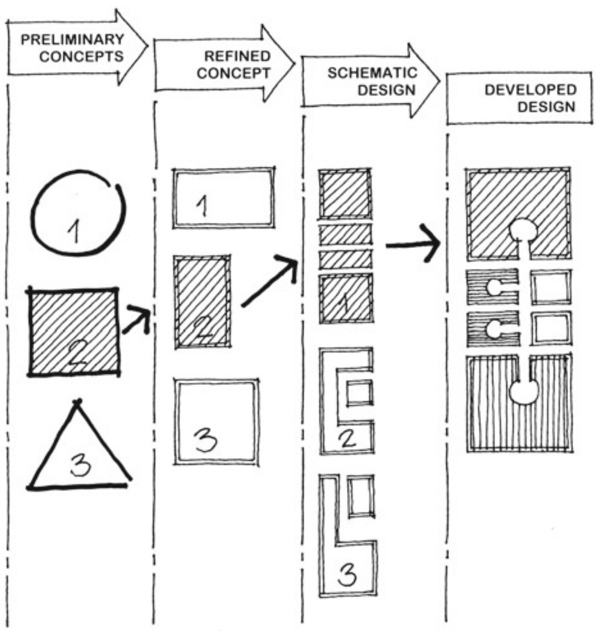

***Figure** 7-1. Evolution of a design arrived at by the alternative choice method.*

Delivering successful designs is demanding, due to the difficulty of defining the problem, the complexity of the information required, and the number of participants who may be involved. Under the best of circumstances, designers serve as active collaborators with clients, users, builders, lenders, and reviewing authorities. Each of these players has different priorities and responsibilities, and may be expected to hold different values and to pursue different goals. Integrating these participants and their activities into a unified and effective investigative, decision-making, and implementation process can be challenging, due to their different areas of expertise and differing interests in the outcome (Gifford et al. 2000).

But there is another underlying characteristic of the process that makes success in design difficult to achieve. Designers and their collaborators apply current information to predict future outcomes. Each collaborator provides critical—although sometimes conflicting—information on which to base a design recommendation. On the basis of this broad array of information, designers attempt to predict the future success of design interventions. Designs are based on assumptions about the nature of a future reality, and success is likely only if the underlying assumptions are correct (Jones 1992). Predicting the future, even when information and assumptions are reliable, is an inherently risky proposition. It is this unreliability of the process outcome that makes successful design resolution so challenging. As Jones explains:

> The final outcome of designing has to be assumed before the means of achieving it can be explored: the designers have to work backwards in time from an assumed effect upon the world to the beginning of a chain of events that will bring the effect about. If, as is likely, the act of tracing out the intermediate steps exposes unforeseen difficulties or suggests better objectives, the pattern of the original problem may change so drastically that the designers are thrown back to square one. (Jones 1992, 10)

The practical application of design process must deal with the formulation of goals, creation and management of databases, making and exploring assumptions, establishing and meeting time schedules, and documenting design ideas and performance requirements, as well as mastering the technical requirements of integrating all the steps of the process and bringing them to a successful and timely conclusion.

And because design changes are a common aspect of implementation—new discoveries can come at inconvenient times—design decisions may be required even after construction is underway. Thus, the process serves to organize and unify intellectual and technical resources over the extended time it takes to formulate and implement change in the landscape.

The question, essentially, is how to devise a process that enables the designer to be informed, efficient, and creative at the same time. The basic steps are outlined below as a practical six-step process that makes provision for the learning and reflection required to bring all the issues into focus.

Six-Step Design Process

Under typical practice conditions, the delivery of site-design services is guided by a sequence of six general steps or tasks (Marrs et al. 1989). The six-step process is organized so that each task prepares for the next, leading designers through a logical progression of decisions, first about the nature of the problem, and later, about the effectiveness of a possible design response. The sequential order of the steps suggests the underlying logic of their relationships to one another. In comparison to the consolidated design process outline described above, the steps are organized into a sequence that can be easily communicated to others, notably to potential clients and collaborators.

Step 1. State the design problem. The process begins with an initial assignment or appointment from the client to the designer. This is normally expressed as a formal statement of the design commission recognizing the existence of a condition requiring design change.

Step 2. Define the problem. Investigate the problem and its context in order to identify and assess the critical issues, uncover required information, and develop concepts necessary to the successful execution of the design. A comprehensive description of the issues to be resolved and the performance criteria to be met is recorded in a program of instructions to the designer.

Step 3. Search for solutions. Envision possible alternative courses of action to meet the program requirements and evaluate each design scenario in terms of its suitability to the requirements of users and the site, as well as its acceptability to the client. Select and develop the best idea.

Step 4. Document the design decision. Prepare a record of the elaborated design concept to provide a detailed account of the physical and functional relationships to be established. Documentation, typically drawings and specifications, takes a form suitable to guide implementation in an accurate, complete, and technically appropriate way.

Step 5. Implement the design. Realize the design idea. Construction is normally carried out by independent contractors, with the designer administering the contract for construction on behalf of the client in order to ensure faithful execution of the work according to the drawings and specifications.

Step 6. Evaluate the results. Critically analyze the completed design under use conditions to determine the appropriateness of the information used to inform the design decision, the extent to which it meets client, user, and technical requirements, and fits appropriately into the conditions of the environment. This also is an opportunity to evaluate the design delivery and implementation process. The results of post-occupancy evaluation provide the basis for improved design quality and future service delivery.

The six-step process leads the designer through a sequence of critical- and creative-thinking stages. It begins with a broad vision that improvement is needed, though relatively little may be known about the details of the problematic situation or the opportunities to be explored in determining a future course of action. From there, it progresses to the development of sufficient understanding to guide the formulation of intervention possibilities. With this understanding, the designer proceeds to a final determination of a design for the change to be implemented. Based on the selected course of design action, the landscape is reconfigured and, ultimately, evaluated to determine if the desired results have been achieved.

The design process is organized to provide continuity throughout the life of a project. The continuous nature of design is reinforced over time by the post-occupancy evaluation (POE), which serves as a bridge between projects by systematically linking the knowledge and experience gained on one project to those that follow, providing a mechanism for continually improving design service and design performance with each successive commission (Preiser et al. 1988). This final step brings the process full circle, returning designers to the first step on the next project with the advantage of knowing (rather than just believing) how well (or how poorly) previous designs performed. The progression of design improvement through successive post-occupancy evaluations is illustrated in figure 7-2.

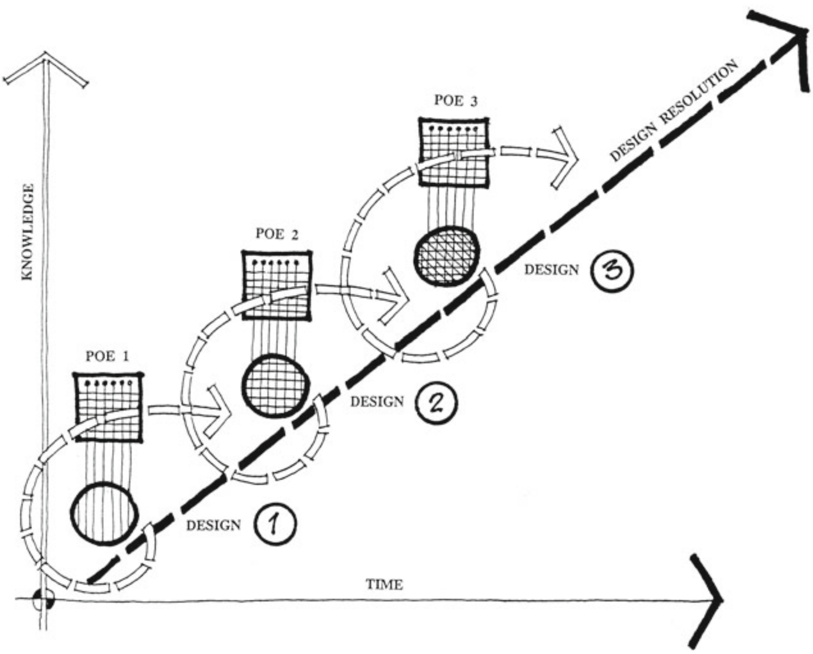

Figure 7-2. *Improvement in design resolution resulting from post-occupancy evaluations of successive designs over time.*

Design Problem Solving

Landscape architect Ervin Zube (1983) describes design as a hypothesis to be tested. Although designers may be reluctant to describe their designs in quite this way to their clients, all designs are experiments. What designers do is speculate that a particular reorganization of the landscape will improve the quality of the environment under future conditions. The design process makes it possible to conduct a controlled experiment, the documented stages of which combine to provide a systematic record of design performance intentions and design results.

From a perspective of knowledge building, as opposed to problem solving, implementation is necessary to provide the objective evidence on which design results may be evaluated. But it is the design program and the post-occupancy evaluation, not the built design form, that document the evidence for evaluating the quality of the decision-making process and the appropriateness of the way information has been employed to effect changes in the environment.

Designers, however, do not have to build their ideas to evaluate them. The process of learning from testing ideas against reality may be achieved intellectually as well as physically—at least partially. By introducing new knowledge into the design process, and testing it against design intent and environmental context, designers model the process of learning by experience. This offers many of the advantages of new insight without the need for implementation, and without the burden of time and expense associated with it. It is for this reason that designs are created in the first place: to formulate and evaluate a proposed course of action in advance of implementation in order to improve the likelihood that the changes imposed will be successful.

Where there are multiple aspects to a design problem to be considered, the most rational method we have for understanding its complex systemic relationships is to hypothetically model and evaluate them as a related set: to test by design. Design modeling provides the opportunity to examine an integrated set of conditions for the purpose of evaluating their potential relationships and outcomes. Design exploration is our primary means of testing possible future outcomes on a holistic basis and determining their potential to resolve conflicts or satisfy unmet needs.

Evaluating alternative design proposals permits the comparison of different courses of action to determine if one is better than another to satisfy the design requirements. Taken together, design speculation and evaluation provide powerful support for the delivery of intellectually defensible design ideas. Designers postulate a possible future condition in order to work backwards to evaluate whether they have established the desired relationships they seek.

The critical step in design analysis—holistic analysis as opposed to the analysis of individual parts or concepts—is provided by developing and testing comprehensive design concepts in relation to their environmental context. Designers have no other means of seeing all the potential relationships in an integrated way. The designer needs to evaluate these relationships as a whole in order to determine if the design form being proposed is the best one, relative to other possible alternatives. Formulating multiple alternative concepts provides multiple opportunities to evaluate, and thereby understand, design form relationships. It also provides the means by which to improve understanding of the design problems.

Design resolution, however, rarely takes a direct path from problem statement to design conclusion (as illustrated by figure 7-3). There is no direct link from one stage in the sequence to the next. Simply understanding that a problem exists does not lead inevitably to an appropriate or satisfying design response. Furthermore, there is no reason to believe that the alternative designs proposed are the most-effective responses possible. The best the system can offer is that the best alternative *considered* may be selected for action. Design success is not the inevitable result of a rational approach. It is the responsibility of the designer to bring the process to a *successful*, not a *rational* conclusion. During the process, design thinking may go through many false starts before a clear path emerges. And it is the

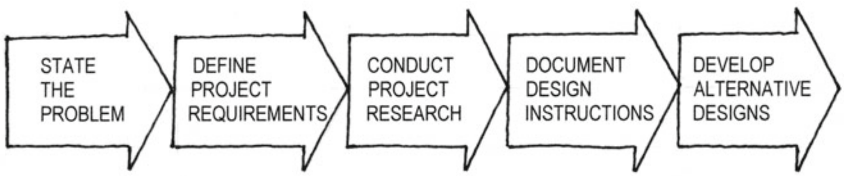

***Figure** 7-3. The six-step design process expressed as a linear sequence.*

identification of false starts, as well as promising leads, that are revealed by systematic research and evaluation. How promising concepts might be revealed is examined below in the discussion of Phases of Design Evolution.

Estimating a design proposal's capacity to satisfy the conditions imposed by the program improves the designer's understanding of the complex interrelationships to be resolved. As this understanding evolves, the designer is able to reexamine proposals with the advantages that new knowledge and insights (resulting from the evaluation of other possible design scenarios) bring to the development of design proposals. And with improved insight, designers are able to improve their ability to formulate more-effective design concepts that can result in meaningful change and improvement.

This brings us back to the question of how to do this. How may the process be applied to yield the desired result? The six steps of design process, outlined previously, are presented as a sequence of general activities. But the linear sequence of steps is useful only as an outline of milestones in the progression of activities, not as a description of the process as an operational system. In reality, the process is rarely applied linearly, with the designer concluding one step and then moving on to the next until the entire sequence is completed. It is almost always, and most successfully, applied as a reiterative or cyclical process, with steps being repeated as the designer attempts to improve the quality of the design idea (Halprin 1969; Lynch et al. 1984; Motloch 2001).

In natural landscapes, we find that the relationships of climate, relief, soil, water, and their associated plant and animal communities are finely tuned in their interrelationships with one another. Because these interrelationships are well understood, biologists often rely on one aspect of the environment to provide clues about another. Knowledge of certain plants—referred to as *indicator species*—can provide reasonably accurate indications about not only what soils, climate, and moisture relationships exist for the plants to survive, but also what animals might use them for food or shelter, and in which seasons. Designers attempt to create similarly harmonious—that is, highly integrated—relationships by design.

Unfortunately, we find that these relationships are usually too complex to be understood or established on the first attempt. But through reiterative investigation and refinement—learning by trial and error—and then using that newfound knowledge, designers are able to create more-complex systems that resolve many, if not all, of the problems. One of the reasons for this is that feedback from identified errors or information omissions provides clues about how to improve understanding and, on that basis, design ideas.

Just as harmonious relationships in natural environments need an opportunity to mature and evolve through succession, so do the designs we develop to recreate them. It is the designer's role to establish these relationships and then adjust and refine them until all the bugs have been worked out before construction begins.

Designers benefit from a process that facilitates the growth and evolution of comprehensive solutions for changing complex environments. The main reason for this is that understanding of the problems also evolves and improves as the design process progresses. Such a process requires the continual evaluation of proposals to identify these newly created problem areas followed by a search for clues about how to resolve them. Ideally, a continuous cycle of design speculation and evaluation is needed if solutions are to evolve and mature (Kaplan et al. 1982; Weisman 1983; Lyle 1985; Zeisel 2006).

Phases of Design Evolution

As noted, the six steps of design define the conventional stages—the milestones—of progression through a typical design project, even though they don't describe *how* they are applied as a process. For the designer, of course, the primary focus of the effort remains the form-giving stage of the process. Because design is based on an intellectual concept, design *form* and design *concepts* are considered to be indivisible: form is the visible manifestation of the concept.

In the development of design form, it is helpful to concentrate attention on what might be thought of as the synthesis, or form-giving, stages of the process. But since form is an expression of structure, function, and process in a specific context, the isolation of form making from considerations of the human and environmental processes to which form making responds is unlikely to be helpful for either understanding the design problem or resolving it. The design process needs to draw attention not just to the form to be created but also to how processes shape form—and ultimately to how form shapes processes: the purpose of design intervention.

To address the complexities of comprehensive landscape change, it is useful to employ a design strategy that operates as an integrated learning and decision-making procedure. It has been shown that one of the most effective ways to learn about a system is to design it (Churchman 1971). Since form making is the designer's primary area of concern as well as their primary strength, it is important to place that skill in the service of learning. Ackoff refers to such a process as an "interactive design process" that focuses on those aspects of the system necessary to provide a holistic understanding of the structure, function, process, and context of the landscape system. To integrate the elements of a system, he recommends "participative design through successive approximation" (Ackoff 1974). It is here that the design process deviates from the rational decision-making process described above, in which a number of choices are created and the most successful alternative is selected.

Under traditional approaches, the envisioned form is created by the designer and then shared with the client and collaborators, and sometimes the users. An alternative approach—an interactive design process—enables the complex views of the participants (designers, clients, users, managers, builders, technical consultants), *acting in collaboration*, to coalesce into a unified group, or team, capable of creating a holistic vision of the more satisfying future they seek.

As we have seen, traditional descriptions of design process are presented as a sequence of steps. The sequence suggests that the process will proceed from one step to another in a more or less linear path. Also by tradition, we understand that, as we engage in design, a number of attempts are required before we are able to satisfy the requirements of a design program—that is, to formulate a successful design. A common approach has been described whereby a number of alternatives are created to be simultaneously evaluated by comparison to the program requirements before the best one is chosen as a final design solution. However, when one alternative builds on feedback from another in a reiterative sequence—rather than a simultaneous comparison of alternatives prepared in a linear sequence—each attempt enables the designer to learn more about the possibilities inherent in the problem, and then to use that improved understanding to reformulate a more satisfying concept: to create a new idea built upon improved understanding as opposed to improving a flawed idea by the addition of refinements.

Designers, like anyone else, are likely to make mistakes. Mistakes are inevitable. But the sequential description of design steps fails to recognize that mistakes will be made—in formulating both the program and the design solution. A successive approximation process is based on two assumptions: first, that designers will make mistakes, and second, that they are capable of learning from those mistakes quickly enough to achieve a higher level of understanding before engaging in another attempt at resolution. The reiterative process is used in order to increase learning about the *nature of the problem* and, on that basis, to improve *design performance* with each successive attempt. The process anticipates that mistakes will be made and incorporates the means of both identifying and recovering from them.

Form making in design focuses on the early, idea-intensive stages of the process, when interaction among collaborators can be of greatest value in shaping the holistic concepts on which designs are to be based. When the various participants interact and share their views, learning—about what is needed as well as about the choices for satisfying those needs—provides the basis for the integrated ideas that will drive the creation of design form.

To focus on the ideation stages of design, the number of steps in the process is reduced from six to four; two of the steps are omitted since the designer engages in neither detailed documentation (step 4) nor implementation (step 5) in the formative, envisioning stages of the process. Although detailed documentation is not appropriate at this stage, it is still necessary to provide adequate representations so that the concepts being examined can be understood and evaluated (Faruque 1984; Zeisel 1988). Form generation focuses on information and ideas. And, while a post-occupancy evaluation (step 6) is not possible at this stage, the evaluation of design ideas by comparison to established performance criteria is ongoing. This leads to a modified four-stage framework to provide an abbreviated context for the conceptualization stages of design. These four stages of the successive approximation process form the basis of a continuous cycle of learning, postulating, evaluating, and, ultimately, deciding about the design form to be created.

To describe the interactive relationships among the idea generation stages of design, it is useful to direct attention to what might be more properly referred to as *phases of interaction* as opposed to design steps. The phases of design interaction represent types of activity—rather than discrete tasks or products—as they proceed in a successive-approximation approach to define the project issues and formulate design concepts. The reiterative phases of form generation are illustrated in comparison to the more comprehensive six-step process seen in table 7-1.

These "phases of design interaction" serve as an operational framework for describing the ideation part of the design process. The form-creation stage of design process makes use of available knowledge as the basis for design speculation, which is then tested to determine its appropriateness to design application. Critical analysis of concepts, to assure that the knowledge gained is being applied appropriately, is undertaken by assessing the merits of the proposals being investigated. Evaluation may lead to the identification of flaws in the program, just as it may identify flaws in the design concept. Consequently, design evaluation is employed to promote the identification of new questions, as well as new research areas, by identifying necessary changes in the definition of the design problem. The evolution of the problem statement may be expected to lead to additional design requirements, and consequently there will be a need to assemble new programmatic information. Design ideation incorporates both *programming* and *design search*. Through design speculation and evaluation, the process enables the designer to learn enough about the system to be able to re-design it better. It is a circular thinking process.

For example, to assess the broad organizational aspects of a design, a first approximation speculation might, as a starting point for design, deal with the large-scale arrangement of land uses and circulation patterns. Then, in a second attempt, the designer might focus on such small-scale aspects as the detailed requirements of activities, materials, or perceptual/spatial relationships. A third attempt might focus on technical

Table 7.1
Four Phases of Design Form Generation

Design Ideation Phases	Design Process Steps
Phase 1: Problem Statement	**Step 1:** State the design problem.
Phase 2: Problem Definition	**Step 2:** Define the problem.
Phase 3: Concept Development	**Step 3:** Search for solutions.
	Step 4: Document the results.
	Step 5: Implement the solution.
Phase 4: Concept Evaluation	**Step 6:** Evaluate the design.

requirements such as efficient locations for utilities, or drainage and grading requirements. Once the problem has been approached from these different perspectives, enough may have been learned through each of them to enable another approximation dealing with structural, functional, and technical issues simultaneously. Or, alternatively, each successive transaction might be based on all these considerations, taken as a whole. The critical task is to formulate the concepts as hypotheses to be tested, and then evaluate the results to determine if the hypothesis is borne out by the evidence.

In the application of a systemic design process, the term *phase* is used to convey a zone of influence in the process rather than a discrete activity with precise boundaries. Each successive phase has a product, but because the product of each phase is integral with all other products, it is only tentative; until the product of each phase has been verified by the products of the other phases of the process cycle, we cannot be certain that any of the products are "correct" or in harmony with one another. Only when the outcome of each phase of the process reaches a state of equilibrium with the outcomes of all other phases, and each product appears to be equally appropriate relative to all the other products, can any of them be considered complete or systemically correct. Design thinking for systems incorporates both critical and creative thinking into a holistic process, just as the successful design concept integrates the subsystems into a whole, and holistically functioning, landscape system.

To summarize: operating in a cyclical pattern of statements of problem definition, creative speculation, and critical evaluation for feedback, the reiterated phases improve design understanding and provide the basis for a repetition of the four-phase cycle at a more advanced level of understanding. Reiteration of the phases may reveal that the designer has made mistakes or has failed to foresee critical relationships that need to be identified, and thus it prompts additional effort to correct them before continuing with the investigation.

The holistic design concept—incorporating both the statement of the problem and a proposed solution—evolves in the same way that nature evolves: as a series of integrated wholes—design seres—of increasing complexity and interdependence rather than as an accumulation of spatially related parts. The same can be said of design thinking. As comprehension of the issues—and the proposals for resolving them—matures and increases in depth and complexity, design resolution requires a thinking process that responds by synthesizing and integrating the increased learning that is taking place. And as industrial designer Tim Brown cautions, "Insights rarely arrive on schedule, and opportunities must be seized at whatever inconvenient time they present themselves" (Brown 2009, 64). The formulation of a design concept relies as much on the discovery of meaningful relationships as on the creation of a new idea.

One of the greatest challenges for the designer is to forego previously learned approaches or prototypes from earlier design experiences for application to current problems. We tend to retain successful ideas and apply them to new situations, whether they are appropriate or not. Repeated investigation tends to carry design thinking into a deeper understanding of the situation at hand and reveal just how different each design condition really is, thus bringing about a more objective understanding of the issues, and with it, more-appropriate and unique design innovations.

Creative thinking, just like landscape evolution, is not a linear or predictably rational process. Successive-approximation process provides opportunities for dialogue and creative exchange from which irrational but nevertheless useful ideas find expression. Repeated cycles to produce multiple design options provide numerous vantage points from which to evaluate and understand the complexities of the problematic situation. Establishing a system of rapid and predictable feedback loops based on whole (but still evolving) design ideas provides the potential for increasing understanding of the whole system (problem and solution). As designers improve their understanding of the parts of the design in their relationships to one another, they improve their understanding of the whole. This is achieved by the investigation of all of the issues integrally as they relate to the total context of the problem situation when they are expressed as a comprehensive design concept.

Improved system performance is a fundamental characteristic of evolved ecological and cultural systems. Complex, self-organizing systems maintain harmony and fitness with their environments by gaining information continuously through feedback loops (Capra 1996; Hutchins 1996). The role of feedback is illustrated by the example of steering a ship. As frequent compass readings reveal departures from a set course that are brought about by wind or current, the helmsman makes corresponding corrections to bring the ship back on course.

In much the same way, as natural systems detect failures to meet their performance goal (a healthy relationship with the environment), new information (negative feedback) stimulates changes to improve or correct the relationship. The reiterative design process provides the opportunity for creative speculation (setting a course), critical evaluation (checking the compass to determine if the ship is on course), and the means to determine the conditions that cause deviations between an environment's intended performance and its assessed performance (wind or currents pushing the ship off course). Awareness of a discrepancy between intended and assessed performance, as well as the identification of its cause, provides the basis for feedback to improve the relationships. If the intended (designed) course has been properly set, the ship arrives at its destination. Sometimes, however, unexpected conditions, such as a storm affecting the ship's set course, or in design, a sudden change in economic conditions, requires an alternative course of action.

Because improving relationships with the environment is the function of both ecological change and imposed design change, the evolution of design understanding can be based on the same type of feedback/response mechanisms found in evolved natural systems—processes developed over millions of years of trial and error—to improve the fitness and success of their relationship with the environment. And, it is here that we see the critical role of maintenance in sustaining the design form, since the process of landscape making extends far beyond the initial design and implementation. The forces stimulating continued evolution continue after the landscape has been changed by design.

In nature, feedback loops operate perpetually. If we are to model design on universal change processes, then rigorously controlled feedback opportunities need to be continuous throughout the deliberation process. And, significantly, they should be based on the best information available in order to approximate the forces to which these changes are to respond. Feedback also must be immediate to have its greatest benefit (Hutchins 1996). Delayed feedback or faulty information is unlikely to reveal a direct connection between cause and effect, and is thus unlikely to indicate appropriate actions to improve the unsatisfactory relationship. In the worst case, delayed feedback allows faulty assumptions to become entrenched and to reinforce the prosecution of a flawed design approach.

The cyclical relationships among the phases of design ideation and analysis are illustrated in figure 7-4. Each phase is linked in a continuous pattern through the alternating phases of design thinking, the arrows indicating a clockwise progression between them. Based on this cyclical pattern, successive cycles of design activity (illustrated in fig. 7-5) pass repeatedly through the four phases, as suggested by landscape architect. Richard Moore (1980). Project time begins at the center of the diagram and radiates out in all directions, as indicated by the arrows pointing in the four cardinal directions. The starting point is the moment that thinking begins on the project. Programming activity begins then and moves along the spiral path through the four phases, with each cycle of the feedback loop marking increments along the time lines.

By engaging the process as a means of learning as well as formulating design concepts, the designer is alert to all creative possibilities. The key to the answer lies in the formulation of the question. In some cases the problem statement, or the understanding of the critical issues, may remain unchanged throughout the reiterative search process. But by anticipating that the critical issues *might* change, the designer reduces the likelihood that important learning opportunities will be missed. And in design practice, the requirements to be met almost invariably change as the design investigation proceeds. By shifting the focus from solutions to

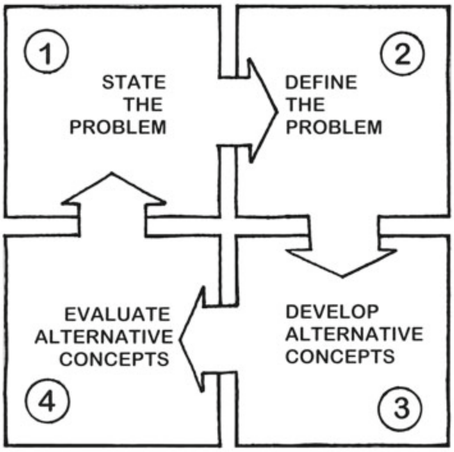

***Figure* 7-4.** *A cyclical programming and design process.*

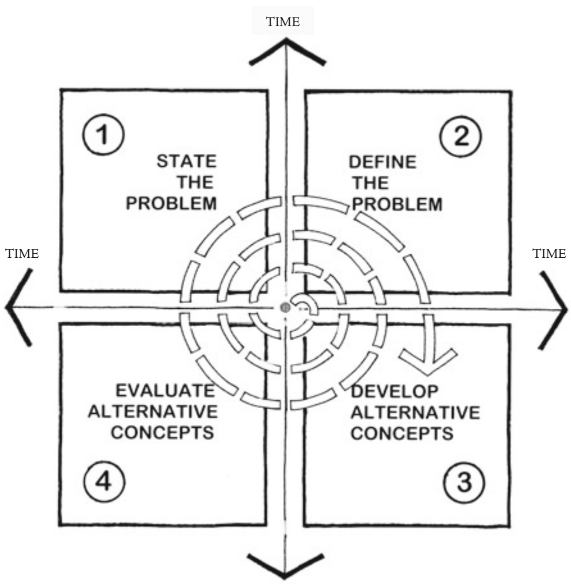

***Figure* 7-5.** *Multiple iterations of the cyclical programming and design process illustrated by the spiral path.*

problems, designers prepare their minds to see and learn from new insights. A decision-making process is transformed into a learning process, but without forfeiting its creative form-making potential.

Because the pattern is reiterative, it embodies another important feature. There is no requirement that research must occur prior to design, or vice versa. After the first cycle, all phases become part of a continuum of interactive problem restatement / problem redefinition / concept development / concept evaluation, and so on, so there is no particular requirement or benefit to begin the process with any particular phase. Successive-approximation design is an evolutionary process of learning and creation, so it matters less where it begins than where it ends.

The important consideration in design is to get the process moving rather than to wait for the "right" moment or "enough" information. As with any investigation, the most important thing is to begin immediately, wherever it is most convenient to "prime the pump" and begin the learning process (Twiss 1968). And, just as with priming a pump, we must put something in before we can expect to get anything out. The process, once initiated, draws the designer into an increasingly deepening understanding of the problematic situation.

A design process that seeks insight—not confirmation—reduces the likelihood that decisions will exclude important considerations simply because they have not been immediately recognized. It also limits the possibility that decisions will fail to take advantage of significant relationships or opportunities that cannot be anticipated early in the process. Many design opportunities are not revealed until the project has been thoroughly researched and tested by design, and sometimes, unfortunately, not until they have been implemented. In either case, the cyclical approach provides a mechanism for deferring commitment to a particular course of action until a great deal has been learned about the problems and the potential solutions to be considered. As Louis Pasteur said, "In the field of observation, chance favors only the prepared mind" (1854). The reiterative process provides designers with many chances to prepare their minds for the discovery of useful design ideas (Nickerson 1998).

An integrated programming and design process, one that is knowledge-building as well as knowledge-based, provides a systematic means of evaluating the research data and the problem issues interdependently rather than individually. Integrating the evaluation of all the design issues simultaneously is one of the most difficult problems the designer faces. Design concepts—design prototypes—provide our primary means of seeing the problem as a whole rather than the issues individually. Reiterative design feedback provides an effective strategy for integrating the analysis and promoting the discovery of the most appropriate direction for systemic landscape change. Each cycle through the four form-giving phases of design ideation provides another opportunity to create new conceptual design alternatives, and each design prototype, in turn, provides the opportunity for evaluation and new feedback, with the potential for improved understanding of the problem (Sawyer 2013).

Benefits of a Reiterative Design Process

One of the major benefits of an iterative approach is the repeated opportunities it creates for critique and analysis from a wide range of design participants. Many opportunities are created to see the problem and its potential solutions from multiple points of view. This is particularly relevant for multidisciplinary design participation. Because both the definition of the problem and its design solution are continuously open to reinterpretation, new revelations may originate from any discipline or in any of the phases and may influence all the others directly and more or less simultaneously. Ideally, the process continues until the feedback responses reveal no new information. Once it is believed that the most appropriate and complete statement of the problem has been achieved, the formal programming part of the process ends and attention shifts directly to design decision making. Typically, the next phase of design process then calls for an investigation of detailed issues such as technical or legal or material requirements, which may further alter a concept. The design program and design solution evolve together because both have been "created" and then developed by the integrated analysis of the successive-approximation process.

Another important benefit of a cyclical process is that design ideas tend to improve with progressive investigation. As a consequence, they oftentimes acquire a life of their own and sometimes drift away from their original intended purpose. Cycling back to revisit the problem statement on a regular basis not only strengthens the designer's understanding of the problem but also assures that the proposed solutions remain faithful to established, as well as revised, design intent.

If designers follow the process through a sufficient number of iterations, it will provide optimum potential for holistic understanding, ideation, evaluation, and, ultimately, creative innovation. But this is true only if the process moves along rapidly. Speed is essential to make the process operational within a limited time frame, and in design, time is always limited. Speed in moving through the cycles, however, should not be misinterpreted as haste in concluding the process. Speed is only useful if the project is moving in the right direction. In the final analysis, the designer has only one chance to get it right when the landscape is changed. Thorough design investigation provides the best chance under the prevailing circumstances.

It is also important to bear in mind that the improved understanding resulting from the evaluation of concepts can be as great—perhaps even greater—from the consideration of weak or poorly formulated concepts as from those that may appear to have serious merit. Design concept investigation, or prototyping, is "*inspirational*—not in the sense of a perfected artwork but just the opposite: because it inspires new ideas. Prototyping should start early in the life of a project, and we expect them to be numerous, quickly executed, and pretty ugly. Each one is intended to develop an idea 'just enough' to allow the team to learn something and move on" (Brown 2009, 106).

As the ideation process advances, the number of concepts tends to decrease while their level of resolution tends to increase. As they become more refined, the concepts tend to transition from the consideration of broad-scale, long-term issues to a focus on small-scale, short-term, and detailed issues.

Through an integrated programming and design approach, designers are able to attack the large, overly broad question, or initial statement of the problem, as it might be received from a client. A commission to "design an urban park" is essentially meaningless in the formulation of an effective design solution. This type of charge provides the designer with a great deal of creative freedom but little in the way of direction. Without elaboration regarding where, when, for whom, in what context, and at what cost, the design question cannot be realistically answered. It is necessary, initially, to think in terms of the whole system, to elaborate the question and determine how widely—or narrowly—to extend the boundary of the problem: that is, to expand the brief. The designer's initial task is to break the large, unanswerable problem statement into many smaller, answerable design questions representing all of its essential aspects. But, as we have seen, dealing with the parts is not the same as dealing with the whole. So, through repeated investigation of integrated design possibilities—design prototype experimentation—the designer has many opportunities to see the problem holistically and to create and refine a comprehensive statement of the design problem. The result of the final stage of the process is the systemic reintegration of the many smaller design questions into a unified design concept.

Good thinking takes time. Effort with this approach is simply shifted from an emphasis on traditional front-end investigative procedures to less traditional inquiry by design in which knowledge building is incorporated on a need-to-know basis. As the design problem evolves and the need for new information is revealed, as is inevitable when learning our way into a complex situation, we gain the ability to gather and incorporate closely targeted information into the design deliberation as a natural output of the process. Design inquiry does not replace traditional research. It is always necessary to begin with a general investigation into the situation. What this approach does is amplify and structure detailed research in order to improve the chance that the results will be applied effectively. Each new piece of information is gathered in response to a specific line of inquiry: the design need, or the way information is to be used, is determined *before* obtaining the information required to formulate a design in response to that need. When information is gathered in direct response to a known question or requirement, the role it is to play in the process becomes clear. The more effective the application of available knowledge, the more likely it is to lead directly to improvement in the environment.

CHAPTER EIGHT

Problem Definition

The beginning is the most important part of the work.

—Plato

Judge a man by his questions rather than by his answers.

—Voltaire

Psychologist and philosopher John Dewey said that "a problem well stated is half solved." Albert Einstein elaborated on the theme when he said that the "formulation of a problem is far more essential than its solution, which may be merely a matter of . . . skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance." Raising the right questions to correctly frame a problem has been a recurring theme among the world's great thinkers. It is a creative act, as relevant in design as in science or philosophy or any other endeavor.

The formal process of framing a design problem is described as design programming. The **design program** is the statement of a problem to be solved by design (Peña et al. 1987). When design problems are clearly defined, the likelihood of their successful resolution is improved. If the problem is unclear, or if the client and designer hold conflicting views of the critical issues to be resolved, the likelihood of a successful resolution is cast in doubt.

Because of the enduring appeal of grand-tradition design as an operative paradigm, it is not surprising that design programming has not yet become one of the strengths of design practice.

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It is not uncommon to hear designers, or even design instructors, comment on design proposals that they "like" or "dislike" in design critiques. The notion that individual preference does not constitute reliable evidence has yet to become a universal attribute of the design disciplines. The *science* of design is often subordinated to the *art* of design. Design programming is intended to balance the approach: to provide a comprehensive understanding of the problem to which all the relevant parties—designer, client, users, technical collaborators—can contribute and agree.

Framing the Problem

Design programming represents a systematic departure from traditional design approaches (i.e., intuitive and personalized decision making within a framework of prevailing values, past experience, and contemporary style). Thus it is sometimes unwelcome among adherents to the view that "good design" springs from the creative genius of the gifted designer. Design talent is not to be dismissed, but it resolves little when misapplied. The tradition of a **design brief**—a communication from the client to the designer to define a desired need—left the decisions about what the design response would be largely in the hands of the designer. The key difference between a traditional design response to a brief from the client and that of a programmed response to a comprehensively defined problem is that the brief is only a small, although indispensable, part of the design program. Through problem-definition research—design programming—the larger design problem and its context are explored (White 1991).

Proponents of rigorous programming procedures are primarily those who hold that design is neither art nor science, but an evidence-based creative process. The designer must first determine what is to be achieved, then how to achieve it. In this view, design is conceived as a systematic process through which both science and art are embraced to bring about innovation and predictable improvement through change in the environment. Alternatively, in some situations the environment remains unaltered but behavior is changed as a consequence of some new understanding or insight.

From a programming perspective, the designers begin each new commission with the assumption that they *do not* know what the problem is, but that they are capable of discovering it through systematic research and analysis. Although this might not be a typical approach, evidence indicates that it results in a more effective design response. Often, what appears obvious is, in reality, also untrue. Effective programming requires verification. But, as the philosopher Alfred North Whitehead points out, "familiar things happen, and mankind does not bother about them. It requires a very unusual mind to undertake the analysis of the obvious" (Whitehead 1925). Questioning the obvious, however, is the only way to move beyond convention and is essential for the creation of new insight. There is also a tendency for designers to apprehend problems according to conventional categories, which influences the way they are framed and resolved in the time-constrained environment of practice. And because time constraint is one of the most serious challenges of design practice, anything that might prolong the process tends to be seen as an additional and perhaps unnecessary burden.

Early work by Christopher Alexander (1964) focused on the identification and analysis of environments that people found successful. The identification of successful design relationships provided information that could be incorporated into the creation of new environments. Under a later approach (Alexander et al. 1977), he attacked the design problem by breaking it down into manageable categories or subproblems. Different design collaborators (representing different areas of knowledge) established a number of requirements for successful design resolution. These requirements could be synthesized into the formulation of design *elements*: the correct solution to a subproblem. These elements could then be combined into patterns, and the patterns combined and recombined into a *pattern language* to define "goodness of fit" for the organization of a complex system—a building or landscape—leading eventually to resolution of the problem as a whole.

Architect William Peña (1977), one of the pioneers of programming, describes it as a pre-design activity distinct from design. He describes programming as *problem seeking* and design as *problem solving*. Problem seeking is primarily an analytical process. Problem solving is primarily a creative process. But while problem definition and problem resolution are different aspects of design, the process for addressing them need not separate these interrelated considerations.

Among the types of information the program needs to include are descriptions of different design intentions regarding:

1. **Clients**—describing project purpose, the character of the setting needed to meet functional and organizational requirements, and the resources available to address them.
2. **People**—describing the full spectrum of users, their behavioral and perceptual requirements, and the expectations of clients and other members of the community.
3. **Environment**—describing the physical, ecological, and cultural context and design constraints due to existing or anticipated conditions, including the requirements of codes and regulations.

Notably absent from this list is consideration of the designer's intentions. Although it is reasonable for designers to be interested in advancing their personal reputations and careers through their designs, there is an ethical dilemma posed by using their clients' projects for ulterior purposes.

Obstacles to Application

The rapid pace of contemporary change in the environment, as well as our growing awareness of the complexity of the issues to be resolved, create a condition of urgency for responsible, knowledge-based planning and design decision making. But the successful application of knowledge is difficult. Having knowledge about environmental, functional, or social issues is not enough; the designer must know how to interpret and apply that knowledge in a design situation. There are many obstacles to effective knowledge application (Capra 1982). Among the most significant of these are:

- the diversity of knowledge areas to be integrated through design;
- the absence of any institutionalized framework for information;
- lack of understanding about what is known and what is unknown;
- the inability to predict what knowledge is most urgently required;
- profoundly different approaches to the creation of knowledge;

- lack of understanding about the values encoded in the information produced.

The scale and timing of landscape-change initiatives also present challenges regarding how problems are framed. Landscape-planning projects, for example, differ from design projects in a number of respects. While the information required to define a landscape-design problem is site-specific and immediate, the information required for landscape planning is regional in scale and thus reliant on long-term trends. The geographic extent and the time intervals covered by landscape-planning initiatives are too great to be addressed by explicit designs for immediate implementation. For this reason, the process of problem definition for landscape *planning* is different from that of landscape *design*. An outline of an approach to defining landscape planning problems is provided in the online Appendix I at: http://islandpress.org.

The challenge of applying knowledge through design is further complicated by the matter of context. Each design situation—the client, the design users, activities, the community, and the site to be developed—presents a unique combination of setting, personalities, values, resources, and intentions. Because each design situation is unique, each one requires different knowledge and insights to address it. It also is difficult to apply design ideas developed in a particular context to other environments or for other clients and users. It is only the procedural aspect of design that can be reliably transferred from one project to another. With improvements in designers' thinking and working processes about how to manage information in order to reach decisions, there come improvements in their design performance.

Purpose of Programming

As programming became more widely employed as a critical stage of design process, it became more systematic and comprehensive regarding the information it included. And as designers began to use programming more extensively, they began to recognize that the process provided benefits beyond its originally intended purpose. Originally dating from the mid-nineteenth century, programming was used to provide a description—

essentially a list of the requirements for a design solution. It also provides a metric for evaluating the adequacy of design performance (Sanoff 1977). We now recognize that it plays an important communication role as well. Programming serves a number of critical functions in design, to include:

- **Establishing systematic communication between designers, clients and users.**
- **Providing the information required to understand and resolve the critical issues.**
- **Providing a clear, complete definition of the design problem to be resolved.**
- **Informing clients and designers of the comprehensive scope of the problem.**
- **Providing a mutually agreed basis for evaluating design performance.**

An important function of programming is to establish systematic communication among designers, clients, and users. This communication needs to focus on an objective assessment of the issues before discussions of design responses are considered. Unless the client and designer are in agreement on the basic goals and requirements of a design initiative, it becomes difficult for them to work together to develop, and agree on, a proposed solution. It is imperative that the knowledge-building aspect of design process be employed to clarify complex issues and reduce the potential for conflict among the collaborators and stakeholders. This is particularly relevant for design initiatives in which a number of disciplines or parties are represented.

A less obvious but equally important role of programming is to provide clients with a clear understanding of the issues to be resolved. Clients may understand the functional and organizational requirements of a design initiative but be unaware of issues such as safety, liability, regulatory restrictions, costs implications, historic precedent, or environmental sensitivity. Because it is the clients' responsibility to make decisions for a project, it is necessary that they fully understand the implications of those decisions. It is the designer's responsibility to inform clients about the comprehensive nature of the problem as well as the details involved in it.

Active participation in the programming process enables clients to make informed decisions about whether to accept or reject the design advice to be offered later.

One of the most important purposes of programming is to provide a common basis for evaluating design proposals. Unless both client and designer are using the same criteria, there can be serious conflict regarding their mutual understanding of the merits of the design ideas being proposed. The same is true regarding their mutual responsibilities to one another and the project. Unless clients are aware of the value of a design innovation to create opportunities or resolve problems, they cannot be expected to accept or implement the design. Almost all designers have had the unfortunate experience of design advice being ignored, resulting in the inevitable manifestation of the problem it was intended to solve. It is primarily during design programming that this kind of difficulty can be avoided.

Designers, just like everyone else, have regrets about some aspect of their work. Typically, what they regret most are not the design mistakes they may have made, but the sound advice—offered to but not accepted by clients—that could have avoided future problems or resolved conflicts. In such situations, it is usually only later, too late for the advice to be helpful, that the client realizes the value of the unheeded advice. Often, the advice in these situations was rejected because the client failed to understand the nature of the problem being considered, and thus failed to realize the value of the recommendation being offered. The designer's failure in such cases is primarily a failure of communication: the designer failed to adequately describe the problem to the client's satisfaction, rather than failing to correctly diagnose or formulate a strategy for resolving it.

An example of such a failure is illustrated by the account of a client who refused to have a parking lot reconstructed—at the contractor's expense—to specified design levels after it had been improperly installed. The contractor convinced the client that it would be too costly to reconstruct the paving at the elevations provided on the plans. The paving looked fine to the client in August when the work was performed. In January, water that had not drained properly became a sheet of ice on the parking lot surface, with the result that one of the client's employees skidded into his parked car while attempting to maneuver into a parking place on the icy surface. The design had been correctly rendered but the execution was faulty and the need for adequate drainage had not been adequately explained.

The designer's best opportunity to avoid such failures occurs during design definition, when a problem is identified, and in subsequent explanations of how the design being proposed resolves the problem. Regarding a knotty problem, Einstein offers a suggestion: "If you can't explain it simply, you don't understand it well enough." Designers must understand problems thoroughly if they are to solve them successfully, which includes solving their own communication difficulties in explaining problems, as well as the benefits of their solutions, to clients. Programming provides the opportunity for these conversations to take place.

When the right questions are posed, the design answers are more likely to support reliable innovations to resolve the problematic situation. They are also more likely to be understood by the client. When the program is documented, it provides a record of the designer's responsibilities to the client in regard to solving the specified problems. Reciprocally, the program also documents the client's responsibilities regarding their expectations in evaluating the services provided by the designer. The program, unlike the design services contract that outlines work products, timing, and fee schedules, specifies the performance intended by the design intervention—which can only be determined after the design services contract has been signed and work on formulating the design program for the project has begun. This formalized communication enables both client and designer to reach a clear understanding of their mutual responsibilities—serving as a reminder and, in effect, a design-performance contract between the designer and the client—and as such, it should be fully documented as a matter of sound business practice, just like any other form of agreement.

Design Programming Process

Programming is the first act of design (Lynch et al. 1984). To be most effective, the design search (problem seeking) should include design application (problem solving) as part of an integrated creative and critical-thinking process. Formulating and evaluating design concepts is not just a way to resolve the problem of design form, but a way to better understand the problem as an integrated set of requirements.

When undertaken as a central aspect of design process, programming includes a number of relatively discrete research, analysis, and synthesis activities. In general terms, the integrated tasks of a comprehensive programming and design process may be outlined as follows:

1. **State the design problem to be resolved in general terms, and specify goals.**
2. **Comprehensively define the issues and requirements to be addressed.**
3. **Conduct research of the issues and analyze their critical influences.**
4. **Translate research conclusions into design performance criteria.**
5. **Formulate design concepts to satisfy the performance requirements.**
6. **Evaluate the likely performance of design concepts for feedback inputs.**
7. **Restate/refine the design problem and critical issues on the basis of feedback.**

The purpose of these integrated tasks is to organize design inquiry in a way that leads directly to usable information—that is, information that has a direct bearing on design performance. One of the first requirements in programming is to formulate a comprehensive definition of the critical issues affecting design response. This serves to organize and direct project research in productive areas and leads, through analysis, to a definitive statement of design instructions and performance requirements. A broad understanding of the critical issues enables the designer to establish a frame of reference from which to assess all the information gained through research relative to intended design outcomes.

The next step is to establish a conceptual design approach that identifies the specific information to be collected and establishes the significance of the issues as they relate to one another in a way that integrates all the relevant concerns. The outcomes of this process of knowledge building, design integration, and feedback assessment are a set of comprehensive performance requirements to guide the formulation and evaluation of design proposals. The evidence on which the performance criteria are based is acquired through data collection.

Data Gathering

The quality of design is more often a reflection of the type of questions posed than the answers provided. Asking the right questions is one of the most important factors to design success, and thus it is one of the critical aspects of design process. Unless we are clear about the destination, the likelihood of arriving is low. There is, however, a practical question about what information to gather. Considering the limits of time, it is necessary to gather as much needed information as possible during the time available. At the same time, it is important to avoid spending valuable time gathering information that cannot be used to improve problem understanding or design performance. Unfortunately, designers cannot know in advance exactly what information will be most valuable. A common way of addressing this dilemma is to separate data gathering to define the problem into two stages:

1. **Framing the problem**—First, general background information is compiled to paint a broad-scope picture of the critical issues germane to design intentions and context.

2. **Filling in the details**—Later, as the broad outlines of the problem becomes clarified and more detailed information is seen to be required, more closely targeted information can be gathered to support detailed environmental, performance, technical, and implementation requirements.

Framing the problem as the first stage of the investigation establishes the overall parameters of the problem, which then establishes the context for more detailed investigation. The detailed design requirements, such as specific users, activities, or materials requirements are developed in the second stage of data gathering. To guide the acquisition of needed information, the designer must understand the critical issues. There are four general areas of investigation that help to establish these issues.

- **Requirements of users**—Determine the needs and activity requirements of the primary users of the proposed setting, as well as secondary and tertiary users—those acting in their support, such as visitors or administrative, maintenance, or security personnel—to determine the functional, behavioral, and perceptual concerns of all the people the design is intended to serve. The findings of these investigations lead to an understanding of the performance requirements for the design as a behavioral setting.
- **Functional requirements**—For each activity to be provided, there are preferred (or limiting) relationships to be established (or avoided) in order to facilitate optimal functional relationships for each activity, such as site operations, security, maintenance, etc. These requirements need to be investigated for each proposed activity—individually and collectively—as a set of related activities. These findings lead to an understanding of the functional criteria to be met by design.
- **Site conditions**—Investigate the natural and cultural features and processes of the site, as well as their broader environmental context, to determine how site factors will influence design performance. It is equally important to determine how design performance may be expected to influence site processes. These findings provide an understanding of the contextual relationships into which the design is to be integrated.
- **Constraints**—All design initiatives operate under constraints, such as the values of the client, the expectations of users, economic limitations, natural-process considerations, legal requirements, or time restrictions, any of which can influence the character of a design solution. Identifying the relevant constraints provides the information needed to understand the legal, financial, environmental, and sociopolitical context within which the design change is to be carried out.

Filling in the details, the second stage of data gathering, provides the fine-grained information needed for better understanding of issues such as the specific users, activities, or materials requirements—information critical to a successful design outcome. Once there is clarity on the detailed nature of these issues, the designer can gain a fuller understanding of their meaning and influence on design performance.

To obtain detailed information, designers may conduct four different types of investigation to help to flesh out and reveal the design implications of the critical issues:

- **Evaluation of similar facilities**—Conduct parallel studies of similar existing situations to determine the strengths and weaknesses of these places as functional, behavioral, experiential, or ecological settings.
- **On-site investigations**—Conduct detailed investigations of existing site conditions, activities, and processes to determine their potential influence on design constraints and opportunities.
- **Review of current literature**—Determine the state of the art regarding the type of facility or problem to be resolved by reviewing published research and case studies as a point of departure for establishing areas of project research or design performance standards.
- **Inquiry-by-design**—Conduct preliminary design studies to establish the specific relationships to be encountered by the proposed development in order to determine the interrelationships among the features and activities to be provided regarding the conditions on the site where they are to be located.

One of the easiest ways to gain on-site information is to simply observe what is going on. Systematically observing people as they engage in their normal activities, or looking for evidence of those activities that they have left behind, requires little prior preparation and can lead to clear direction for the design changes to be pursued.

John Zeisel (1988) recommends several complementary techniques for establishing the user requirements of design: making behavioral observations, observing the physical traces of activity, conducting focused interviews, and administering questionnaires.

- **Behavioral observation** enables designers to determine what people actually do in a setting, and to learn how designed places either support or interfere with these activities. Observers, however, are cautioned to avoid reaching false conclusions as a result of prompting unnatural behavior from subjects as a consequence of their being watched (Zeisel 1988). Discreet observations are most likely to reveal authentic behavioral traits.

- **Observing physical traces** means looking for the evidence that people have unconsciously left behind, such as shortcut paths across a lawn or the rearrangement of furniture for social interaction. These traces of past use reveal how places are actually used, rather than how designers may have intended them to be used. Sometimes the absence of traces, such as evidence of normal use or wear, reveals that places may not have been used for the intended purposes at all.
- **Conducting interviews and administering questionnaires** requires a basic knowledge of survey methods to assure reliable results. This type of investigation relies on detailed attention to the type of information being sought and the form of the questions to be posed in order to avoid prompting desired responses. When questions are well framed and responses interpreted accurately, they provide valuable information about user needs and perceptions. But, as a note of caution, questionnaires that are poorly designed or poorly interpreted can lead to confirming responses that reinforce stereotypes or preconceived opinions that do little to improve understanding or guide productive design decisions.

These information-gathering approaches may be employed to create a comprehensive database to inform and evaluate design proposals. But before information can be used to guide design decisions, the raw data must be translated into a usable form. This begins with data analysis.

Data Analysis

It is necessary to know how information is to be used before it is possible to assess its importance to design. For example, if the requirement is to provide sports fields on a site with seasonally saturated soils, the type of hydrologic information to be gathered and the requirements for its analysis will be directed toward interventions to lower and control groundwater levels. Alternatively, if the design requirement were to create a year-round wetland and wildlife habitat, the analysis of the same information would be directed toward methods to maintain soil moisture on a year-round basis. The data may be collected and analyzed but, without a direct relationship to the requirements of an intended use, it may still fail to provide improved understanding of the situation.

Additionally, design research and analysis should never be confined to the limits of the property to be designed. Determining the reach of design influence on the adjacent landscape, and, conversely, the extent to which the broader context may influence the designed setting, should be one of the first areas of investigation in a programming exercise.

One of the most efficient and effective ways of establishing the relevance of information is by design testing—examining its relationship to an intended design application within the context of its surrounding environment. It is only through design application that all the relevant relationships will be revealed as an integrated set. Through design testing, designers are able to conduct an integrated analysis to reveal how the different pieces of information relate to one another through practical application.

The purpose of analyzing research data is to determine how knowledge may be applied in order to improve design decisions: determining the most appropriate (or inappropriate) locations on a site for the proposed activities and the most appropriate (or inappropriate) relationships to be established among them. Once these general conclusions have been reached, attention may be shifted to the development of more-refined information collection and analysis, such as the detailed criteria to be met in the consideration of materials choices, technical performance, or experiential relationships.

Design concepts are employed as the means by which to analyze data as an integrated set of relationships. Concepts are the ideas about how to satisfy the design objectives at the standard specified by the performance criteria. As will be indicated later, in table 8-2, design concepts should be comprehensive enough to address multiple design objectives, or at least contribute to satisfying them. The design concept describes the underlying logic for a course of action, suggesting how a proposed design, once developed and implemented, might lead to the satisfaction of the desired objectives. Since the design concept is only a spatially expressed idea, there is no certainty that it will lead to an effective solution to the design problem. In programming, the concept is an idea to be investigated—a prototype that establishes a potential means of satisfying the design goals as a set of relationships. Articulating the concept enables the designer to explain and to examine the rationale for a proposed course of action irrespective of any particular form expression and facilitates discussion of the pros and cons of an idea before it is accepted or developed as an integrated design-form proposal. Examples of evidence-based design concepts may be found in online Appendix G.

Programming is the designer's way of providing guidance for the creation of landscapes that are both satisfactory in the eyes of clients and users and successful as integrated improvements in the environment. Only when the quality of the environment has been comprehensively improved relative to context and the required activities can the design process be considered successful.

One of the critical considerations to successful programming is that the information it contains must be complete and factual. Unfortunately, designers can never foresee future information needs well enough to determine precisely what information will be needed to support design decisions prior to their formulation, although what was needed is often clear after the design has been completed. For this reason, the development of design concepts is one of the designer's most effective means of identifying deficiencies in program information. Through the evaluation of preliminary design concepts—design prototypes—missing or inadequate information is revealed. Once these deficiencies have been identified they can be used to guide the acquisition of additional information until all necessary data have been collected. For these reasons, as well as for precipitating feedback, programming is not just a preliminary or pre-design activity. Rather, it is better understood as an ongoing learning requirement throughout the design decision-making process. As new insights about design needs develop, both the program and design concepts need to be able to evolve and improve in response.

Translation of Conclusions into Design Instructions

The pivotal function of programming is to translate information into useful knowledge; that is, into *design performance requirements*. These instructions to the designer should be neither overly vague nor overly restrictive. They must be clear enough to guide the formulation of effective design proposals without dictating specific choices. Designers require at least four things from the program:

- **A definitive outline of required features, activities, and environmental constraints;**
- **Clear guidance about preferred relationships and intended design performance;**
- **Understanding of the conditions and standards to which the design must conform;**
- **Flexibility and freedom to create the best possible overall relationships.**

If there is too much uninterpreted data, designers will be unable to relate knowledge to design decisions. If there are too many restrictions or preconditions, designers will lose flexibility and be unable to maneuver within the context of existing conditions to establish desired relationships and formulate appropriate design solutions. Design performance instructions need to describe *what* the desired results are without specifying *how* they are to be achieved.

Program Documentation

For the program to provide useful design guidance, it needs to be documented with clarity and economy. It must be factually accurate, thorough, and succinct. The program is a working document and as such should record only the information needed to guide or evaluate design proposals; it should not attempt to explain or justify that guidance. Backup research and analysis may need to be documented and appended for the sake of bookkeeping, but should not be a part of the body of the design program. Detailed background information would make the program too unwieldy for convenient use. To assure agreement on the design program, the information it contains must be understood by all parties. It should be recorded in a format that makes the design guidance easily accessible to the designer, the client, or other interested parties such as involved users, design collaborators, or technical consultants.

To facilitate convenient access to the design instructions, the program information needs to be organized into easily recognizable categories, according to the topics considered useful to influence design decisions, not according to areas of research. The program information can be organized by broad categories, for example, facts, reasoning, and imagination. The facts include such things as site conditions, user requirements, required features, and budget limitations. Reasoning is expressed in the mission statement, goals, objectives, desired relationships, and technical performance criteria. Imagination is incorporated through design concepts. Collectively, the program elements provide an opportunity to develop a holistic description of the influences that shape a design decision.

Once the data have been analyzed and conclusions regarding design performance have been reached, the program information is documented to clarify the design guidance, often as a hierarchically ranked array of design requirements progressing from the most general to the most detailed. These requirements typically include the project goals, objectives, required features, and performance criteria. These are written to conform to a general understanding of the project as outlined in a project commission or mission statement. The basic elements of a program might include:

Mission statement—A brief outline of a project's basic purpose, the mission describes the rationale for decision making and the responsibilities of the designer to the client, end users, and members of the local community. It is typically a vision statement describing the opportunities to be created and problems to be resolved. The mission statement provides overall direction and continuity for the project and establishes the core ideas to be pursued.

Project goals—The goals state the intended results of design intervention—why design change is being undertaken. If the goals cannot be clearly defined and written, it is unlikely that the designer knows with any certainty what they are. Unstated goals cannot be shared with clients or design collaborators, cannot become the basis for general agreement, and are unlikely to be achieved (Peña 1987). Goals are not related to design form (e.g., football fields) but to design outcomes (recreation).

If the design intent is to improve upon conditions as they presently exist, the first questions to be asked are: What are the conditions to be improved upon?, and What constitutes improvement in the environment to be changed? Design goals define the desired results of the changes to be imposed, such as improved convenience, function, or safety. The intended performance outcomes of a design intervention need to be as comprehensive as possible if the project intentions are to be addressed holistically. Alternatively, if the goals include defining the parameters of the project realistically, they should be limited to the possibilities inherent in the project, the authority of the decision makers, and the capacity of the decision-making process. The relationship between clearly established goals and success has long been recognized. On this subject, even Aristotle offered the following advice: "First, have a definite, clear practical ideal: a goal, an objective. Second, have the necessary means to achieve your ends; wisdom, money, materials, and methods. Third, adjust all your means to that end."

Examples of design goals might include providing recreational opportunities or protecting development from flood damage. Illustrations of design goals for The Woodlands, a new town near Houston, Texas, and their relationships to a series of design objectives intended to satisfy them are shown in table 8-1.

Project objectives—Design objectives describe the means to be employed to satisfy the project goals. Unlike goals, which are general statements of project intent, the objectives are concrete steps specifically related to design form. The objectives describe physical relationships. This requires consideration of the general form of relationships to be employed to satisfy the goals, but not necessarily in the context of an overall design concept—the various objectives may be unrelated to one another, at least in the program. It is the design that integrates them into a unified form. For example, to satisfy the goal of providing

Table 8.1
Design Goals and Objectives

Environmental Goals: / Environmental Objectives:	Minimize vegetation removal and loss of shade	Maintain large contiguous areas of natural forest	Maintain maximum groundwater recharge	Preserve the natural drainage pattern on the site	Minimize flooding and stormwater runoff from site	Minimize erosion and siltation	Minimize pollution of the site	Maintain perennial stream flow	Manage forest for optimum wildlife habitat (food, water and cover)	Maximize resource/energy conservation
Maximize utilization of site resources	●		●	●					●	●
Maintain a viable forest condition on the site		●	●	●		●		●	●	
Manage water regime for benefit of natural and introduced systems			●	●	●	●	●	●		
Prevent the loss or deterioration of site resources	●	●		●	●	●	●		●	●
Maintain a favorable climatic condition for human comfort	●	●			●				●	●

Table 8-1. *Design goals for environmental issues at The Woodlands, showing how multiple design objectives are intended to contribute to the satisfaction of each goal. (Table by the author, 1975.)*

recreational opportunities, objectives might include the development of a golf course or a soccer field. To meet the goal of protecting development from flood damage, the design objectives might include locating golf-course fairways in a floodplain to utilize land that is occasionally inundated while keeping club or maintenance buildings on higher ground. Examples of design objectives for The Woodlands, with their relationships to the relevant design concepts intended to satisfy them, are shown in table 8-2.

Table 8.2
Design Objectives and Concepts

Environmental Objectives: / Design Concepts:	Stabilized drainage swales and natural streams to be use for stormwater runoff	Stormwater to be temporarily impounded over highly permeable soils	Sediments are to be collected in silt traps before stream interception	Drainage swales to remain forested where possible	Minimize impermeable surfaces in development	Up to 1/3 of the site to be maintained as permanent open space	Maintain forest diversity (vegetation size, age, species structure, density)
Minimize vegetation removal and shade loss	●			●	●	●	●
Maintain large contiguous areas of natural forest	●	●		●	●	●	●
Maintain maximum ground water recharge	●	●			●		
Use natural drainage pattern for development runoff	●	●					●
Minimize flooding and storm-water runoff from the site	●	●	●	●	●		
Minimize erosion and siltation			●	●		●	
Maintain perennial stream flow	●		●	●	●	●	
Manage the forest for optimum wildlife habitat				●		●	●
Maximize energy/resource conservation	●		●	●			●

Table 8-2. *Design objectives for environmental issues at The Woodlands, showing how multiple design concepts are intended to contribute to the satisfaction of each objective. (Table by the author, 1975.)*

Required features—The activities to be provided and the features necessary for their support, such as social interaction areas, park benches, or toilet facilities, need to be specified, typically as a list that includes their size, number, or extent, to assure that both client and designer have identical expectations of what the design is to provide. If the client expects a soccer field with adjacent parking for 100 cars, and the designer understands the need for only 50 cars, the resulting proposal will be found lacking and will have to be revised at the designer's expense. The responsibility for documenting and reaching agreement on these requirements lies with the designer, and it is during the programming process that the requirements are to be discussed and agreed upon.

Design performance criteria—The features and activities to be provided must meet some specified standard. In general, the higher the standard to be met, the higher the cost of providing these features and activities. Performance criteria refer to the desired qualitative or quantitative standards of the physical relationships to be established. The performance criteria, which cover all aspects of design, address those areas in which the quality of design performance may be measured (Garvin 1988). These might include:

- spatial requirements of the activities to be provided;
- functional requirements of the activities to be provided;
- mutually supportive adjacency relationships between activities;
- reliability of the design functioning as intended;
- conformity of design functions with established standards;
- conformity with contemporary technology or materials;
- durability or useful life expectancy;
- serviceability and ease of maintenance;
- fitness of the design to the environment in which it is located;

- appropriateness to the limits of financial resources;
- aesthetic qualities in relation to user expectations and environmental context;
- perceived quality as determined by the client or users.

Typically, the area requirements for the desired features of a design are among the first criteria to be established, because they are exclusionary. If there is insufficient space to accommodate an activity, it cannot be fully provided. These criteria would include such things as the surface area required for a parking lot or a sports field. Location requirements (such as adequate surface area for parking near access roads), functional relationships (parking near sports fields), and technical or construction limitations (land too steep for economical development or handicapped access) are also among the more obvious of the design performance criteria. Performance criteria for critical site conditions might include considerations such as maintaining storm-water runoff at pre-design peak-flow levels or habitat diversity in open space.

The most reasonable way to evaluate design quality is by comparing the results with the goals and performance requirements that the design is intended to satisfy. Performance criteria specify the relationships to be satisfied by a designed condition. However, if the goals are inadequate to address all the critical issues or to yield the design intentions, the design may, by programmatic definition, be considered a "correct" solution that nevertheless fails to address the full spectrum of human or environmental needs, or ensure an appropriate outcome. An example of a design program is located in the online Appendix F at: http://islandpress.org.

In managing a design project there are three main cost factors: the budget, the program, and the choice of materials. The client may control any two, but the designer must control the one remaining (Allen 1980). For example, if the client establishes the programmatic requirements and the materials selection, the designer must be free to determine whatever budget outlay is required to meet these requirements. If, on the other hand, the client wants to control the program and the budget, then the designer must have the prerogative to select the materials that will fit within the limits of the budget and satisfy the program. The client is not in a position to control all three. Designers must have discretion over at least one of these three factors if they are to responsibly satisfy their obligations to the client and the project. When designers exercise control over the program, they have the greatest opportunity to influence the overall quality of the resulting design intervention. But the choice must be left to the client.

Landscape Suitability Analysis

Analysis of a landscape's compatibility for intended uses, or **suitability analysis**, is a process of determining the fitness of a specific landscape condition to support a well-defined activity (Steiner 1991). Landscape suitability analysis is based on the underlying logic that ". . . the ability of the landscape to support a particular land use varies according to the physical, biological, and cultural resources that are distributed over a geographical area" (Ndubisi 2002). Its fundamental purpose is to determine the appropriateness of using a landscape setting for a particular activity based on the intrinsic "suitabilities" of the site.

The basic premise of suitability analysis is that each aspect of the landscape (the structural bearing capacity of soil, for example, or existing vegetation type) has inherent characteristics that are, in some degree, either suitable or unsuitable for the activities being planned, and that these relationships can be revealed through detailed evaluation and assessment (Marsh 1998). The intended result is to provide the rationale for establishing a site plan that takes advantage of the landscape's intrinsic attributes while avoiding unsuitable locations for activities where obvious conflicts or incompatibilities exist. The purpose of the process is to determine the optimum site location for activities while minimizing negative impacts on the environment.

The factors to be considered in suitability assessment include the human, biotic, and abiotic aspects of the landscape. Human factors include considerations such as community needs, economics, community organization, demographics, land use, and history. Biotic factors include wildlife and vegetation. Abiotic factors include soils, hydrology, topography, geology, and climate. The independent analysis of these site factors is carried out to determine the extent to which each factor is favorable or unfavorable for the location of the activities being considered and leads to a suitability assessment for each activity over the whole of a site.

Mapping Suitability

The cultural features considered in a suitability analysis may include factors such as existing land uses, zoning requirements, circulation patterns, utilities, and community-service facilities. The site being analyzed is typically mapped with a different suitability assessment map (or layer of analysis) for each factor considered. For example, there might be suitability assessments for landscape layers such as topography, soils, geology, vegetation, and so on. Each layer is mapped to indicate those portions of the site that are suitable, unsuitable, or neutral for each activity being contemplated. These maps do not depict the site conditions themselves, such as different soil types or plant communities, but the extent of their *suitability* for a specific type of development as revealed by an assessment of that particular site characteristic. The site is mapped according to suitability assessments that may be expressed, for example, as high, moderate, or low suitability.

Ultimately, all of the site-factor suitability maps are synthesized into a composite map to provide an overall picture of the site regarding its general appropriateness for the different land uses being considered, rendered as a composite suitability assessment map for the site as a whole, or for each activity to be considered. The suitability assessment provides the rationale for locating development on those portions of the site most suitable for each activity, or, at least, avoiding locations that are incompatible or are likely to interfere with development or operational requirements.

On the basis of the suitability assessment, an overall development plan can be organized to optimize the planned activities in relation to existing site conditions. Although it is cumulative rather than holistic, the suitability-analysis approach to making land-use planning decisions has demonstrated its value over many decades of application. The process helps landscape planners and site designers examine, set parameters for, and solve the problems associated with locating human activities in the

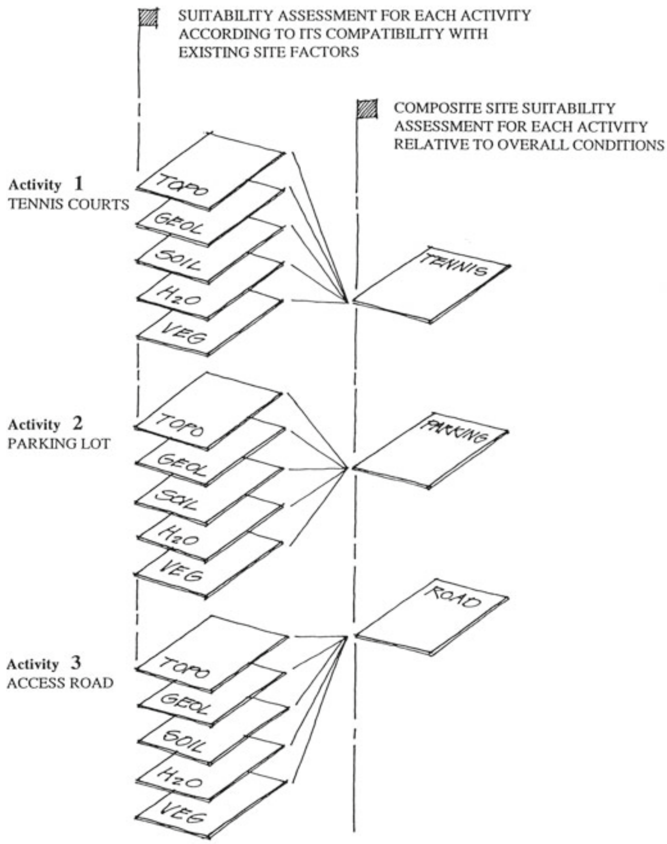

Figure 8-1. *Schematic diagram of a landscape suitability analysis.*

landscape and employing the resources of the landscape to optimal advantage (Ndubisi 1997).

Limitations of Suitability Analysis

Suitability analysis, while valuable, has significant weaknesses. It does not render a determination of whether the activities being planned are the most appropriate for development. Nor does it establish the most appropriate relationships among the activities to be developed. In reaching overall landscape-planning decisions, both of these considerations are as important as determining the most-appropriate site locations. These relationships are critical to a thorough understanding of the problem.

The knowledge gained by suitability analysis reveals only the relationships between the land-use activities being planned and their landscape setting. The process is an analytical procedure to help define site-specific problems and opportunities, not a comprehensive investigative and planning tool.

Predicting the beneficial effects of land planning and design proposals requires verifiable evidence regarding a few fundamental relationships:

- The activities being proposed are appropriate to and compatible with the existing urban or cultural context.
- The activities being proposed are appropriate to and compatible with the existing ecological context in which they are to be located.
- The resource base is sufficient to support the proposed landscape development without stressing or threatening existing site processes or development.
- The plan takes full advantage of existing site attributes, and these are supportive of the activities being proposed.
- The activities within the development are arranged to avoid conflicts and create mutually supportive adjacency relationships among them.

To improve the predictability of landscape planning and design initiatives, designers require information of two kinds: evidence that the problems to be resolved have been correctly and comprehensively defined, and evidence that the conditions being proposed are likely to resolve the problematic situation. The following chapter explores ways to obtain that kind of information.

CHAPTER NINE

Design Collaboration

The ultimate good is better reached by free trade in ideas. The best test of truth is the power of the thought to get itself accepted in the competition of the market.

—*Oliver Wendell Holmes*

Never doubt that a small group of thoughtful, committed people can change the world. Indeed, it is the only thing that ever has.

—*Margaret Mead*

As growing evidence reveals the linkages among environmental, social, and technical requirements, and design problems become increasingly interconnected and complex, landscape architects are challenged to address issues beyond their previous experience, and moreover, beyond the capabilities of any single discipline (Roy 1979; Musacchio et al. 2005; Calkins 2012). A fundamental principle of ecological thinking is that all aspects of the landscape are relevant to an understanding of its highly integrated structure and function. As a consequence, designers require a comprehensive assessment of the issues and relationships regarding a site as well as the people and the activities to be accommodated. And because knowledge changes rapidly, this assessment needs to be based on the most up-to-date information available.

The traditional method of design has been described as a "black box" approach, employing tacit knowledge that, while widely accepted, may

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lack evidence-based facts in its support (Schön 1983; Hedfors et al. 2008; Collins 2010). Supposedly, the designer investigates the situation, takes all the relevant considerations under advisement, and "creates" a design idea. When decision making takes place within the mind of the individual designer, there is little record of how a design decision is reached or what information is considered—or is not. For the individual designer, this approach is both a challenging and, when successful, an exhilarating process. The problem with this approach, though, is that there is no way to follow the logic of the design argument.

A promising path to stronger design delivery is a deliberative approach that reveals what knowledge is being applied and how it is being used to guide design innovations. Collaboration among representatives from multiple disciplines not only infuses a wider spectrum of considerations into design process deliberations, it also forces transparency about what information is being used and how it is being applied. An increasingly common method of developing this broader and more detailed understanding is through the collaboration of multiple disciplines engaged in a comprehensive design venture (Parker 1990).

Having representatives of broad areas of current knowledge as active participants on a design team facilitates decisions that incorporate considerations beyond the limits of conventional programmatic and design concerns. Collaboration strengthens design thinking in the same way that species diversity imparts resilience and stability in the landscape. Disciplinary diversity strengthens design process by providing a more complex range of positions from which to assess and respond to uncertainty and change.

But, as architect William Caudill cautioned, "It is a real trick to get people of different disciplines to work as a smoothly operating team" (Caudill 1984). Collaborative design requires the active contributions of team members with profoundly different points of view. To perform this role, the participants need to be integrated into a learning and decision-making team that enables them to create unified solutions to the problems of the environment. Integrative thinking requires a systems approach.

Systems Design

Systems design is modeled on the processes of natural landscape evolution. In nature, many factors interact to shape landscape form as it evolves toward increasing integration among its physical, chemical, and biological components. There is constant feedback among the landscape's subsystems as they influence one another to transition toward mutual accommodation and integration. Nature, however, is too complex to model as a complete system. For example, we know that modeling climate alone, an area of investigation that has received concentrated attention for several centuries, is a demanding and often inaccurate area of science. And climate, of course, is only one of many factors influencing landscape development. When we consider the combined roles of the landscape's multiple subsystems—climate, geology, soils, hydrology, plants, animals, and the intricacies of human activity and interaction, all with their own levels of complexity and unpredictability, we begin to see the difficulty of developing a comprehensive model of the landscape. And yet, some form of such a model is needed.

The purpose of interdisciplinary design is not to apply *all* available knowledge to determine a new course of action, but to apply *the most critical* knowledge to the design's greatest advantage. As the knowledge base increases, so does the number of issues that designers need to consider. The object of systems design is to identify the critical factors and their interrelationships, determine the *least number* of *most-influential* relationships affecting system outputs, and manage these relationships to achieve the intended performance outcomes.

Significantly, this must be accomplished without unduly altering or stressing the system being managed; that is, the landscape must be maintained in a healthy state while it is being modified to incorporate new activities or perform new roles. Under ideal circumstances, systemic design interventions are implemented to *initiate* the change process. Once the form of the landscape has been modified, the ongoing processes of the environment are engaged to bring about the desired performance outcomes.

Designers shape landform to drive activity. For example, landform is shaped to promote site drainage that will proceed without harm to development while, at the same time, precluding damage to downstream ecosystems by flooding or reducing water supplies. The same may be observed with the installation of plants, whose growth will create spatial enclosure or shelter, but without introducing species that diminish habitat health and productivity. Particular reliance is placed on the system itself to carry out the maintenance of a design—keeping drainage ways clear, for example, by introducing low-growing native plants—to sustain an intended design effect. Change in landscape form is the means by which landscape processes are engaged to create improved landscape performance. Although all this is easily said, actually accomplishing these aims on a whole-landscape basis is a major challenge for the design community.

Successful landscape change depends on the designers' ability to integrate the environment's physical, social, and ecological systems into a mutually sustaining whole. Equally important, the modified landscape must retain its systemic capacity for continuing development and renewal as conditions evolve and new demands present themselves. To create landscape systems with the capacity to satisfy these requirements places three demands on design teams. They need:

- The depth of expertise to fully understand and correctly frame the design problem;
- A comprehensive knowledge base to guide the development and evaluation of design ideas; and
- A decision-making strategy with the capacity to integrate the insights from different disciplines and value systems—the sources of a comprehensive knowledge base—and apply them holistically.

An important implication of this type of approach is that the strategy that designers employ, as well as the form of the changes being proposed, must have the potential to continually adapt and change based on the learning that takes place among the collaborators as new insights are revealed about the nature of the systems being managed. The process is further complicated by the fact that the more a team learns and the more their shared knowledge emerges, the more demanding and interrelated the design performance requirements become.

Conventional design approaches tend to employ conventional methods and, often, conventional wisdom to guide the development of design proposals. This simplifies the decision-making process but does little to facilitate new insight or innovation. Unfortunately, each discipline has its own conventions. Creating an intellectual climate that embraces a new way of approaching design—to include approaches from disciplines outside the design fields—is an emerging role of the design professions. Innovation is required, but not just in design form. There must be innovation in design thinking as well.

Collaboration with Other Disciplines

Since each of us sees the landscape and our role in changing or managing it in a slightly different way, what we see of the landscape lies as much within our minds as in the environment itself (Meinig 1979). For this reason, design teams integrate the strengths and expertise of different participants to enrich the base of understanding and eliminate unsubstantiated biases in design approach. For example, one of the most innovative designs of the twentieth century was for the Pompidou Center in Paris, executed by architects Renzo Piano and Richard Rogers. Peter Rice, the engineer for the project, described the reason for their collaboration:

> The architect, like the artist, is motivated by personal considerations, whereas the engineer is essentially seeking to transform the problem into one where essential properties of structure, material, or some other impersonal element are being expressed. This distinction between creation and invention is the key to understanding the differences between the engineer and the architect, and how they can both work together on the same project but contribute in different ways. (Rice 1994; Piano 2008, 7)

Collaborative design, in addition to its benefits, also has embedded problems. It is often described as a "messy" process (Brown 2009). People with different areas of expertise may approach problems differently. The basic question is how to organize the dialogue among participants from disparate disciplines with different approaches focused on a complex problem in which they all have an interest but none has overriding control.

Managing a collaborative design enterprise requires skills beyond those normally provided in design schools (Mulder 2010). For some contemporary practitioners, managing other specialists has become their design specialty. It is this new role that designers need to master if they are to participate effectively—and, more importantly, to lead the collaborative design teams required to resolve complex landscape development problems.

Successful design within complex economic, social, political, and ecological contexts is made difficult by more than just the conflict among competing interests and personalities. Designers also must contend with the shifting nature of the design problems due to the dynamic conditions that create them (Senge 1990), and the difficulty of accurately defining and managing what have been aptly described as "wicked problems" (Rittel et al. 1973).

Unless designs fully integrate detailed consideration of the broad range of critical issues they are intended to resolve, proposals for extensive landscape change will not lead to comprehensive improvement, and may even, on occasion, be harmful. The design-team approach has been adopted because of its two basic, and equally important, advantages:

- It is built on a more extensive and reliable knowledge base to describe and model the system to be designed.
- It has the potential for building new knowledge; that is, it has the synergistic potential for creating knowledge beyond that held by the individual team members.

One of the primary benefits of interactive team learning is its tendency to shift attention from problems in isolation to the unique conditions of the project confronting them. As team members coalesce into a group with a sense of shared purpose and responsibility, the territorial boundaries of their disciplines expand and coalesce into the boundaries of the project as a whole. In this way, the critical relationships between disciplines become just as important as the individual knowledge areas the team members bring to the deliberations. In fact, it is often in the interstices between disciplines where the richest learning opportunities are to be found. In the course of exchanging information, collaborators' shared insights lead to what has been described as "bridging knowledge." Bridging knowledge integrates the isolated knowledge residing in the team member's different disciplinary areas and merges into something new, creating a more comprehensive view of the problematic situation. It is this new way of seeing the situation that reveals new juxtapositions and creative insights about design relationships (Hedfors et al. 2008, 23).

One of the main challenges of working in teams is communication. When people from different disciplines interact, they may lack a common method of interaction or communication such as that which typically exists within disciplines. Consequently, it is often difficult for professionals from different disciplines to interact productively, since they have different methods of exchanging information and reaching decisions. These problems can be overcome, but it requires commitment to clear communication—which means listening as well as sharing information—by all the participants. "Unless all the team members commit fully to making the process work, it probably won't" (Conner 2006). One of the most troubling difficulties for team members to overcome is that of perceived infringements on their professional territories.

Territorial conflict, a behavior characteristic that seems to be a constant in nature (Ardrey 1966; Caudill 1984; Bell et al. 1996), creates a situation that must be continuously confronted. The territories in this context are not physical but professional territories, sometimes called "turf." To balance the level of turf conflict and resolve difficulties without destroying the creative potential of interpersonal and interdisciplinary interaction requires the establishment of innovative working procedures and organizational structures. Traditional design approaches typically operated as closed systems, with the consequence that little outside information flowed into and enriched their deliberations. For optimal information exchange, the team members' professional boundaries need to become porous. A systems design process integrates the different team disciplines into an open system within a single project boundary.

There are two basic types of teams: multidisciplinary and interdisciplinary. The different organizational forms reveal an emphasis on either control or innovation.

- **Multidisciplinary teams** include members from different disciplines under the leadership of a single discipline. The knowledge base of these teams is expanded but the definition of the problems they address tends to be disciplinarily focused—as when a multidisciplinary team addresses an engineering problem. On such a team, success is measured in a disciplinarily distinct way. The team is intended to provide an improved engineering outcome. The additional expertise is there to strengthen the lead discipline. The turf of these teams is well defined as "belonging" to a particular discipline. Although the problem may be disciplinarily defined, the team members are pursuing individual goals (Tress et al. 2003, 2005), creating the potential for stress within the team, in particular regarding who gets credit for success.

- **Interdisciplinary teams** also comprise multiple disciplines, but the description of the problem and the outcome tends to be more open to interpretation, established by the team members collectively. Interdisciplinary team members work together to achieve a shared goal. Success on interdisciplinary teams may not conform to any particular disciplinary definition. The role of these teams is not to maximize the outcome for a particular discipline but to optimize the outcomes for all the participants—to solve problems as they really exist as opposed to how they might appear through a particular disciplinary lens. These teams address problems holistically rather than disciplinarily. The turf of these teams is more open to interpretation as the members define both the problem and their mutual responsibilities on a collaborative basis.

The basis for effective team interaction is the learning that takes place among people with different knowledge and experience. When all the participants are collaboratively engaged, the team learning process serves as the mechanism for reaching collective understanding of the issues and leads, ultimately, to consensus and shared ownership of the resulting design decisions. But this is only likely if the team is constituted as an effective learning organization. Systems scientist Peter Senge defines three core learning capabilities as necessary for the development of an effective learning organization: *fostering aspiration*, *understanding complexity*, and *reflective dialogue* (1990). He describes five approaches or disciplines for developing these group-learning capabilities:

- **Personal mastery**—continually clarifying and developing individuals' personal and professional vision, seeing reality objectively, focusing on the issues, and having the patience to develop the ability to see critical relationships. This is the learning organization's basic foundation.
- **Development of mental models**—continually improving deeply ingrained assumptions, generalizations, or images that influence how we understand the world and how we take action. Mental models must be rigorously scrutinized and periodically amended if appropriate learning (intellectual change) is to take place.
- **Creation of a shared vision**—collectively forming a clear picture of the future to be created, a vision that incorporates all relevant points of view and enables team members to excel in their individual contributions because they do so in their own self-interest.
- **Reliance on systems thinking**—managing activities and interactions within a conceptual framework; that is, a body of knowledge and tools developed to make patterns clearer and to help the team discover how best to change patterns by focusing on outcomes and critical relationships rather than the objects of design.
- **Reliance on team learning**—developing an ability to think collectively based on dialogue and participation in order to surpass the power of any single person or discipline and accelerate the learning process.

Because of the advantages of team learning and synergy, and in spite of very real interpersonal, organizational, and communication problems, the interdisciplinary design approach is becoming an increasingly important organizational structure for addressing complex and difficult-to-resolve planning and design initiatives. For collaboration to be successful, particular attention must be given to the formation and management of interdisciplinary teams.

Because "wicked" design problems tend to be unique as well as complex, the organizations established to address them are typically *ad hoc* and short-term, intended only for the life of the project they are formed to address. This means that these organizations often lack the continuity and the ability for members to continually learn from one another that exists when people work together over an extended period of time. The short-term nature of teams makes leadership one of collaborative design's most urgent problems.

Rather than using sub-consultants to support the elaboration of a lead designer's ideas, interdisciplinary team members collaborate as equals to define and resolve problems holistically. However, participation on teams of equals is not something for which designers (architects, engineers, landscape architects, or planners) are particularly well prepared by their training (or perhaps, their temperament). Most designers tend to trust their own (disciplinary) ideas more than they trust the ideas of others who operate from a different knowledge base or value system.

In the relatively recent past, a team approach was considered unsuitable for the creation of design ideas, particularly in pursuit of the excellence in personal achievement to which all professionals aspire (Caudill 1971). In fact, the term "design by committee" was coined as a pejorative to convey the "inevitable" diluting effect of consensus. But design by *committee* is not the same as design by *team*.

Collaboration with Clients and Users

Clients have the authority to be heard. Although they may not always be able to articulate their design needs, they always have the ability to get the designer's attention. Determining the interests of clients is relatively easy, but this is not so true of the needs of users, who may be unknown at the time a design is being formulated. Nevertheless, without direct contact with the users or representative groups acting as surrogates to approximate the needs of future users, there is serious risk of reaching conclusions based not on the needs of people but only on the opinions of their needs as understood by designers or clients. For example, designers may provide a sitting area intended for elderly park visitors, only to learn after implementation that, due to traffic noise, the elderly shun the setting and, because the park is near a school, it has become a hangout for teenagers.

Because the views of designers and users often conflict (Berger et al. 1985), it is now recognized that the views of users must be consciously included as a central feature of any process for reaching effective design decisions. User values must be clearly understood if designs are to address the way those being designed for actually use the landscape and adapt to it (Abbott 1995; Ndubisi 1997). Although designers and social scientists alike have difficulty in reaching the understanding necessary to ensure that culturally distinct values are incorporated into design decisions, some useful methods have been identified. In addition to research methods such as interviews and questionnaires, there are more-direct methods of gaining information.

To ensure place-based design, consideration should always include participation by the people affected, involving the inhabitants in a meaningful way (Ndubisi 1997). The values of the people from the affected community, rather than those of the design community, should be given preference (Reason 1994). Community participation through workshops or through the inclusion of community spokespersons on teams has become a common way of empowering people to participate directly in shaping their living or working environments (Hester 1984; Kotze et al. 1984; Abbott 1995). One of the most effective ways to ensure that people's needs are correctly understood is to involve them directly in defining the design problem. Landscape architects John Motloch and Thomas Woodfin (1993) have identified a number of tasks they regard as essential if designs are to create settings meaningful to the people who use them. To promote culturally sustainable decisions and address the full range of operative values, they suggest that designers need to:

- Discover the value systems operating at the local level.
- Respond sensitively to the user groups' value systems as well as to their perceptions of problems, coping strategies, and organizational structures.
- Identify the needs and perceptions of the full range of users, many of whom may approach the world from different value systems.
- Provide designs that address the needs and perceptions of the users in order to build consensus, minimize stress, and avoid conflict.

These measures will support the creation of places that promote self-esteem, local involvement, and a strong place-specific sense of community for users with diverse value systems. When these conditions exist, the places designed become not only settings for behavioral interactions, but territories to which individuals and groups belong, and to which they have responsibilities for defense and maintenance over time—that is, the place becomes a culturally sustainable space (Newman 1973).

"Participatory design fosters a better understanding of 'community' and is in itself a reflection of (socially) ecological processes evolving towards higher forms" (Kaplan 1983, 311). Participatory decision making, however, has inherent organizational and social interaction challenges. The type of organizational structure being employed influences the outcome of the decisions reached. Different types of organizational structures have been identified with respect to group decision making. These include *pyramidal structures*, *factional structures*, and *coalitions of power* (Ahmed et al. 1990).

- **Pyramidal power**—structures resulting from elitist models that place the greatest power in the hands of a few at the top—a traditional design paradigm in which the designer or client is presumed to know best and, therefore, should be responsible for making final decisions.
- **Factional power**—structures that occur when groups with diverse interests compete for influence in order to address their different, often conflicting, concerns—a common scenario when resources are limited or the values of designers and users or clients conflict.
- **Coalition power**—structures created when individuals or groups form alliances to address issues in which they share a common interest. Community participation is most likely to succeed when there is both a strong community structure to promote the formation of coalitions and when the issues to be addressed are understood to be common to all participants in the decision-making process.

Community participation, sometimes called *design facilitation*, is a process that focuses on coalition building and, as a consequence, provides one of the most effective forms of collaboration between designers and users. The building of coalitions requires a significant amount of mutual interaction and learning for participants to determine where their common ground lies. Unfortunately, most traditional design training has not included preparation in coalition building or in mutual education. Traditional design training is based largely on an elitist model with the designer at the top of the pyramid. Most community-based or environmentally sensitive projects require grass-roots participation in decision making, with input coming from many sources in order to produce broadly acceptable design results.

The future practice of landscape architecture, particularly on projects with complex environmental or social conditions, is likely to require considerably greater use of coalition power than decision making by authority. One effective way that this can be achieved is through the use of interdisciplinary teams. Deviation from a conventional mind-set is much more likely to come from outsiders than insiders, since they are the ones who see things from a different point of view (Barker 1992). Team coalitions that unite diverse disciplines or stakeholders are made up mostly of outsiders, improving the chance of innovation. Divergent sources of information from coalitions representing different values and perspectives are critical to the formulation of new insights.

Collaboration with Design Teams

Effective participation on collaborative teams requires sensitivity to many issues not traditionally taught in design schools. First of all, teams are the antithesis of individual action. **Teams** are groups of people (usually small groups) who hold themselves mutually responsible for achieving common goals through the integrated application of complementary skills (Katzenbach et al. 1993). By definition, design teams are collaborative in nature and structure.

The performance of design teams is difficult to evaluate directly, since the results of their one-of-a-kind output may only become known after their work is completed. A number of factors contribute to the success or failure of team design initiatives. Some of the factors thought to determine team success include the effectiveness of the team's organizational culture, the nature of the work task, mission clarity, team autonomy, and performance feedback (Sundstrom et al. 1990). The extent to which team members share a common vision of project success, the nature of the team's leadership, team size, and how team members define their responsibilities regarding their participation all have an influence on the outcomes of team collaboration (Murphy 1997).

Shared Vision

The greatest likelihood that a design team will realize its full potential is when all the members share a strong personal commitment to their common enterprise (Katzenbach et al. 1993). For team members to be committed to interactive collaboration, they must share some common core values. Without a shared sense of purpose, it is almost impossible for people with the breadth of expertise and disciplinary differences needed for addressing issues holistically to cohere into an effective learning team.

One of the first priorities in establishing a team is to engage the members in the development of a set of project values to guide the work of the group. Through these, a sense of common purpose can be created to govern their collective behavior (Senge 1990; Parker 1994). This is established by the collaborative formulation of a set of inclusive project goals. In addition to providing the team members with an opportunity to learn how to interact with one another, it enables them to share in setting the direction for the project through their individual contributions.

Teamwork is most creative when it operates with a few clear principles and a great deal of individual freedom (Wheatley 1992). Teams working as learning organizations, with a capacity for self-development and periodic renewal, naturally tend to develop their own unique vision as members share knowledge and increase one another's overall understanding of their common purpose. Central to the process is a capacity for good listening. Unfortunately, since most people seem to trust the things they best understand, individual designers may trust their own vision of the future more than that of someone else whose vision they may neither understand nor appreciate very well. Team interaction that promotes good communication, and in particular, good listening (which is not a universal trait), is one of the most important factors to the creation and maintenance of a sense of common purpose.

Good communication, based on the personal commitment of all participants, is essential for the development of a shared vision of what the altered landscape is to become and what it is to achieve.

Team Leadership

Effective team leadership is rare and, usually, subtle. On interdisciplinary teams, the leader's primary function is to provide focus and direction for the group by constantly reminding members—sometimes forcefully—of the project vision they themselves have created. Since the best teams are self-defined, self-managed, self-taught, and self-regenerating, it is not the function of the team leader to establish the project vision. Successful leaders are those who can bring out the best contributions of the members individually and, as a consequence, the team collectively (Mulder 2010). A prerequisite for successful leadership is mutual respect between team members and leaders.

Effective leaders facilitate team interaction by protecting members from embarrassment and power struggles. The team cannot be dominated by a few who may be highly verbal or have dominant personalities. Domination by a few diminishes the contributions of less assertive members, thereby diminishing the quality of team learning and, as a consequence, the quality of the team's shared understanding.

The team leader's most important and most difficult role is to transform what is often a collection of assertive, goal-oriented, and accomplished individuals into an integrated working group. To do so, the leader has to acculturate the team members into a common project culture (Mulder 2010). Since most participants will be present because of their prior success in doing things in their individual ways, it may be difficult for them to abandon proven working methods and accept the team process. This can be particularly true of designers who have been trained from their earliest years to think as individuals (Caudill 1971).

The team leader needs strategies for reducing team members' reluctance to forego their proven working practices and accept the innovative approach required for collaboration on teams whose main "product" is not a building or a landscape, but innovation. There are a series of tactics for reducing resistance to innovation that are useful to team leadership (Bright 1988). These include focusing attention on:

- **Perceived advantage**—Collaboration should provide benefits that an individual approach cannot.

- **Compatibility**—Team collaboration should fit with and build on existing disciplinary methods or models.
- **Simplicity**—Team collaboration must be easy to comprehend as a concept and to employ as a procedure, extending and expanding rather than substituting prevailing conventions.
- **Divisibility**—The team collaboration process can be applied one step at a time, building on itself in phases.
- **Communicability**—To make it easier to understand and accept, the process should be describable using conventional vocabulary rather than a new disciplinary jargon.
- **Relative Cost**—The process should cost less (or at least not significantly more) to employ than conventional methods. Failure to accept the process should be seen as a higher cost than acceptance.
- **Consequence of failure**—The consequence of failure in applying the team process should not present a serious risk of loss or humiliation to participants.
- **Familiarity**—The way the process is presented should not "feel" strange or unfamiliar. It should be conducted in a form that the team can accept out of habitual familiarity (Duhigg 2014).

The essential requirement for leadership is credibility in the eyes of the team members. Past experience is an important source of credibility, but respect must be maintained on a continuing basis. This is best achieved by leaders who show respect for the individual team members and their particular areas of expertise through the nature of their routine interactions.

Team Size

A team should be as small as possible while maintaining its capacity to perform the required mission (Parker 1994; Bertcher et al. 1996). As team size increases arithmetically, each member has more people to interact with and the relationships among the members increase geometrically, demanding significantly increased time and energy for communication and interaction. This, in turn, requires greater management oversight in order to prevent the loss of the team's intellectual agility and effectiveness.

Team size also is a significant factor in communication. The larger the team, the more rules members must accept to maintain effectiveness. Larger team size reduces the team's flexibility and freedom to act, and results in a loss of spontaneity and creativity. Larger teams provide fewer opportunities for each person to participate actively, and some members may participate very little. One result of limited participation is that some individuals will undergo little personal change from the process, and, as a consequence, the group's ability to function as a learning organization will be diminished. The increased complexity of communication is illustrated by the examples shown in figures 9-1 and 9-2, where the team is shown seated at a conference table.

Assessment of architectural teams reveals that many designers prefer their teams to be small enough to build the close, productive relationships that lend themselves to ease of communication—usually about five members—but large enough to achieve critical mass and assure the development and exploration of a variety of ideas (Lawson 1994). Team size, however, depends more on the knowledge requirements of the project than the preference of the participants.

Team Member Responsibilities

The most important decision in forming a team is the selection of its members. Successful team participation requires members who understand and accept two general responsibilities throughout the life of the project: to help define and achieve the group's common purpose and to maintain an atmosphere of collegiality and creative collaboration within the team environment (Adair 1986; Forsyth 1990). Neither of these responsibilities can be satisfied in the absence of the other.

Design team members assume a number of specific responsibilities: to uphold the standards of performance in their respective professional disciplines, to support other team members in meeting their standards, and to creatively integrate the team's multiple talents to produce an overall understanding and design result of exceptional quality. Meeting all these responsibilities requires attitudes and working habits to which team members may be unaccustomed and for which they may be ill prepared by past experiences.

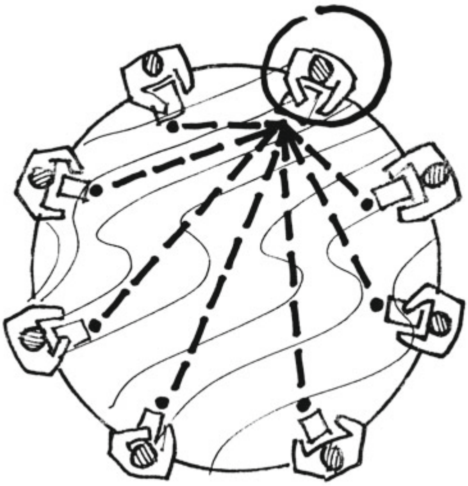

Figure 9-1. *Simple communication pattern among team members seated at the table for a single- or multi-discipline team with direction from a single leader.*

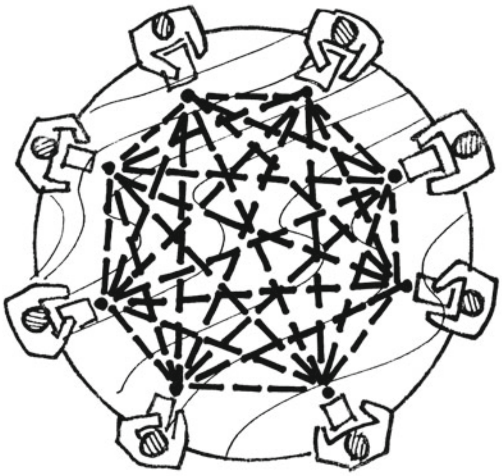

Figure 9-2. *Complex communication pattern among team members for an interdisciplinary team.*

To be genuinely creative, participants on an interdisciplinary team must be willing to relinquish personal control of the design process and of the design concept, to trust the collective vision of their fellow collaborators, and to see the problem from a broader perspective than their previous experience may provide.

To achieve the understanding required for excellence in design performance, team members must act in ways that bring out the best contributions of one another as well as themselves. Unfortunately, we do not traditionally see the work of our collaborators as our personal or professional responsibility. This is because, between professions, we are not traditionally team players. The different disciplines have developed around real differences.

The most important contribution of designers is their skill in composing the elements of the environment into a satisfying and effective form. Many designers tend to be more synthetic than analytic in thinking style, and it takes the integration of both styles to realize the greatest understanding and resolution of the issues (Peña et al. 1977). Designers also are particularly well prepared to formulate and predict the possibilities inherent in conceptual ideas. This includes the ability to pull the ideas of others together and express them in a way that ensures everyone's understanding of the implications of an idea under discussion—particularly in their contextual relationships. The designer's fluency in the universal language of graphic communication facilitates the understanding and discussion of concepts—including the concepts of others as well as their own—in order to advance the investigative process. It is particularly important that ideas under discussion are made concrete and visible through graphic display to ensure shared understanding and reduce reliance on memory or interpretation, which may vary widely among the different team members (Warfield 1990).

Interdisciplinary Process

People don't participate in interdisciplinary collaboration because it is an easy way to reach decisions, but because the decisions they reach are more effective. Cooperation with others may be the most demanding way to design, since there is so much to be learned, and each time something new is learned the bar is raised, making resolution more difficult and, often, throwing the team back to square one to begin again with a new insight or concept. The intensity of interaction among people with different values and knowledge makes the process, as well as the design result, highly unpredictable. Also, what will be learned from participating in the process is unpredictable. Design teams can never know what they are going to learn next or how they may be required to respond as they learn their way into the problematic situation. But the learning process itself can be enormously satisfying.

Curious, intellectually active people take satisfaction from the challenge of continual learning, particularly when the penalty for failure is high and success depends on their ability to learn quickly and apply knowledge effectively. When the process works at its best, the full spectrum of the problem areas is both understood and resolved with a level of performance that cannot be matched by a single-discipline approach. Even the strongest individuals cannot compete effectively with strong teams in holistically resolving the complex problems of the environment. Within groups, it is usually the competitive personalities who are most successful; between groups, it is the cooperators (Wilson 2012). As industrial designer Tim Brown says, "All of us is smarter than any of us" (Brown 2009, 26).

To facilitate collaborative interaction, an outline of some common Rules of Engagement for collaborative teams may be found in the online Appendix H at: http://islandpress.org.

CHAPTER TEN

Design Thinking

The real voyage of discovery consists not in seeking new lands but in seeing with new eyes.

—*Marcel Proust*

Good design thinkers observe. Great design thinkers observe the ordinary.

—*Tim Brown*

There is a difference between *being* a designer and *thinking* as a designer. The fact that someone designs things does not mean that they are doing it well, and simply recognizing a design need does not mean that it will be satisfied by the changed conditions they propose. Design thinking requires bridging the "knowing-doing gap" to turn insight into innovation (Pfeffer et al. 2000). To the design thinker, the world is continually open to reinterpretation, innovation, and improvement. Design thinking is a way of reconceptualizing reality that can be applied to any kind of problem (Brown 2009). Successful design thinkers are capable of fresh insights into problems as well as a capacity to conceive novel ways of responding with new ideas. Regardless of how much a designer may know, it is through creative insight and innovative knowledge application that success is realized.

Thinking is the designer's principal tool. Design thinking consists principally of two activities: "constructing mental models and [then] simulating them in order to draw conclusions and make decisions" (Richmond

Michael D. Murphy, *Landscape Architecture Theory: An Ecological Approach*, DOI 10.5822/ 978-1-61091-751-3_10, © 2016 Michael D. Murphy.

2001, 117). This also is a definition of design. What designers create are new ideas; typically, these are ideas tailored to the circumstances of their client's situation. The first requirement of design is to understand the situation to be changed. Because each person perceives a different reality, each one, to some extent, lives within a different environment. To design for the commonly shared environment, rather than one that is socially or individually conceived, the designer needs to objectively determine what that is. And, since people are a part of the environment to be designed, the difficulty of seeing themselves further complicates objective observation and assessment. To better understand reality, designers need to impose rigorous controls on their thinking processes.

To think about *how* we think, it is helpful to consider some basic concepts of brain function. The left and right hemispheres of the brain are thought to have distinct functions, with different types of mental activity centered primarily in one hemisphere or the other. In highly simplified terms, the left hemisphere of the brain is said to have a greater role in processes related to critical thinking, such as language, logic, analysis, and reasoning. The right hemisphere, thought to be more influential in creative and emotional thinking, processes colors, images, feelings, intuition, and creativity. The influence of the two brain hemispheres on thinking is, in fact, a matter of controversy, but whether or not the left-brain/right-brain dichotomy ultimately proves to be valid, it provides a convenient way of examining different kinds of thinking processes. Comparisons of some of the relevant characteristics of left-brain/right-brain (critical/creative) thinking are illustrated in table 10-1.

Although both critical and creative thought processes are engaged in any thinking task, many designers favor their creative thinking, and they are encouraged in this—just as engineers, on the other hand, might be encouraged to favor critical thinking.

Although people may favor one type of thinking or another, the two types must interact in order to build a complete picture of information being processed. Some people may start from a creative leap to reach a conclusion, while others proceed from established facts to construct an understanding based on evidence. Regardless of how one proceeds, the more balanced the contributions of creative and critical thinking

Table 10-1
Comparison of Critical and Creative Thinking

Critical Thinking	Creative Thinking
Analytical	Generative
Convergent	Divergent
Vertical	Lateral
Probability	Possibilities
Judgment	Suspended judgment
Objective	Subjective
Segmented	Contextual
The answer	An answer

functions, the more effective the thought process is likely to be. Overreliance on either logic or creativity can leave the designer with a deficiency in their overall mental-processing capacity. Developing strength in both is necessary for the most-effective design results, as we see with design teams comprising creative and critical thinkers (DeBono 1971).

It is also helpful to recognize that people who favor critical thinking think differently than creative thinkers. For example, a physicist may think things through in a linear manner, putting information together in a logical pattern in order to see the details before reaching an understanding of the whole. An artist may put information together more randomly in order to quickly visualize a whole from which the details later emerge. When people with different analytical strengths and thinking strategies collaborate, they should not expect others, employing a different strategy, to follow the same path to a conclusion. Recognizing that these differences exist helps designers to work more effectively with people favoring different thinking processes, whose thinking strengths are required if problems are to be defined and solved holistically.

Critical Thinking

While most design attention is focused on creative thinking, it may be critical thinking that has priority in the sequence of design thought. This is not because creativity is less important but because designers need to be certain that they are creatively applying themselves to the right, or at least the most salient, problems. Creatively addressing trivial problems, or problems defined in isolation from their context, is unlikely to lead to useful change in the landscape. And, unless they deal with problems that clients or users consider relevant, designers cannot expect their clients to pursue the ideas they develop about how to resolve them.

Designers, just as those in any other field, tend to trust that increasing skill and knowledge will lead to design progress—the greater their knowledge and experience, the greater their ability to design successfully. But the history of our human past tells us that there is nothing inevitable about progress in design, or in anything else (Regal 1990). Progress in design, as in all human endeavors, depends on our ability to continuously learn, to think clearly about what is being discovered, and to apply knowledge creatively in order to engage the future in new and more-effective ways. Increased skill alone may only lead to doing the same old things more efficiently. The quality of the designers' thinking will have to improve before they can improve the quality of their ideas. Critical thinking is a prerequisite to changing the way people think, which, in turn, is necessary to improving the way problems are understood—and on the basis of that improved understanding, to improving design ideas about how to solve them.

Characteristics of Critical Thinking

Critical thinking involves more than the skill of logical analysis. It involves questioning the assumptions that underlie customary, habitual ways of thinking; that is, it questions not only the information under consideration but also the thinking process by which it is being chosen and evaluated. It also requires the ability to think and act differently on the basis of this critical questioning. Some of the characteristics of critical thinking include (Brookfield 1987):

- **Process-oriented, not outcome-oriented**—Critical thinking requires an ongoing process of learning and questioning of assumptions. Those who engage in critical thinking find it difficult to arrive at a final conclusion. Reaching a final state that describes a singular truth or desired result is contradictory to the skeptical nature of the critical thinker. The environment and the ideas to describe it are thought to be dynamic and evolving rather than fixed. As a consequence, ideas and the processes to create them are open to continuing evaluation and interpretation.

- **Driven by context**—Manifestations of critical thinking are dependent on the context in which they occur. To the critical thinker, there is no conclusive way of describing reality through the development of universal truths. Ideas are contextual and thus vary according to timing or circumstance. Critical thinkers see the world as dynamic and open to reinterpretation rather than static, and they are confident about the possibilities for understanding and improvement through reasoned action.
- **Productive and positive activity**—For the designer, negative assessment of existing interpretations or conditions is motivated by a desire for improvement. By thinking critically, these people tend to increase their acceptance of diversity in approach or in reasoning, making them more receptive to differences and respectful of the values or insights of others in their search for improved understanding and positive change.
- **Triggered by positive as well as negative stimulus**—Critical thinking is just as likely to result from a traumatic or unpleasant circumstance as from an exhilarating or joyful one. In either case, critical thinkers tend to reinterpret past events, ideas, or actions in light of current knowledge or experience, and to extrapolate applications in order to create a more satisfying conclusion.
- **Emotional as well as rational**—Emotions are central to the critical-thinking process. The exhilaration of an intellectual breakthrough is just as rewarding and relevant as the rationality of its content. Abandonment of old assumptions can be personally liberating, just as the creation of a new intellectual paradigm is satisfying as a strategy for responding to that abandonment.

Among the benefits of critical thinking, the most important is the change a person's thinking undergoes as a consequence of their improved capacity for understanding. In dealing with "wicked problems," designers need the most powerful thinking they can muster to understand and resolve them. By improving the quality of their critical thinking, designers free themselves from the constraints that tradition and prior models impose on their perceptions. This freedom of thought limits the influence of past experience to cloud the designer's thinking, especially about things as they are becoming. Seeing a situation clearly improves the designer's ability to think creatively about how things might be under altered circumstances (Weston 2007).

Creative Thinking

The future is invented through creative thought. Creative thinking "unlocks the path to new discoveries, whether it is in art or science. The act of creation is the crux of meaningful design, innovation, or invention" (Hill 2006, 326). Designers speak of being creative. But, in fact, designers create nothing new. What designers actually do is to rearrange the form of the existing world into more-meaningful relationships. The concept of a garden is an ancient idea and the components from which a garden is formed are found in nature. It is more accurate to say that designers recompose the landscape: they rearrange the elements of the landscape to improve the human condition. By reforming the setting, designers create new conditions and relationships.

Creative thinking is a process of determining how to alter and reconfigure ideas or things to produce something new and valuable. Creative thinking is also an attitude—an approach based on flexibility and innovation about what is possible, and a conviction that improvement is achievable. Because creative thinking is an inquisitive and open-minded way of thinking, it reveals possibilities that would not otherwise present themselves. Thinking creatively does not mean that the person engaging in it is an artist, such as a musician or a painter, but that they approach any aspect of life with the anticipation of new potentials. Creativity exists in all fields and areas of thought.

Bringing about meaningful change requires an unconventional way of thinking. By definition, conventions come from the past. Designs are for the future. Designers seek creative solutions to problems because no other response will do. Conventional responses do not provide solutions to contemporary problems. Because the world has changed since these conventions were established, so must the design solutions that respond to those changes. Unless designers part from tradition, their designs will not improve on current conditions or address the changing conditions of the future. But that does not mean that any departure from the past will lead to a better-informed solution to the problems confronting society. Innovative departure is useful only when it is successful relative to intent and context. Innovation requires experimentation, since the best path to the future can never be certain. Analysis—design testing—is necessary in order to determine if an innovation is as successful as intended.

Characteristics of Creative Thinking

Creative thinking is defined as a capacity to imagine new possibilities or associations that are both *original* and *useful*. Innovations must be effective as well as novel. Creative thinking is complex, multidimensional, and only partially understood. It has been characterized by five attributes (Torrance 1970):

- **Fluency**—the ability to produce and express a number of different ideas to meet specified requirements within a limited period of time.
- **Flexibility**—the ability to produce ideas in a variety of categories, shifting easily from one mind-set to another, and to use knowledge or materials in different ways.
- **Originality**—the ability to produce unusual, unique ideas—ideas that are novel or unconventional, unanticipated ideas that "no one else would think of."
- **Elaboration**—the ability to develop and expand an idea in the detail necessary to fully establish its usefulness or appropriateness to application.
- **Resistance to closure**—the ability to keep an open mind and get past the first idea that comes to mind and extend the search for even greater possibilities.

Successful designers with the capacity for creating original, useful ideas tend to exhibit these thinking traits. Cognitive studies suggest that creative thinking is a skill that can be learned. All people may have been creative before they became acculturated into a particular way of thinking by their society, education, or life experiences (Capra 1982; Regal 1990). Pablo Picasso once said, "Every child is an artist. The problem is how to remain an artist after we grow up." Because these creative-thinking characteristics can be learned or, perhaps more accurately, relearned, they are an explicit—rather than implicit—component of design education. Learning to think more flexibly and fluently is not just helpful but necessary to the creation of innovative and useful ideas (Kvashny 1982; Kavenski 1991). Improving creative-thinking skills is the most productive way of improving one's ability to apply knowledge and enhance innovation in design ideas.

Discovering new associations and relationships is facilitated by an awareness of the sources of ideas. In landscape architecture, there are many sources of ideas to be revealed by new juxtapositions: social interaction, human experience, ecological dynamics, functional relationships, aesthetic satisfaction, materials choices, and many more. Improving the ability to address these issues requires that designers constantly increase their understanding of them and the relationships they bear with one another as they interact to shape the landscape.

Although effective design conceptualization requires both creative and critical thinking, it should be organized to assure that these different ways of thinking complement rather than conflict. A common way for designers to improve understanding is to pose a series of "what if?" questions and move from program to design response in an alternating pattern of design investigation (Lyle 1985). The sequence enables designers to formulate a series of conceptual design scenarios—"what if we did this?"—and then evaluate these possibilities in order to gain deeper insight into the critical issues. The sequence alternates between creative and critical thinking (De Bono 1994), each one reinforcing the other.

The designer creates a new idea, then critically evaluates it to determine its strengths and weaknesses from various perspectives, and as a result, broadens the basis for improved understanding, opening new possibilities to greater creativity in reinterpretation. Psychologist Edward De Bono (1999) cautions that it is necessary to keep the different thinking types separate. When thinking creatively, avoid becoming concerned with the limitations of practicality; this is restrictive. When thinking critically, avoid the attraction of an idea simply because it is innovative. This reciprocal process creates the expanding insight and knowledge from which to generate and evaluate proposals and gain increasingly useful feedback on which to base even better—more creative—design ideas (Csikszentmihalyi 1990).

Thinking differently—innovatively—is not an easy proposition; often it is resisted and always difficult to achieve. But genuine understanding is achieved only through disciplined effort to observe the world from many points of view, discover new relationships, elaborate ideas in detail, and, in particular, withhold judgment until a number of possibilities have been examined. The tools for creating a new way of thinking are available but our habits to the contrary are deeply entrenched. "The most stubborn habits, which resist change with the greatest tenacity, are those which worked well for a space of time and led to the practitioner being rewarded for those behaviors. If you suddenly tell such persons that their recipe for success is no longer viable, their personal experience belies your diagnosis. The road to convincing them is hard. It is the stuff of classic tragedy" (Hampden-Turner and Arc in Gharajedaghi 2005).

Ultimately, design ideas must be realized as new conditions in the landscape if they are to become useful. Attention must eventually be shifted from the creation of ideas to their implementation. The execution of ideas reveals most clearly the need for perseverance in bringing a design to fruition. In order to help bring ideas to realization, graphic artist Michael Bierut offers suggestions that helped him to produce many highly regarded designs. To demystify the creative process, he outlines some useful guidelines. Above all, he cautions, "Remember who you are doing it for, remember why you are doing it. . . ." He summarizes some of the important lessons he has learned about the hard work of bringing ideas to a successful conclusion (Bierut 2009):

- **Listen first, then design**—Let the client supply ideas.
- **Don't avoid the obvious**—Embrace the obvious, at least for examination.
- **The problem contains the solution**—Let the problem inform the solution.

These simple suggestions provide some deceptively useful advice about the creative process, as Bierut has documented in over eighty-five notebooks of his work he has kept over the years. The least obvious tip he shares, but perhaps one of the most useful, is the benefit of keeping well-documented notes of the creative process, as he has done since beginning his design practice in 1982. Design as a reflective process is improved by having something to reflect upon. This brings us to a final consideration in design theory: how design ideas are conceived and communicated.

Visual Thinking

Although we are able to feel and hear and smell the landscape, it is visual perception that provides a sense of the landscape as a totality and that most thoroughly integrates into our memory—the image we recall. Although vivid in our experience, the smells of rain or spring flowers, or the sounds of wind through leaves, are difficult to retain and convey to others. The most effective means of recalling or describing a landscape is through visual imagery.

Verbal communication is necessary to provide a detailed description of a design concept in its cultural and ecological contexts, and to describe its rationale as a recommended course of action. Graphic communication is necessary to illustrate locational and perceptual conditions (physical, textural, chromatic, and scale relationships) and to approximate the visual experience. To communicate effectively, the designer must be fluent in both verbal and graphic language, but the unique skill of the designer lies in visual and spatial thinking and expression (Posner et al. 1976; Ware 2008).

Graphic Communication

Information about design form needs to be conveyed in a way that provides a sense of the experience of a concept as if it were a physical reality, in addition to showing locational or spatial relationships. Just as music must be heard and paintings must be seen to be appreciated, designs are best understood as a sensory experience, or in the case of design proposals, as a virtual experience. Because verbal descriptions are inadequate to convey the richness of a design form idea, designers rely on graphic imagery to describe physical form. As Leonardo da Vinci advised: "And you who think to reveal the figure of man in words, with limbs arranged in all their different attitudes, banish the idea from you, for the more minute your description the more you will confuse the mind of the reader and the more you will lead him away from the knowledge of the things described. It is necessary for you to represent and describe" (Boorstin 1983).

In addition to the form of a composition, there are other, more subtle dimensions to be communicated, such as the richness of detail expressed through shadows, colors, and textures that affect how a setting is perceived. The color palette of the landscape is established by its ecological context. Hot arid landscapes, for example, tend to be dominated by the tan and brown hues of the earth, with high intensity sunlight washing out the saturation of colors. Tropical or humid settings are typically dominated by the deep green hues of the vegetation that mantles the soil, and with more-intense color saturation under the diminished light intensity under a forest canopy. Whether it is the designer's intention to conform or contrast with existing cultural or ecological contexts, their concepts are most explicitly described with chromatically sophisticated visualizations.

One of the difficulties presented by the requirement for graphic communication is our general lack of detailed knowledge of the features of the visual field to be described. For the most part, we view the environment only selectively in order to locate specifically target information, such as a person or a street sign. The visual background of these target images, although ubiquitous in our experience, makes little lasting impression on our memory. Then there is the issue of using graphic communication. Even though most people are thought to engage in some form of visual thinking (Deza 2009), graphic communication is a form of expression that is often marginalized by formal education. Consequently, graphic skills tend to be developed late in the educational preparation of many designers, often as a second language, with the same problems of fluency and awkwardness that many people experience when communicating in a second language. This is problematic, because learning a language is easiest when undertaken early in life. But for anyone intending to master demanding design situations, fluency in the language of spatial and visual expression—whether through drawing with pen or pencil on paper, creating digital images, or fabricating models—is indispensable to effectively investigating form ideas, conceiving design arrangements, and expressing them in a comprehensible and persuasive way.

Visual Language

By using recalled images of the landscape as a form of vocabulary—even though people may be unable to recall or describe the visual context of the physical environment in any detail, they can easily recognize it when it is presented to them—the designer is able to build on the receiver's familiarity with the existing spatial context to engage in a visual dialogue about what might be altered to bring about the improvement intended. But to be effective experientially, the communicated imagery needs to approximate the common understanding, or visual perspective, of the receiver. By employing normal—three-dimensional, eye-level—imagery of a proposed condition, the designer can overcome the near impossibility for a client or user to estimate the visual experience of a condition based on a plan view of the landscape, which is the conventional method of displaying spatial relationships.

Although a plan view may be the most effective way to show accurate, two-dimensional spatial relationships, it is inadequate to describe the complexity of a three-dimensional visual field. And, in design, the three-dimensional visual effect is one of the most important aspects of a successful composition. It is not possible, for example, to convey what a person or an automobile might look like when observed from plan view, and it is well understood that people have preferences and make decisions about one another and automobiles based on their physical appearance—as seen from the normal, eye-level perspective. The same is true for landscapes. Unless clients have a credible indication of a future condition's appearance, it is difficult for them to make informed choices about what should be excluded or changed and what should be retained in a redesigned landscape. But, before a design concept can be shared with others, it must be resolved in the mind of the designer.

Visualization as a Design Tool

In addition to communicating, one of the most beneficial aspects of visual thinking and expression is the constant learning associated with it. The more designers engage in drawing, and particularly in representing known objects, the more they become aware of the detailed features and relationships to be represented. Representational images are especially useful in revealing how a changed relationship in one place can also alter adjacent relationships. Drawing is an activity that improves our ability to see (Hill 1966). It "cannot be detached from seeing and thinking about the fundamental nature of the subject matter being represented" (Ching 1990, 5).

In the creation and communication of convincing visual imagery, every detail and its relationship with context must be clearly understood and positioned in a spatial setting. This also is a requirement for designing. The act of creating images enables the designer to focus attention on all the details of the environment being investigated as a set of interrelated forms, space, colors, and textures. Drawing requires focused attention on the specific condition being examined *in its context*, and it is this concentrated attention that leads to spatial understanding. And there is another consideration. Although visual imagery facilitates the designer's examination of a number of elements in their spatial context, it also enables them to remove features or background information when they confuse or overly complicate the focus of design attention or communication. Through fluency in the creation and manipulation of visual imagery, the designer is able to examine the spatial environment comprehensively and to focus sufficient attention for effective understanding, design investigation, and communication.

One of the main benefits of visual thinking is that it permits the designer to analyze an image as if it were a physical reality—in both two-dimensional and three-dimensional modes. The graphic portrayal of a possible future condition provides more than a representation of a potential design arrangement; it also describes a virtual setting that the designer can respond to. Each image of a proposed situation provides the designer with an approximation of the conditions to be examined in order to determine whether a concept resolves the design problem from an experiential perspective and creates the desired organizational or perceptual attributes. The design image reveals functional conditions, such as visual access to amenities, the effectiveness of screening, design legibility, wayfinding clues, and many other conditions to be resolved. It also provides the designer with a means of evaluating aesthetic considerations: how an arrangement might be perceived as a satisfying visual experience that is appropriate to the intended activities or character of their setting.

Graphic representation is also a powerful tool for comparing situations between two points in time or among multiple options for a setting (Faruque 1984). Designers routinely use graphic images to illustrate a comparison between existing and proposed conditions or between alternative design options. Such images enable the receiver of the visual information—typically a client or user—to virtually experience and compare what they have with some possible future condition before deciding on a course of action.

Spatial-visual imagery provides designers with the evidence needed for examining the alternative possibilities as designers must do as they think their way into the design situation, just as they rely on pictures to describe a possible solution. Landscape architect Omar Faruque explains: "The act of drawing forces us to think. It is a corrective process. It prompts decision making. As designers, we like and conceive new ideas. But it is the process of drawing that pressures us to examine and decide on them, evaluate, develop, and use them" (Faruque 1984, 169).

Drawing not only confirms what is understood, it also reveals what is not. A convincing visual image cannot be produced without a thorough understanding of the features and the precise relationships that are required to compose it. It is the designer's primary investigative tool. The process of forming a design may be thought of as a dialogue between the designer and the problematic situation. The designer produces sketches of alternative possibilities that speak about potential situations, and on the basis of their examination new possibilities are revealed, extending the conversation. It is through this dialogue that the spatial setting is understood and, eventually, resolved (Faruque 1984).

The designer "shapes the situation in accordance with his initial appreciation of it, the situation 'talks back' and she responds to the situation's back-talk" (Schön 1983, 79). Emergent interpretations are continually discovered and then tested for their utility in intervention. Each slight change in the visual question restructures the problem, leading to greater clarity regarding the problem and the possibilities for design change that lie within it. The design process is a visual dialogue to apprehend both unanticipated problems and potentials of the situation to undergo transformation.

CHAPTER ELEVEN

Conclusion

Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did. So throw off the bowlines. Sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream. Discover.

—Mark Twain

Spartans did not ask "how many are the enemy," but "where are they?"

—Agis, King of Sparta, 427–401 BC

Ultimately, the role (perhaps the goal, and certainly the hope) for the profession of landscape architecture is to make meaningful and lasting contributions to the quality of the shared landscape. If designers can do this with each project they undertake, no matter how small or how large, and these contributions accumulate over time, the beneficial influences of landscape design will be expressed in the nature and quality of human life.

The most pressing need for good design lies in the quality of the local landscape: the streets, parks, neighborhoods, schools, shops, offices, and factories where people live and work and play each day of their lives—and, significantly, the extent to which these places integrate seamlessly with one another and with the broader urban and regional landscapes in which they are situated in order to create fitting relationships between people and place. What has been aptly described as the "Great Work" of our age (Berry 1999) "must begin where we are, in the small acts of everyday life,

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stitching together a pattern of loyalty and faithfulness to a higher order of being" (Orr 2002, 4). If there were to be a single agreed-upon purpose in landscape architecture, it might be to change, with each new design, our concepts about how to learn from and reform the ordinary landscapes that shape and inspire our daily lives. As Garrett Eckbo wrote in 1950:

> A good theory of landscape design, then, must be a theory of form as well as function. It must be artistic as well as practical, in order to produce the maximum for those who will experience work influenced by it. Every work of landscape design, conscious or unconscious, whether it be the utility garden of the southern sharecropper or the Central Composition of Washington, D.C., produces an arrangement of forms, colors, and textures in space which results in some sort of cumulative effect, good or bad, on those who pass through it. . . . This we can work toward every day on every job and every project, no matter how small or inconsequential it may seem. (Eckbo 1950, 58)

The quality of the urban landscape depends not on whether it has been formed by the marble palaces of Venice or the mud buildings of Timbuktu. What matters most is how well the shared landscape has been shaped to accommodate vibrant human interaction and to fit comfortably into—and to celebrate—its unique ecological setting.

As growing populations and rising standards of living in a time of continuing environmental threat exert ever-increasing pressures on the landscape, it is imperative that societies manage their relationship with this irreplaceable resource in increasingly effective and innovative ways. But sound, evidence-based design is not the only thing that is necessary for the effective development of human settlement. The lessons of science over recent decades reveal that the relationships between people and the land are becoming precarious and fragile. Increasingly effective management of the landscape is required if there is to be hope for sustaining the quality of human life on Earth. For this we require expanding our knowledge about how this might be achieved, and relying on that knowledge more than ever before, but design skill—the artful application of knowledge—is of equal importance if management of the landscape is to be undertaken

Figure 11-1. *View of the Doge's Palace and Saint Mark's Campanile on the Piazzetta in Venice, Italy, a city built on 118 small islands in the Venetian Lagoon on the Adriatic Sea. (Source: Valerio Manassero via Wikimedia Commons.)*

Figure 11-2. *View of adobe architecture in Timbuktu, Mali, a city built on the sands of the Sahara Desert. (Source: Wikimedia Commons.)*

successfully. Design skill is the designer's method of thinking as well as acting. Corresponding with improved knowledge and skill is the requirement for an increasingly systematic and reliable model of what the landscape is and how we might relate to it through design.

Acceptance of a new model requires that change be embraced through the continuous examination and development of new ideas. New ideas are the principal contribution of the design community. Any such new idea needs to deal with how to creatively integrate a broad and rapidly expanding knowledge base as the underpinning of design performance. In this regard, it is useful to remember the advice of chemist Linus Pauling, two-time recipient of the Nobel Prize: "If you want to have good ideas you must have many ideas. Most of them will be wrong, and what you have to learn is which ones to throw away" (Crick 1995). It is through improved understanding of their potential performance outcomes that we determine which ideas are good enough to keep and act upon. It is through improved design performance rather than changes in design form that real advances are made.

On Creating a Healthy Human Ecosystem

The greatness to which designers aspire will result from more than sound knowledge expertly applied to satisfy the requirements of utility, economy, aesthetic experience, social vitality, or ecological sustainability. It will be more than the form concepts that integrate knowledge to achieve these aims. Excellence in design results when all these considerations are brought together to achieve a synergy of form and process that is greater than the sum of their parts, creating a dynamic and interactive system of vibrant, regenerative, and sustainable human–environment integration. Ultimately, how well we live will be determined by how intelligently we pattern our lives with and within the landscape. For this reason, the challenge of good design, and good design thinking, continues to expand at a pace even greater than the accumulation of knowledge or the demands for action in response to it. Design excellence can never be established as a permanent condition in the landscape. Each significant achievement creates a new plateau of expectation that raises the bar in the continuing quest to improve the conditions of life. The opportunities for designers are limited only by their knowledge and creative insight.

Although challenging to perform well, landscape design can be one of the most beneficial services to society. When reduced to their essence, there are only two basic considerations in life: ourselves and the environment. The manner of our engagement with the environment, which includes other people as well as climate, mountains, forests, and cities, determines everything that is necessary and important in life—sustenance, health, community, experience, knowledge, creativity—and avoids the things we fear—chaos, ignorance, poverty, isolation. To a significant extent, meaning in our lives comes from our experience with one another and the environment. Designing landscapes that create opportunities for productive and joyful engagement between people and the environment is not only among the most noble of services, it is also one the most rewarding to provide. But constant learning and improvement is required if design is to be delivered at the full measure of its potential (Hough 2004).

Of particular importance is the insight to be gained from examining human systems through the prism of ecosystem science. If human settlements were designed and managed according to the principles of ecology—creative community interaction relying on a continuous transfer of energy and the perpetual recycling of a fixed supply of critical materials organized to increase complexity and fitness—we would have a profoundly different conception of the urban environment. Consider some of the most obvious changes that might ensue if urban environments were designed and managed according to the principles of ecosystems.

The landscape would not be thought of as unused, or wasted, until it was compartmentalized and urbanized or mined for resources. The form and function of human settlement would not be designed in confrontation with the processes of nature but arranged to harness these forces in creative and constructive ways. Ecosystemically derived designs would preclude the permanent requirement to maintain the artificially formed settings and systems to which we have become accustomed by employing natural processes as the driving force to sustain and regenerate the conditions on which people rely. Urban systems would be motivated more by renewable than nonrenewable energy. Pedestrian circulation and the density of services required for it would be a central feature of urban life. The concept of waste would not exist, and materials would be employed in a system of perpetual use-recycling-reuse (Calkins 2012).

Equally important to a comprehensive ecological approach is the need to consider the landscape from a humane perspective. If the shared landscape were designed as a sheltering behavioral setting, intended to create opportunities for productive human exchange as well as harmonious and delightful human experience, the ordinary landscape would have a character quite unlike the one that far too many know today. The richness and beauty of the landscape would be understood and appreciated for its value to system resilience as well as to human experiential and economic benefit. Richness of experience would be understood to be as valuable as richness of accumulation. Diversity and complexity would be seen as stabilizing influences rather than a source of conflict or inefficiency. The landscape would be designed and managed for what it is and what it is doing without us, as well as for the benefits people derive directly from it.

On Being a Designer

There is an implicit message in an offer of professional service that the designer is knowledgeable of such a process and expert in its application. Design process is, after all, the only area of knowledge in which designers can claim exclusive expertise. Almost all other knowledge originates from disciplines outside the design domain. When armed with such a design inquiry and change strategy, designers are in an improved position to predict whether their theory and its influence on what they do to shape the landscape—how they design and why—will lead to the satisfaction of the goals they set out to achieve and, not incidentally, the goals that their clients, design users, and members of the general public wish to achieve by the design initiatives they undertake.

In addition to design process, there is the issue of the knowledge required to achieve excellence in design performance. Designers have to be well enough informed by current knowledge and well equipped with contemporary technology to predictably devise and realize the improved conditions being sought through design change. An evidence-based design approach requires the systematic identification and integration of the knowledge required to frame design problems and estimate their likely satisfaction. It is useful to approach design from the view that without a deep understanding of problems, designers would be unable to meet their responsibilities. Without problems—things we do not have, things we do not know, or things we cannot do—design would not be needed (Quinn 1968). Without problems there would be no compelling purpose for innovation. Furthermore, as Alfred North Whitehead once wrote, "Unlimited possibility and abstract creativity can procure nothing. The limitation, and the basis arising from what is already actual, are both . . . necessary and interconnected" (1926). Without a deep understanding of conflicts or limitations, designers cannot create the altered conditions to resolve them. It is through our understanding of problems that possibilities are revealed. To maintain an understanding of them requires constant learning to stay abreast of the dynamic conditions in the environment.

Finally, there is the matter of design skill. Designers must be highly skilled in the integrated processes of acquiring knowledge, translating it into meaning as to design performance, creating insights to shape new form relationships, and communicating these relationships to others so that they may understand and act on the change being recommended. Regarding design skill, Garrett Eckbo once commented, "Of all the arts, design is the slowest to master" (Eckbo 1984)—this from one of the great American masters of design, one to whom the mastery of design came easily. If he was right, and it seems likely that he was, landscape architects must be prepared to invest the time and energy required to achieve that mastery. It is not coincidental that designers refer to their work as "practice."

What designers sell is advice based on the ideas they create for reforming the landscape. When people take the advice, and act on these recommendations, design ideas become manifest as physical and relational realities. For clients and users, the physical reality may be the ultimate objective. But for designers, the quality of design ideas—as ideas—is as important as the quality of the environments they create. Ideas are the raw materials of design. Ideas matter because they inform actions; it is ideas that change the world. And, in the selling of ideas, designers need to remain mindful that advice is most readily taken and acted upon when it is understood and believed to be useful. Design success depends as much on communicating the rationale, utility, and value of ideas as it does on their physical expression.

Toward a Theory of Design

We are still in the early stages of forming a coherent theory of landscape architecture. The attempt here has not been to provide a definitive statement of theory but rather to articulate an ecosystemic position from which to develop a comprehensive theory of landscape architecture. As an interpretation of design theory it examines a few basic questions. What is it that landscape architects do? Why do they do it? How do they do it? How do they do it well? To answer these questions requires a comprehensive body of knowledge. The evidence presented here is a summary of the ideas of some of the most able and articulate thinkers in our field. In addition to the contributions of landscape architectural practitioners, teachers, and researchers, this examination has drawn from a wide range of designers and scientists from other fields—anthropologists, architects, artists, ecologists, engineers, geographers, geologists, graphic designers, industrial designers, planners, psychologists, and sociologists—whose ideas have contributed to design knowledge and theory over the last half-century.

As educated citizens, we need theory not only to satisfy our curiosity about the world and our place in it but, just as importantly, to establish our role in society as architects of the landscape. I encourage you, the reader, as you progress into careers in practice and research, and continue your learning by experience, to continue to observe, to read, and to reflect, and, most importantly, to research and write your own version of landscape architecture theory as the next generation of pioneers to define the role and nature of landscape architecture. Remain an active student of the landscape and commit your thoughts to writing over time, and you will see more clearly what your ideas are and you will better determine where they are leading the profession you are preparing to lead. As an idea, ecologically based design will continue to evolve through your pursuit of the path to its future, which for most designers is a lifetime search.

Regarding that search, I have two hopes for your journey through theory. First, that it provides an intellectual undercurrent of lifelong learning that will carry you along the intellectual and professional path of your choice. And second, that the journey will be as enjoyable as I am certain it will be rewarding. As novelist Ursula K. Le Guin said, "It is good to have an end to journey towards; but it is the journey that matters, in the end."

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Index

Figures/photos/illustrations are indicated by "f" and tables by "t."

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Advance praise for *Landscape Architecture Theory*

"As Kurt Lewin observed, 'There is nothing so practical as a good theory.' Landscape architecture is a discipline that has benefitted greatly from a few good theories, including 'parks are good for people' and 'design with nature.' Even so, theory in the field has not been well organized or systematically understood. With this fine book, Michael D. Murphy wonderfully fills these gaps. *Landscape Architecture Theory* provides a valuable resource for scholars, students, and practitioners to understand how the discipline can help guide change to improve the human condition."

—**FREDERICK STEINER**, Dean, University of Pennsylvania School of Design

"*Landscape Architecture Theory* is indispensable reading for anyone looking for a compelling synthesis of seminal ideas that have shaped theory about how people interact with the landscape—and how the ensuing knowledge can be translated successfully into practice. This book stands apart from other theory texts as a persuasive investigation of the role of design in mediating the dialogue between biophysical and human processes in order to facilitate a mutually sustaining relationship between people and the landscapes they inhabit."

—**FORSTER NDUBISI**, Professor and former Department Head, Landscape Architecture and Urban Planning, Texas A&M University

MICHAEL D. MURPHY is professor emeritus of landscape architecture at Texas A&M University, where he taught for over forty years. His interests and teaching experience focused on ecological design and programming as a means of integrating the talents of multidisciplinary planning and design teams. In recent years, he has been involved in landscape restoration in the central Texas hill country. He lives in Mason, Texas.

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