LESSON 01

INTRODUCTION TO PROJECT MANAGEMENT

Broad Contents

- Management
- Key management concepts
- Functions of management
- Comparison of 20th and 21st century organizations

1.1 What is Management?

Managing is an art of getting things done through and with people in formally organized groups.

Management is the process of designing and maintaining an environment in which individuals, working together in groups, efficiently accomplish selected aims towards any project. It is the art of creating an environment in which people can perform as individuals and yet cooperate towards the attainment of group goals.

1.1.1 Management as a Process:

According to this, management is the process of using organizational resources to achieve the organization's goals through ***planning, organizing, leading,*** and ***controlling***. It is thus, a set of activities directed at an organization's resources with the aim of achieving organizational goals in an ***efficient*** and ***effective*** manner.

1.1.2 Management as People:

This refers to a group of people who engage in "Process of Management".

1.2 Key Management Concepts:

- **Project Organization:** It comprises of people working together and coordinating their actions to achieve specific goals.
- **Goal:** A desired future condition that the organization seeks to achieve.
- **Resource:** An asset, competency, process, skill, or knowledge controlled by organization. Various types of resources that an organization possesses are as follows:
  - People
  - Information
  - Machinery
  - Financial capital
  - Raw Materials

A resource is strength, if it provides an organization with a competitive advantage. On the contrary, a resource is a weakness; if it is something the organization does poorly or does not have capacity to do. Organizational resources include: Human, Physical, Financial, Technological, and Information.

1.3 Evolution of Management Concept in Modern Era:

a) **Frederick Taylor – Father of Scientific Management** was a Mechanical Engineer. He invented high speed steel cutting tools. He got the opportunity to know first hand problems and attitudes of the workers. Based on these he identified that in order to improve the quality of management, the major concern was to *increase efficiency in production, lower cost, raise profits through higher productivity, and also increase the pays/salaries of the workforce.*

His message of management was to give people their best opportunities to be productive, and in turn reward workers for their individual productivity. This increase in labor productivity is not possible without the following:

- Providing ample rewards
- Adequate trainings
- Continuous managerial support

Thus, Fredrick Taylor concluded that ***"low productivity in any project is matter of ignorance on part of labor and management".***

b) Henry L. Gantt stressed the importance of *"developing understanding of systems both for labor as well as management."* He emphasized that in all problems of management, human element is the most important one.
Gantt gave graphic methods of describing project plans in order to have better managerial control. He highlighted the importance of time and cost in planning and controlling projects. He made the famous ***Gantt chart*** *which is the forerunner of PERT.*

1.4 Key Aspects of the Management Process:

The key aspects of the Management Process can be explained with the help of the following diagram:

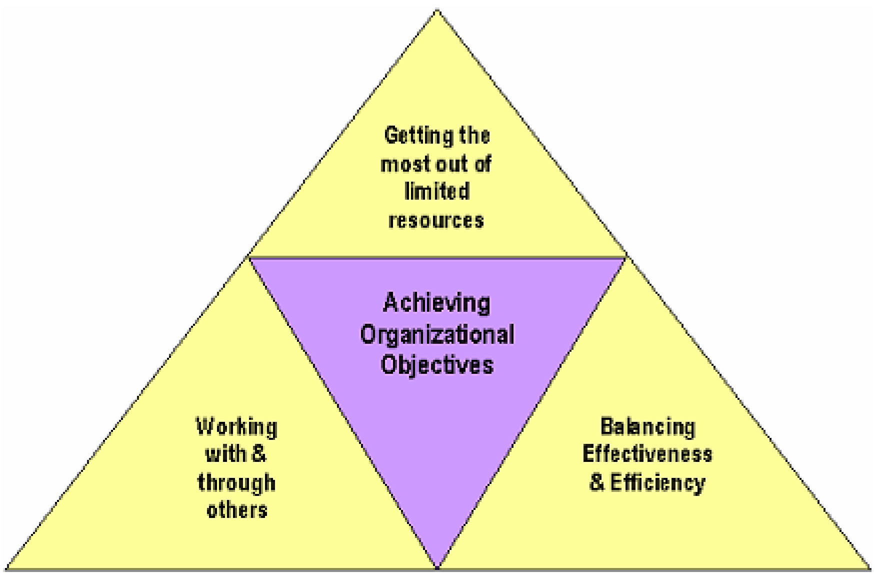


Figure 1.1: Management Process Aspects

1.5 Functions of Management:

The process of management consists of four basic managerial functions. These are:

a) Planning:
Planning is the process of setting objectives in any project and then determining what should be done to accomplish them. It is a capstone activity of management. Managers at every level do planning. Planning activities determine an organization's objective and based on these helps it in establishing appropriate strategies for achieving them. These strategies provide the organization with the direction and serves to obtain a match between the external environment and internal capabilities. The strategies are intended to achieve a sustained competitive advantage over the competitors.

b) Organizing:

Organizing is the process of assigning tasks, allocating resources, and arranging coordinated activities to implement plans. It involves establishing intentional structure of roles for people to fill in organizations.

c) Leading:

Leading is the process of arousing enthusiasm and directing human resource efforts toward project and organizational goals. It involves influencing people so that they contribute towards organizational and group goals. Leadership predominantly is concerned with the interpersonal aspect of managing.

In projects most important problems arise from people in terms of their desires, attitudes, and behavior (as individuals as well as in groups). Thus, effective project managers also need to be effective leaders.

Leadership implies follower-ship and people tend to follow those who offer means of satisfying their own needs, wishes, and desires.

d) Controlling

Controlling is the process of measuring performance and taking actions to ensure desired results in any project. It involves measuring and correcting individual as well as organizational performance to ensure that events conform to plans.

Controlling facilitates accomplishment of plans. There are three basic elements that are involved in controlling. These are:

1. Management should establish standards of performance.
2. Performance should be assessed periodically and information should be updated that indicates deviation between actual versus the established standards.
3. Actions should be taken to correct performance that does not conform to the standards.

1.6 Management Functions: Planning, Organizing, Leading & Controlling:

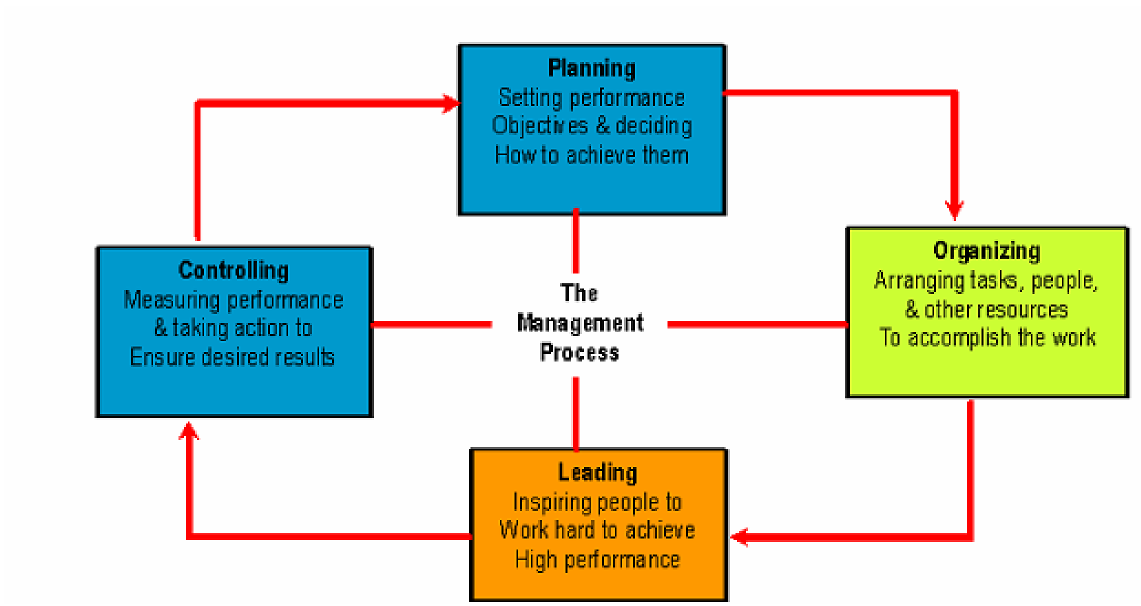


Figure 1.2: Management Functions

1.7 Managerial Functions in Organizations Undertaking Projects:

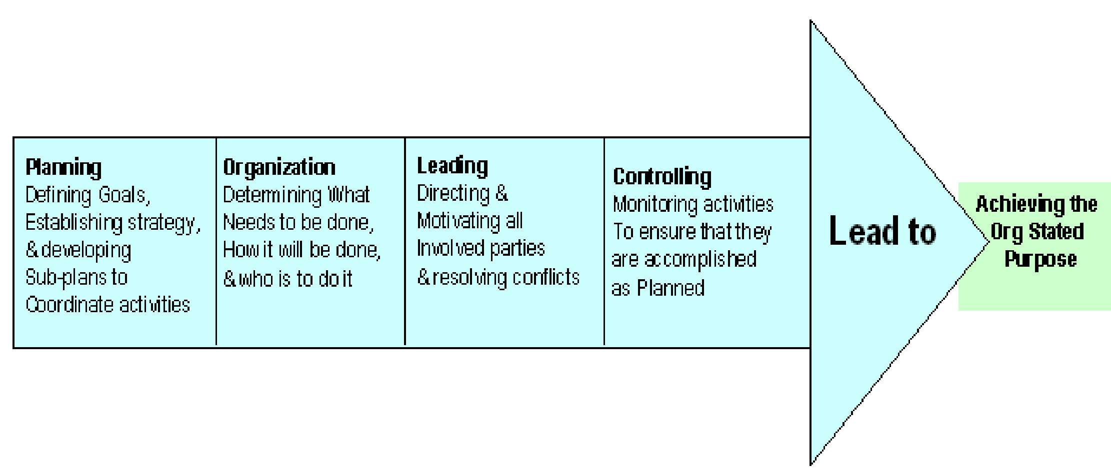


Figure 1.3: Managerial Functions

Organizations are arranged in ways that try to maximize *synergy, i.e. the ability of the whole to equal more than the sum of its parts*. This means that an organization ought to be able to achieve its goals more effectively and efficiently than would be possible if the parts operated separately. Organizations comprise of various levels. These are depicted in the following figure:

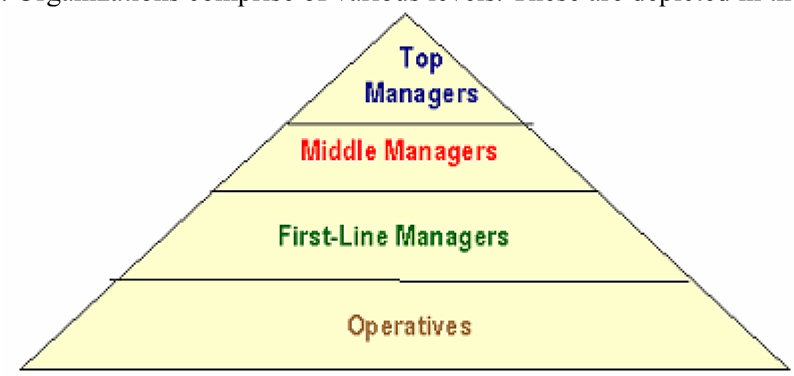


Figure 1.4: Various organizational levels

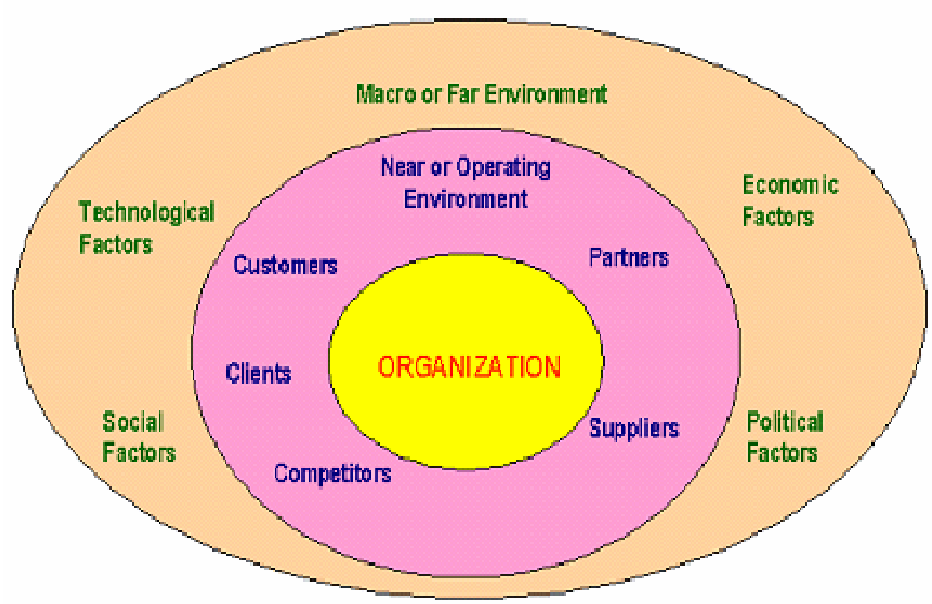


Figure 1.5: A model for organizational environment

1.8 Comparison of 20th And 21st Century Organizations:

20th Century Organizations	21st Century Organizations
Structure • Bureaucratic • Multi-leveled • Organized with the expectation that senior management will manage • Characterized by policies and procedures that create many complicated internal interdependencies	**Structure** • Not bureaucratic, with fewer rules and employees • Limited to fewer levels • Organized with the expectation that management will lead, and lower-level employees will manage. • Characterized by policies and procedures that produce the minimal internal interdependence needed to serve customers.
Systems • Depend on few performance information systems. • Distribute performance data to executives only • Offer management training and support systems to senior people only	**Systems** • Depend on many performance information system, providing data on customers especially • Distribute performance data widely • Offer management training and support systems to many people
Culture • Inwardly focused • Centralized • Slow to make decisions • Political • Risk averse	**Culture** • Externally oriented • Empowering • Quick to make decisions • Open and candid • More risk tolerant

1.9 Economic And Social Forces Driving Need For Major Changes in Organizations:

This is illustrated in the following figure:

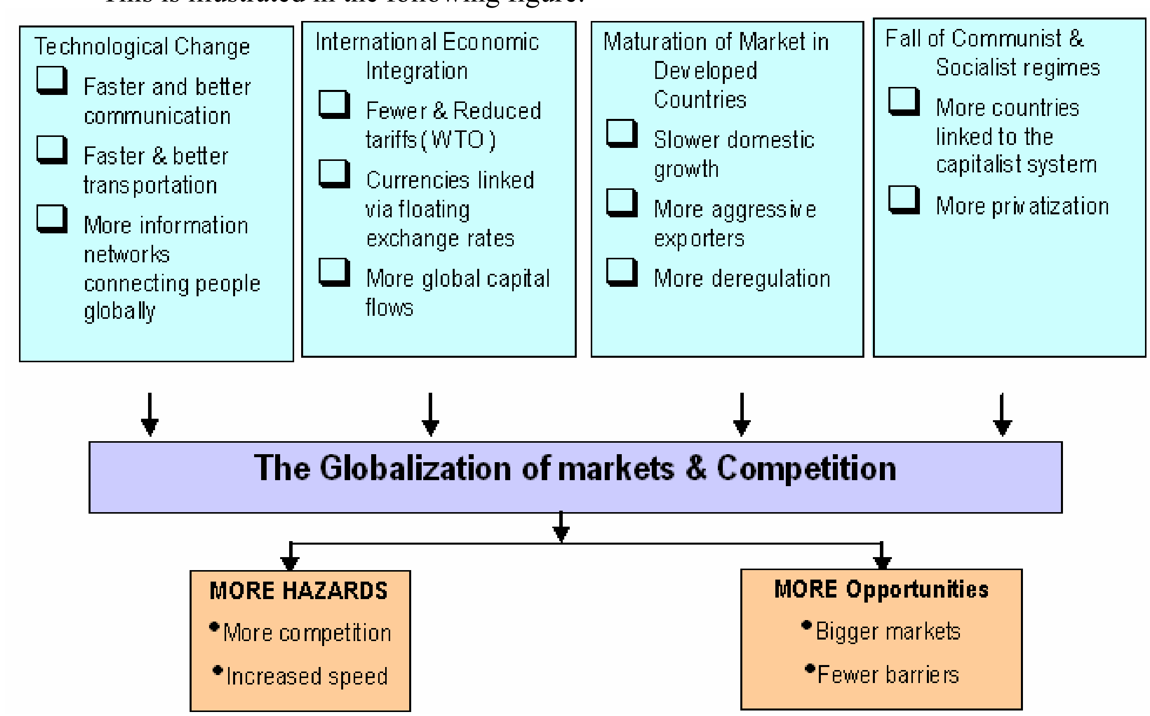


Figure 1.6: Economic and Social changes driving change

In order to have large scale changes in organizations, there are some distinctive transformation processes. These are as follows:

- Reengineering
- Restructuring
- Quality programs
- Mergers and acquisitions
- Strategic changes
- Cultural changes

1.10 Paradigm Shifts:

From	**To**
Industrial Society	Information Society
Forced Technology	High Tech/High Touch
National Economy	World Economy
Short Term	Long Term
Centralization	Decentralization
Institutional Help	Self-Help
Representative Democracy Hierarchies	Participatory Democracy
North	South
Either/OR	Multiple Option

LESSON 02

CONCEPTS, DEFINITIONS AND NATURE OF PROJECTS

Broad Contents

What is a project?
Why projects?
Attributes of a project
Characteristics of projects
Project environment
Project participants
Projects and strategic planning
Examples of projects
Project types

2.1 What is a Project?

J. M. Juran defined that *"a project is a problem scheduled for solution."* Problem refers to the gap between where you are and where you want to be, with an obstacle that prevents easy movement to close the gap.

Projects are a group of activities that have to be performed with limited resources to yield specific objectives, in a specific time, and in a specific locality. Thus, **a project is a temporary endeavour employed to create a unique product, service or results.** Projects are an investment on which resources are used to create assets that will produce benefits over an expanded period of time. It is a unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of *time, cost* and *resources*.

2.1.1 Short Range Projects:

They are completed within one year, and are focused towards achieving the tactical objectives. They are less rigorous; require less or no risk. They are not cross functional. These projects require limited Project Management tools, and have low level of sophistication. It is easy to obtain approval, funding and organizational support for short range projects. For example, reduce defect in shop number two from 6 to 4 percent.

2.1.2 Long Range Projects:

These projects involve higher risk and a proper feasibility analysis is essential before starting such projects. They are most often cross functional. Their major impact is over long period of time, on internal as well as external organization. Large numbers of resources are required to undertake long range projects and they require breakthrough initiatives from the members.

2.2 Why Projects are initiated?

Projects are initiated in the following scenarios:

- When starting a new business.
- In order to develop/ modify a product or service.
- For relocating and/or closing a facility.
- For regulatory mandate.
- For some community issues.
- In order to re-engineer the process so as to reduce complaints, reduce cycle time, and eliminate errors.
- For implementing a new system or process.
- To introduce new equipment, tools or techniques.

2.3 Attributes of a Project:

Projects focus on a single goal as compared to a program. They have customers who are affected by the end results. They have to be completed within specified time frame (completion date), within budget (limited resources including, people, money, machines) and should be according to the specifications (with a certain level of functionality and quality).

In brief projects are:
- Directed towards achieving a specific result.
- Coordination of undertaking of interrelated activities.
- Of limited duration, a beginning and an end.
- Prone to risks, that is, every project has a certain amount of risk.

2.4 Characteristics of Projects:

- As already mentioned projects are temporary with a definite beginning and a definite end.
- They also have temporary opportunities and temporary teams.
- Projects are terminated when the objectives are achieved, or conversely, if the objectives cannot be met.
- Most of the projects last for several years. However, they have a finite duration.
- They involve multiple resources (human and non-human) and require close coordination.
- They are composed of interdependent activities.
- At the end of the project, a unique product, service or result is created. Some degree of customization is also a characteristic of projects.
- Projects encompass complex activities that are not simple, and may require repetitive acts.
- They also include some connected activities. Some order and sequence is required in project activities. The output from one activity is an input to another.
- Project Management lives in the world of conflict. The management has to compete with functional departments for “resources and personnel”.
- There exists a constant conflict for project resources and for leadership roles in solving project problems.
- In every project, clients want changes, and the parent organization aims at maximization of profits.
- There can be two bosses at a time and that too with different priorities and objectives.

2.5 Project Environment:

All projects are planned and implemented in a social, economic, environmental, political and international context.

- ***Cultural and Social Environment*** is that how a project affects the people and how they affect the project. This requires understanding of economic, demographic, ethical, ethnic, religious and cultural sensitivity issues.

- ***International and Political Environment*** refers to the knowledge of international, national, regional or local laws and customs, time zone differences, teleconferencing facilities, level of use of technology, national holidays, travel means and logistic requirements.

- ***Physical Environment*** is the knowledge about local ecology and physical geography that could affect the project, or be affected by the project.

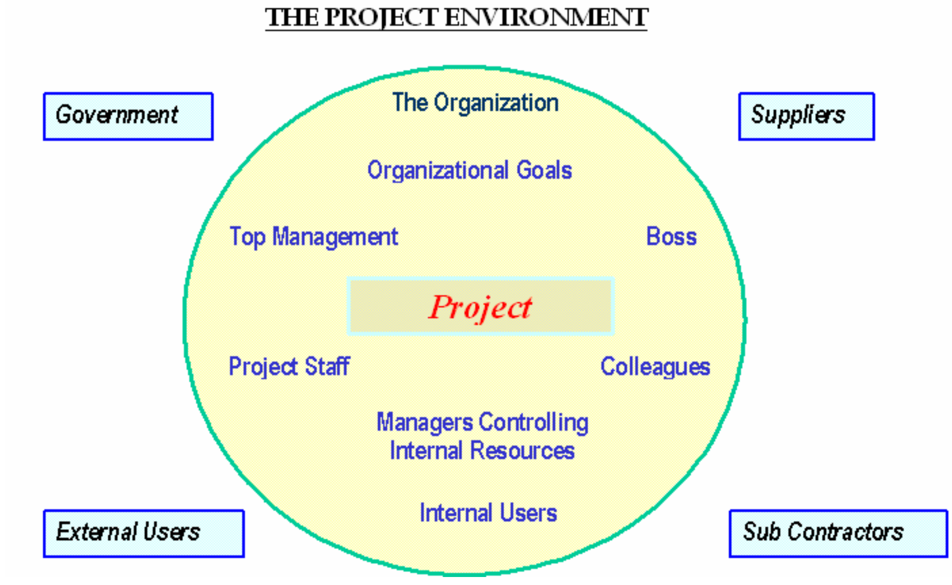


Figure 2.1: Project Environment

2.6 Project Participants:

2.6.1 Stakeholders:

Stakeholders are the ones who have a share, or an interest in an enterprise. Stakeholders in a company may include shareholders, directors, management, suppliers, government, employees, customers, and the community. Stakeholders are influenced by the outcomes and objectives. They have varying level of responsibility and authority. Thus, they should not be ignored. A project manager should try to manage and fulfill the expectations of the stakeholders. There are both positive and negative stakeholders. In some cases, stake holder’s roles and responsibilities are overlapping. For example, an engineering firm also provides financing.

Project stakeholders are individuals and organizations that are actively involved in the project, or whose interests may be affected as a result of project execution or project completion. They may also exert influence over the project’s objectives and outcomes. The project management team must identify the stakeholders, determine their requirements and expectations, and, to the extent possible, manage their influence in relation to the requirements to ensure a successful project.

As already mentioned, stakeholders have varying levels of responsibility and authority when participating on a project and these can change over the course of the project’s life cycle. Their responsibility and authority range from occasional contributions in surveys and focus groups to full project sponsorship, which includes providing financial and political support. Stakeholders who ignore this responsibility can have a damaging impact on the project objectives. Likewise, project managers who ignore stakeholders can expect a damaging impact on project outcomes.

Sometimes, stakeholder identification can be difficult. For example, some would argue that an assembly-line worker, whose future employment depends on the outcome of a new product-design project, is a stakeholder. Failure to identify a key stakeholder can cause major problems for a project.

Stakeholders may have a positive or negative influence on a project. Positive stakeholders are those who would normally benefit from a successful outcome from the project, while negative stakeholders are those who see negative outcomes from the project's success. For example, business leaders from a community that will benefit from an industrial expansion project may be positive stakeholders because they see economic benefit to the community from the project's success. Conversely, environmental groups could be negative stakeholders if they view the project as doing harm to the environment. In the case of positive stakeholders, their interests are best served by helping the project succeed, for example, helping the project obtains the needed permits to proceed. The negative stakeholders' interests would be better served by impeding the project's progress by demanding more extensive environmental reviews. Negative stakeholders are often overlooked by the project team at the risk of failing to bring their projects to a successful end.

2.6.2 Key Stakeholders:

Key stakeholders include the following:

a) ***Project Manager:***
The person, who is responsible for managing the project.

b) ***Customers, End Users:***
The person or organization that will use the project's product. These may be multiple layers of customers. For example, the customer for a new pharmaceutical product can include the doctors who prescribe it, the patient who take it and the insurers who pay for it. In some application areas, customers and user are synonymous, while in others, customer refers to the entity acquiring the project's product and users are those who will directly utilizes the project's product.

c) ***Performing Organization:***
The enterprise whose employees are most directly involved in doing the work of project.

d) ***Project Management Working on the Project:***
The members of the team who are directly involved in project management activities.

e) ***Project Team Members:***
The group that is performing the work of the project. It includes the members who are directly involved in the project activities.

f) ***Sponsors:***
The person or group that provides financial resources, in cash, or kind, for the project.

g) ***Influencers:***
People or groups that are not directly related to the acquisition or use of the project's product, but due to an individual's position in the customer organization or performing organization, can influence, positively or negatively, the course of the project.

h) ***Project Management Organization:***

If it exists in performing organization, the Project Management Organization can be a stakeholder if it has direct responsibility for the outcomes of the project.

2.6.3 Project Stakeholders:

In addition to these key stakeholders, there are many different names and categories of *project stakeholders*, influencing internal or external, owners and investors, sellers and contractors, team members and their families, government agencies and media outlets, individual citizens, temporary or permanent lobbing organizations, and society-at-large. The naming or grouping of stakeholders is primarily an aid to identifying which individuals and organizations view themselves as stakeholders. Project Managers must manage stakeholder expectations, which can be difficult because stakeholders often have very different or conflicting objectives.

For example:

- The manager of a department that has requested a new management information system may desire low cost, the system architect may emphasize technical excellence, and the programming contractor may be most interested in maximizing its profit.
- The vice president of research at an electronics firm may define new product success as state-of-the-art technology, the vice president of manufacturing may define it as world-class practices, and the vice president of marketing may be primarily concerned with the number of new features.
- The owner of a real estate development project may be focused on timely performance, the local governing body may desire to maximize tax revenue, an environmental group may wish to minimize adverse environmental impacts, and nearby residents may hope to relocate the project.

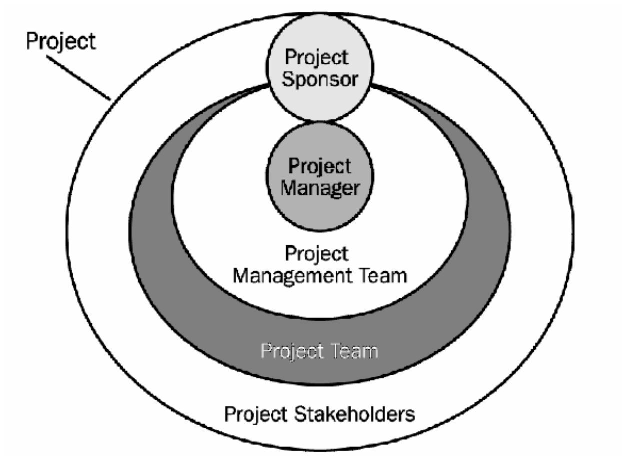


Figure 2.2: Stakeholders and Projects

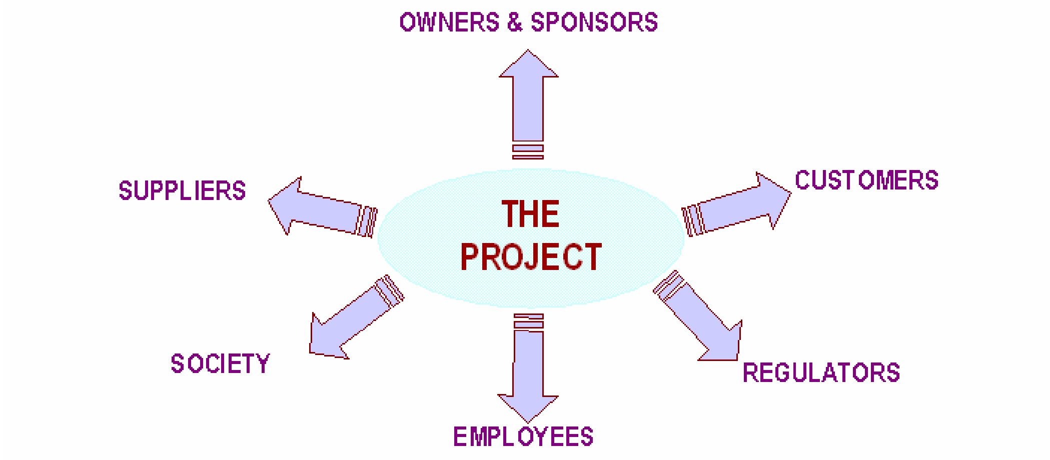


Figure 2.3: Relevant Stakeholders

2.7 Projects and Strategic Planning:

Projects are the means of achieving organization's strategic plans. Following are the strategic considerations that have to be kept in mind while planning for projects:

- The market demand (e.g. a new refinery).
- Organizational needs (e.g. a university offers new courses for revenue generation).
- Customer's requests (e.g. an Internet Service Provider ISP provider lunches DSL).
- Technological demand (e.g. new video games, new cell phones with advance features).
- Legal requirements (e.g. child labor control project, toxic waste disposal center).

2.8 Sub Projects:

Projects are frequently divided into more manageable components or sub projects. Individual sub projects are also a project and are managed as such. They can be sub contracted or out sourced.

2.9 The Triple Constraint of Project Management:

Meeting stakeholder needs and expectations involves balancing competing demands among cost, quality, scope, and time.

$$Q = f(T, C, S)$$

- Where Q is Quality, S is Scope and T is Time.
- Project quality is affected by balancing these three factors.
- Projects fail when:
  a) Estimates are faulty
  b) Time, talent and resources are insufficient or incorrectly applied

Figure 2.4: Overview of Project Management

Figure 2.4 is a pictorial representation of project management. The objective of the figure is to show that project management is designed to manage or control company resources on a given activity, within time, within cost, and within performance expectations. Time, cost, and performance are the constraints on the project. If the project is to be accomplished for an outside customer, then the project has a fourth constraint: that is good customer relations.

2.10 Examples of Projects:

- Designing and implementing an auto tax filing system in a revenue collection organization.
- Hosting a web site of your department.
- Executing an environmental clean-up of a contaminated site.
- Holding a University alumni reunion.
- Provision of clean water to Pakistani nation by 2008.
- Developing a new product or service.
- Effecting a change in structure, staffing, or style of an organization.
- Developing or acquiring a new or modified information system.

2.11 Operations and Projects:

Operations are ongoing and repetitive activities conducted by the staff. Some of these include:

- Financial management and control
- Continuous manufacturing
- Product distribution

Projects are temporary and unique, and are performed by teams that have:

- Clearly defined team and individual roles
- Open and effective communication systems
- Visible rewards for good performance, and have constant pressure to improve poor performance

Common Characteristics between operations and projects are as follows:

- They are both performed by people
- They are constrained by limited resources
- Both are planned, executed, and controlled

2.12 Project Types:

Project End Requirements

Project Methods

	Well Defined	Poorly Defined
Well Defined	**Type I** **Construction**	**Type III** **Software**
Poorly Defined	**Type II** **Product Development, Space**	**Type IV** **OD, Vision, Training Assessment**

Figure 2.5: Project Types

- ***Type I Projects – Large Engineering Projects:***
  They have well defined project methods and end project requirements, such as construction projects.

- ***Type II Projects – Product Development Projects, Early Space Projects:***
  They have poorly defined project methods but have well defined project end requirements.

- ***Type III Projects – Software Development Projects:***
  In these, the shape of end product proceeds. They have well defined project methods, but poorly defined project end requirements.

- ***Type IV Projects – Organizational Development Projects, Vision Definition, Assessment of Impact of Trainings:***
  They have both poorly defined project methods as well as project end requirements.

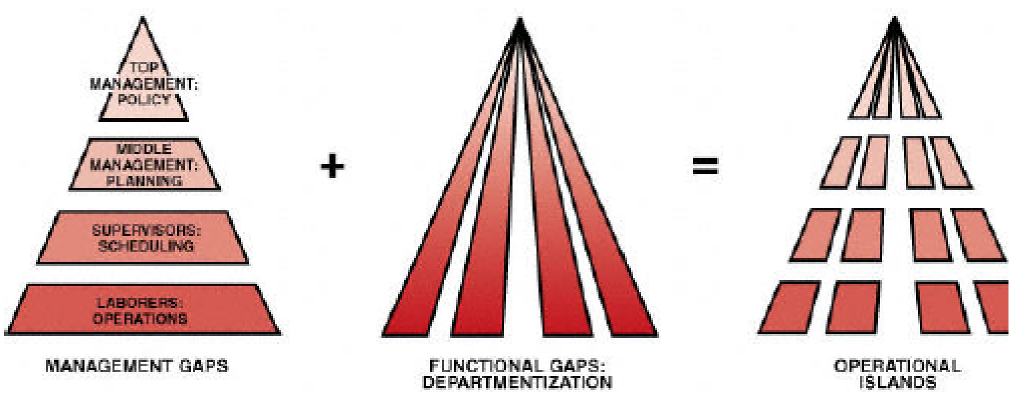


Figure 2.6: Why are systems necessary?

Figure 2.6 shows how many companies are structured. There are always "class or prestige" gaps between various levels of management. There are also functional gaps between working units of the organization. If we superimpose the management gaps on top of the functional gaps, we find that companies are made up of small operational islands that refuse to communicate with one another for fear that giving up information may strengthen their opponents.

The project manager's responsibility is to get these islands to communicate cross-functionally toward common goals and objectives.

Projects fill an essential need in society. Indeed, projects are the major mode in which change is accomplished. It is the mode in which corporate strategy is implemented, business change is addressed, productive teams and their necessary competencies are dealt with, quality of deliverables, and tracking pre-established metrics for management's decision making, as well as closing out a project and creating lessons learned are performed.

This discipline changes over time but the basic business premise never changes:

Accomplish the right thing right the first time within justifiable time, resources, and budget. Projects are the means for responding to, if not proactively anticipating, the environment and opportunities of the future.

LESSON 03

CONCEPTS OF PROJECT MANAGEMENT

Broad Contents

- Project Management
- *Efficiency* and *effectiveness* in projects
- The project management system
- Project manager

3.1 What is Project Management?

Project Management is the discipline of organizing and managing resources in such a way that these resources deliver all the work required to complete a project within defined scope, time, and cost constraints. It is important to note here that a project is a temporary and one-time endeavor undertaken to create a unique product or service that brings about beneficial change or added value. This property of being a temporary and one-time undertaking contrasts with processes, or operations, which are permanent or semi-permanent ongoing functional work to create the same product or service over and over again. The management of these two systems is often very different and requires varying technical skills and philosophy, hence requiring the development of project management.

Thus, in this regard, the first challenge of project management is ensuring that a project is delivered within the defined constraints. The second, more ambitious, challenge is the optimized allocation and integration of the inputs needed to meet those pre–defined objectives. The project, therefore, is a carefully selected set of activities chosen to use resources (money, people, materials, energy, space, provisions, communication, quality, risks, etc.) in order to meet the objectives established by the organization.

Management in any project is concerned with productivity. This refers to efficiency and effectiveness. These can be explained as follows:

Efficiency: In order to be efficient, management is concerned with minimizing resource costs. Efficiency is “doing things right”.
Effectiveness: In order to be effective, management is concerned with getting activities completed. Effectiveness is “doing right things”.

Thus, efficiency is concerned with means and effectiveness with ends. They are interrelated. It is easier to be effective if one ignores efficiency. For example, some organizations are reasonably effective, but are extremely inefficient. They get their jobs done, but at a very high cost.
For the management of any project, it is important not only to get the activities completed (effectiveness), but also to do so as efficiently as possible. Can organizations be efficient and yet not effective? Yes, by doing wrong things well.

The following figure (figure 3.1) shows management seeking efficiency and effectiveness.

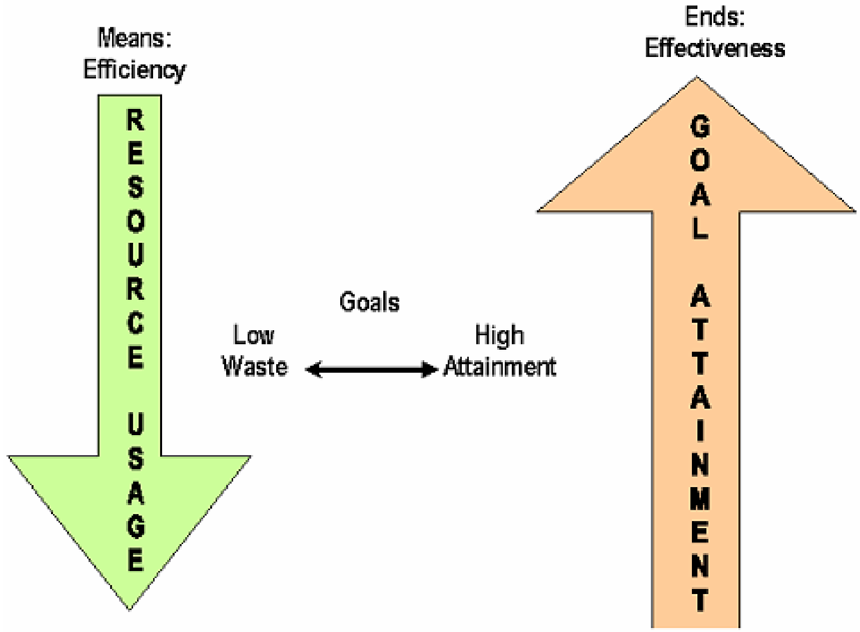


Figure 3.1: Efficiency and Effectiveness

3.2 THE PROJECT MANAGEMENT SYSTEM

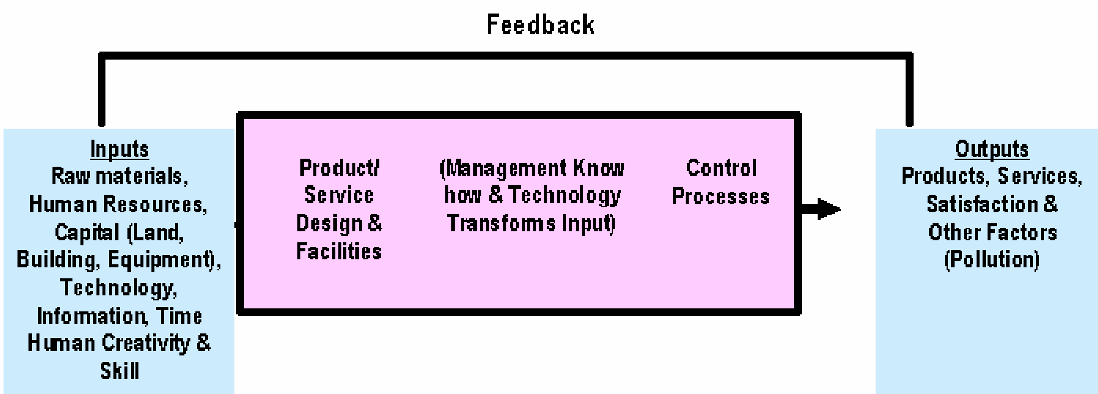


Figure 3.2: Project Management System

Because of the interrelatedness of these driving forces, some people contend that the only true driving force is survival. This is illustrated in Figure 3.3 below. When the company recognizes that survival of the firm is at stake, the implementation of project management becomes easier. The speed by which companies reach some degree of maturity in project management is most often based upon how important they perceive the driving forces to be.

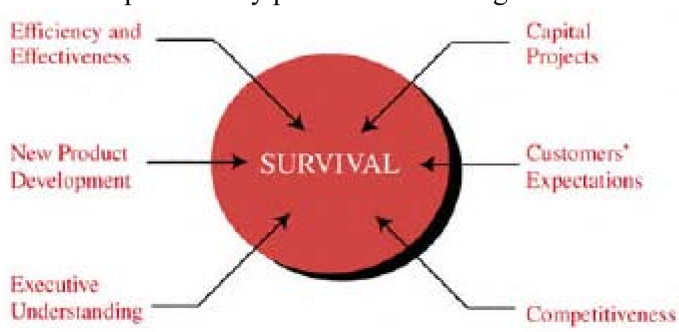


Figure 3.3: Components of survival

3.3 Who is a Project Manager?

A project manager is a professional in the field of project management. They have the responsibility of the planning and execution of any project. A project manager's central duty is to ensure the success of a project by minimizing risk throughout the lifetime of the project. This is done through a variety of methods, both formal and informal. A project manager usually has to ask penetrating questions, detect unstated assumptions, and resolve interpersonal conflicts, as well as use more systematic management skills.

In whatever field, a successful project manager must be able to envisage the entire project from start to finish and should have the ability to ensure that this vision is realized.

3.3.1 Types of Project Managers:

Project managers cannot perform their tasks well unless they have understanding of and are responsive to many elements of the external environment, including; economic, technological social, political and ethical factors that effect their areas of operations.The various types of project managers are follows:

Line managers are responsible for activities making direct contributions to production of organization’s basic goods or services.
Staff managers use special technical expertise to advise and support the efforts of line workers.

Functional managers are responsible for only one area of activity, i.e. finance, marketing, production, personnel, accounting, or sales.

General Managers are responsible for complex organizational unit that include many areas of functional activity.

An administrator is someone who administers work in any kind of organization.

3.3.2 Activities of Project Managers:

Following are the four major activities that are undertaken by the project managers:

1. **Traditional management:** This includes decision making, planning, and controlling
2. **Communication:** This refers to exchanging routine information and processing paperwork.
3. **Human Resource Management (HRM):** It involves motivating, disciplining, managing conflict, staffing, and training.
4. **Networking:** It includes socializing, and interacting with outsiders.

An average manager spends:

- 32% of time in traditional management activities
- 29% in communicating
- 20% in HRM activities
- 19% in networking

Today’s business environment is moving away from the conventional practices and with this; the role of the Project Managers is also witnessing rapid changes.

3.3.3 Success for Project Managers:

There are three general preconditions for achieving lasting success as Project Manager. These include:

- **Ability (A)**
- **Motivation to manage (M)**
- **Opportunity (O)**

Together, they constitute the basic formula for managerial success (S):

$$S = A \times M \times O$$

3.3.4 Ten Facts of Project Managerial Life:

i) Project Managers work long hours. Number of hours worked tends to increase as one climbs the managerial ladder.

ii) Project Managers are busy. Typical manager's day is made up of hundreds of brief incidents or episodes. Activity rates tend to decrease as rank increases.

iii) Project Manager's work is fragmented. Given managers high activity level, they have little time to devote to any single activity. Interruptions and discontinuity are the rule.

iv) Project Manager's job is varied. They engage in variety of activities (paperwork, phone calls, scheduled and unscheduled meetings, and inspection tours/visits). They interact with variety of people, and deal with variety of content areas.

v) Project Managers are "homebodies". They spend most of their time pursuing activities within their own organizations. As managerial rank increases, they spend proportionately more time outside their work areas and organizations.

vi) Project Manager's work is primarily oral. At all levels, they spend most of the time communicating verbally by personal contacts/ telephone etc.

vii) Project Managers use a lot of contacts. Consistent with their high level of verbal communication, managers continually exchange information with superiors, peers, subordinates, and outsiders on ongoing basis.

viii) Project Managers are not reflective planners. Typical manager is too busy to find uninterrupted blocks of time for reflective planning.

ix) Information is the basic ingredient of Project Manager's work. Managers spend most of their time obtaining, interpreting, and giving information.

x) Project Managers do not know how they spend their time. Managers consistently overestimate the time they spend on production, reading and writing, phone calls, thinking, and calculating and consistently underestimate time spent on meetings as well as on informal discussions.

3.3.5 Managerial Skills:

A skill is an ability or proficiency in performing a particular task. Skills reflect the ability to translate actions into results. They are of the following types:

- ***Technical Skill*** is the knowledge of and proficiency in activities involving methods, processes, and procedures.
- ***Human Skill*** is the ability to work with people; cooperative effort; it is teamwork; feel secure and free to express their opinions.
- ***Conceptual Skill*** is the ability to see "big picture" in order to recognize significant elements in a situation, and to understand relationships among elements.
- ***Design Skill*** is the ability to solve problems in ways that will benefit enterprise.

3.4 Tomorrow's Management Today

- Average company will be smaller, employing fewer people.
- Traditional organizational structures will become more team-based and without boundaries.
- Employees will be empowered to make decisions.
- Flatter organizations will be the norm.
- Work will be organized around teams and processes.
- Bases of power will change.
- Knowledge-based organizations will exist.
- Stress will be on vision and values.
- Managers will be change agents.
- Leadership will be more important.

PROJECT MANAGEMENT METHODOLOGIES AND ORGANIZATIONAL STRUCTURES

Broad Contents

Project driven versus non–project driven organizations
Project management methodologies
Systems, programs, and projects
Categories of projects
Product versus Project Management
Maturity and excellence
Informal Project Management
Organizational structures
Selecting the organizational form

4.1 Project driven versus Non – project driven organizations:

On the micro level, virtually all organizations are marketing, engineering, or manufacturing driven. But on the macro level, organizations are either project- or non–project driven. In a project driven organization, such as construction or aerospace, all work is characterized through projects, with each project as a separate cost center having its own profit-and-loss statement. The total profit to the corporation is simply the summation of the profits on all projects. In a project driven organization, everything centers on the projects. In the non–project driven organization, such as low technology manufacturing, profit and loss is measured on vertical or functional lines. In this type of organization, projects exist merely to support the product lines or functional lines. Priority resources are assigned to the revenue-producing functional line activities rather than the projects.

Project management in a non–project driven organization is generally more difficult for these reasons:

- Projects may be few and far between.
- Not all projects have the same project management requirements, and therefore, they cannot be managed identically. This difficulty results from poor understanding of project management and a reluctance of companies to invest in proper training.
- Executives do not have sufficient time to manage projects themselves, yet refuse to delegate authority.
- Projects tend to be delayed because approvals most often follow the vertical chain of command. As a result, project work stays too long in functional departments.
- Because project staffing is on a "local" basis, only a portion of the organization understands project management and sees the system in action.
- There exists heavy dependence on subcontractors and outside agencies for project management expertise.

Non–project driven organizations may also have a steady stream of projects, all of which are usually designed to enhance manufacturing operations. Some projects may be customer-requested, such as:
- The introduction of statistical dimensioning concepts to improve process control.
- The introduction of process changes to enhance the final product.
- The introduction of process change concepts to enhance product reliability.

If these changes are not identified as specific projects, the result can be:

- Poorly defined responsibility areas within the organization.
- Poor communications, both internal and external to the organization.
- Slow implementation.
- Lack of a cost tracking system for implementation.
- Poorly defined performance criteria.

Figure 4.1 below shows the tip-of-the-iceberg syndrome, which can occur in all types of organizations but is most common in non–project driven organizations.

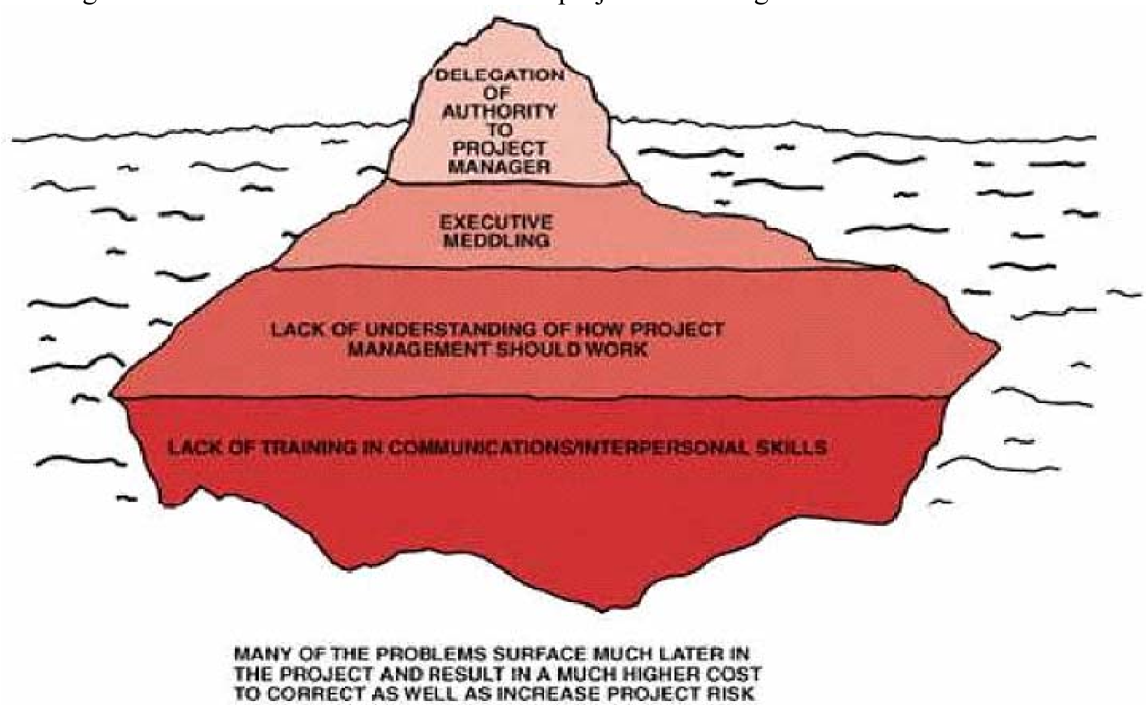


Figure 4.1: The tip-of-the-iceberg syndrome for matrix implementations.

On the surface, all we see is a lack of authority for the project manager. But beneath the surface we see the causes; there is excessive meddling due to lack of understanding of project management, which, in turn, resulted from an inability to recognize the need for proper training. In the previous sections we stated that project management could be handled on either a formal or an informal basis. Informal project management most often appears in non–project driven organizations. It is doubtful that informal project management would work in a project driven organization where the project manager has profit and loss responsibility.

In reality, most firms that believed that they were non–project driven were actually hybrids. Hybrid organizations are typically non–project driven firms with one or two divisions that are project driven.

Historically, hybrids have functioned as though they were non–project driven, as shown in Figure 4.2, but today they are functioning like project driven firms.

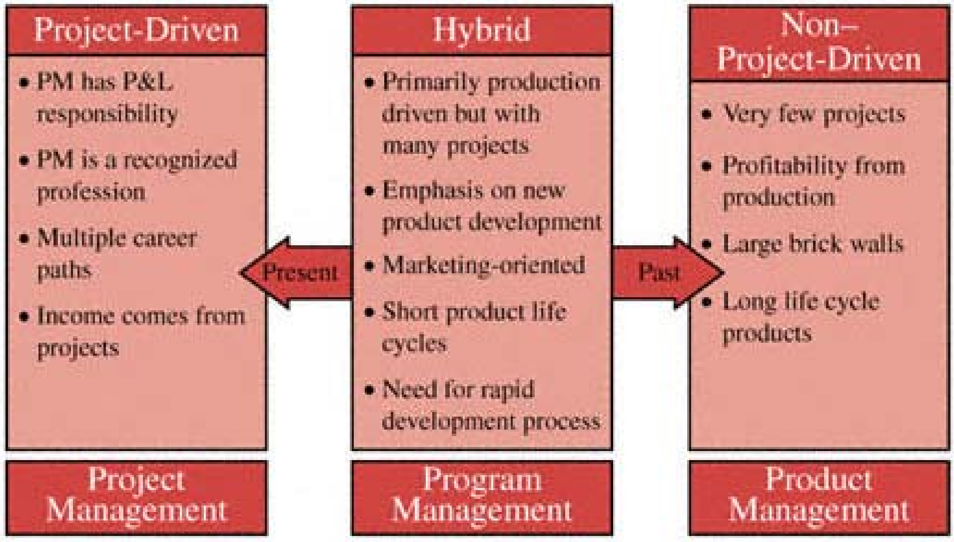


Figure 4.2: Project driven versus non-project driven organizations

4.2 Project Management Methodologies:

Earlier there were no allies or alternative management techniques that were promoting the use of project management. The recession of 1989–1993 finally saw the growth of project management in the non–project driven sector. This recession was characterized by layoffs in the white collar/management ranks. Allies for project management were appearing and emphasis was being placed upon long-term solutions to problems. Project management was now here to stay. The allies for project management began surfacing in 1985 and continued throughout the recession of 1989–1993.

- ***1985:*** Companies recognized that they must compete on the basis of quality as well as cost. There existed a new appreciation for **Total Quality Management (TQM)**. Companies began using the principles of project management for the implementation of TQM. The first ally for project management surfaced with the "marriage" of project management and TQM.

- ***1990:*** During the recession of 1989–1993, companies recognized the importance of schedule compression and being the first to market. Advocates of concurrent engineering began promoting the use of project management to obtain better scheduling techniques. Another ally for project management was born.

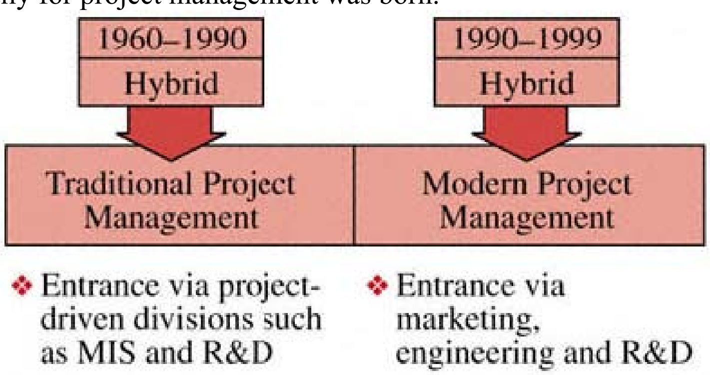


Figure 4.3: From hybrid to project-driven.

- ***1991–1992:*** Executives realized that project management works best if decision-making and authority are decentralized. They further recognized that control could still be achieved at the top by functioning as project sponsors.

- ***1993:*** As the recession of 1989–1993 came to an end, companies began "re-engineering" the organization, which really amounted to elimination of organizational "fat." The organization was now a "lean and mean" machine. People were asked to do more work in less time and with fewer people; executives recognized that being able to do this was a benefit of project management.

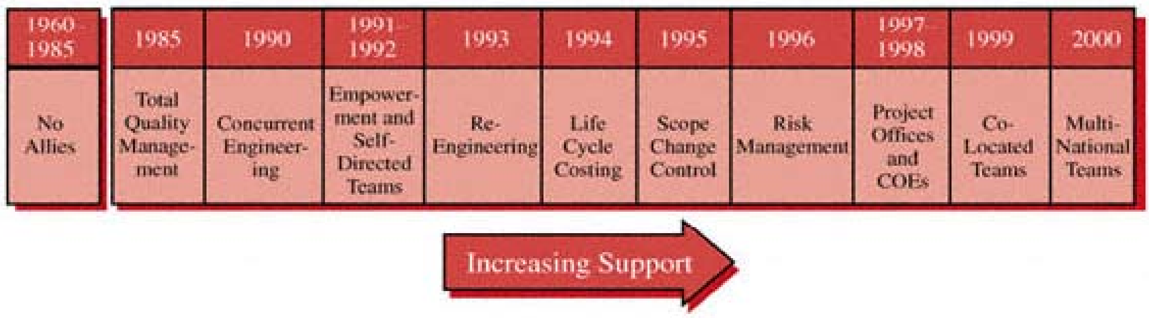


Figure 4.4: New processes supporting project management.

- ***1994:*** Companies recognized that a good project cost control system (i.e., horizontal accounting) allows for improved estimating and a firmer grasp of the real cost of doing work and developing products.

- ***1995:*** Companies recognized that very few projects were completed within the framework of the original objectives without scope changes. Methodologies were created for effective change management.

- ***1996:*** Companies recognized that risk management involves more than padding an estimate or a schedule. Risk management plans were now included in the project plans.
- ***1997-1998:*** The recognition of project management as a professional career path mandates the consolidation of project management knowledge and a centrally located project management group.

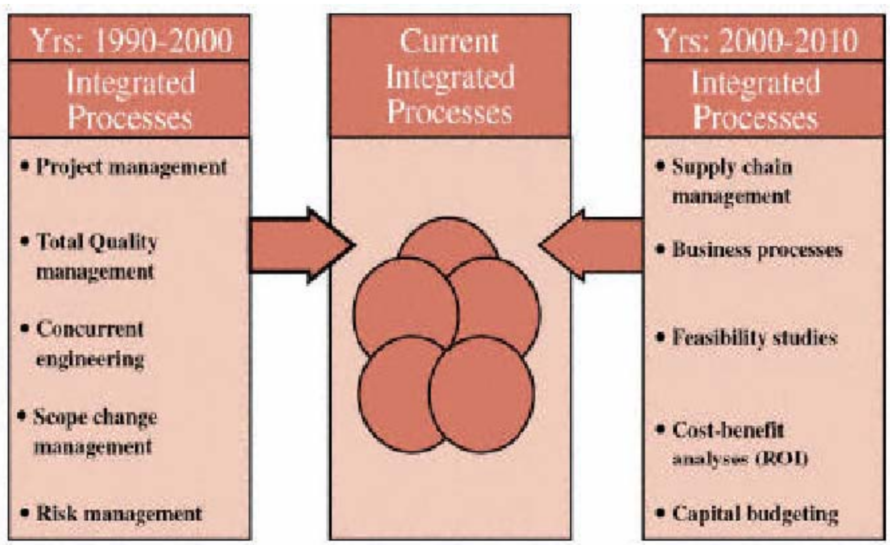


Figure 4.5: Integrated Processes (Past, present, and future)

- ***1999:*** Companies that recognized the importance of concurrent engineering and rapid product development found that it was best to have dedicated resources for the duration of the project. The cost of over management may be negligible compared to risks of under management. More and more organizations could be expected to use collocated teams all housed together.

- ***2000:*** Mergers and acquisitions were creating more multinational companies. It was believed that multinational project management will become the major challenge for the next decade.

The reason for the early resistance to project management was that the necessity for project management was customer-driven rather than internally driven, despite the existence of allies. Project management was being implemented, at least partially, simply to placate customer demands. By 1995, however, project management had become internally driven and a necessity for survival. Project management benchmarking was commonplace, and companies recognized the importance of achieving excellence in project management.
As project management continues to grow and mature, more allies will appear. In the twenty-first century, second and third world nations will come to recognize the benefits and importance of project management. Worldwide standards for project management will occur.

4.3 Systems, Programs, and Projects:

4.3.1 Systems:

In the preceding sections the word "systems" has been used rather loosely. The exact definition of a system depends on the users, environment, and ultimate goal. Modern business practitioners define a system as:

A group of elements, either human or nonhuman, that is organized and arranged in such a way that the elements can act as a whole toward achieving some common goal, objective, or end.

Systems are collections of interacting subsystems that either span or interconnect all schools of management. Systems, if properly organized, can provide a synergistic output. Systems are characterized by their boundaries or interface conditions. For example, if the business firm system were completely isolated from the environmental system, then a ***close*** system would exist, in which case management would have complete control over all system components. If the business system does in fact react with the environment, then the system is referred to as ***open***. All social systems, for example, are categorized as open systems. Open systems must have permeable boundaries.

4.3.2 Programs:

Programs can be explained as the necessary first-level elements of a system. Two representative definitions of programs are given below:

- ***Air Force Definition:*** The integrated, time-phased tasks necessary to accomplish a particular purpose.

- ***NASA Definition:*** A relative series of undertakings that continue over a period of time (normally years) and that are designed to accomplish a broad, scientific or technical goal in the NASA long range plan (lunar and planetary exploration, manned spacecraft systems). Programs can be regarded as subsystems. However, programs are generally defined as time-phased efforts, whereas systems exist on a continuous basis.

4.3.3 Projects:

Projects are also time-phased efforts (much shorter than programs) and are the first level of breakdown of a program. A typical definition would be:

- ***NASA/Air Force Definition:*** A project is within a program as an undertaking that has a scheduled beginning and end, and that normally involves some primary purpose. The majority of the industrial sector, on the other hand, prefers to describe efforts as projects, headed by a project manager. Whether we call our undertaking project management or program management is inconsequential because the same policies, procedures, and guidelines that regulate programs most often apply to projects also. For the remainder of this text, programs and projects will be discussed interchangeably. However, the reader should be aware that projects are normally the first-level subdivision of a program.

4.4 Categories of Projects:

Once a group of tasks is selected and considered to be a project, the next step is to define the kinds of project units. There are four categories of projects:

1. ***Individual projects:*** These are short-duration projects normally assigned to a single individual who may be acting as both a project manager and a functional manager.

2. ***Staff projects:*** These are projects that can be accomplished by one organizational unit, say a department.

3. ***Special projects****:* Very often special projects occur that require certain primary functions and/or authority to be assigned temporarily to other individuals or units. This works best for short-duration projects. Long-term projects can lead to severe conflicts under this arrangement.

4. ***Matrix or Aggregate projects****:* These require input from a large number of functional units and usually control vast resources. Each of these categories of projects can require different responsibilities, job descriptions, policies, and procedures. Project management may now be defined as the process of achieving project objectives through the traditional organizational structure and over the specialties of the individuals concerned. Project management is applicable for any ad hoc (unique, one-time, one-of-a-kind) undertaking concerned with a specific end objective. In order to complete a task, a project manager must:

    - Set objectives
    - Establish plans
    - Organize resources
    - Provide staffing
    - Set up controls
    - Issue directives
    - Motivate personnel
    - Apply innovation for alternative actions
    - Remain flexible

    The type of project will often dictate which of these functions a project manager will be required to perform.

4.5 Product versus Project Management:

For all practical purposes, there is no basic difference between program management and project management. Project management and product management are similar, with one major exception: *the project manager focuses on the end date of his project, whereas the product manager is not willing to admit that his product line will ever end*. The product manager wants his product to be as long-lived and profitable as possible. Even when the demand for the product diminishes, the product manager will always look for spin-offs to keep his product alive. When the project is in the Research and Development (R & D) phase, a project manager is involved. Once the product is developed and introduced into the marketplace, control is taken over by the product manager. In some situations, the project manager can become the product manager. Both product and project management can, and do, exist concurrently within companies.

4.6 Maturity and Excellence:

Some people think that maturity and excellence in project management are the same. Unfortunately, this is not the case. Consider the following definition:

Maturity in project management is the implementation of a standard methodology and accompanying processes, in such a way that ensures a high likelihood of repeated successes.

This definition is supported by the life-cycle phases. Maturity implies that the proper foundation of tools, techniques, processes, and even culture, exists. When projects come to an end, there is usually a debriefing with senior management to discuss how well the methodology was used and to recommend changes. This debriefing looks at "key performance indicators," and allows the organization to maximize what it does right and to correct what it did wrong.

The definition of excellence can be stated as:
Organizations excellence creates an environment in which there exists a continuous stream of successfully managed projects and where success is measured by what is in the best interest of both the company and the project (i.e. the customer)

Excellence goes well beyond maturity. You must have maturity to achieve excellence. It may take two years or more to reach some initial levels of maturity. Excellence, if achievable at all, may take an additional five years or more.

4.7 Informal Project Management:

Companies today are managing projects more on an informal basis than on a formal one. Informal project management does have some degree of formality but emphasizes managing the project with a minimum amount of paperwork. A reasonable amount of formality still exists. Furthermore, informal project management is based upon guidelines rather than the policies and procedures that are the basis for formal project management. This was shown previously to be a characteristic of a good project management methodology. Informal project management mandates:

- Effective communications
- Effective cooperation
- Effective teamwork
- Trust

These four elements are absolutely essential for informal project management to work effectively.

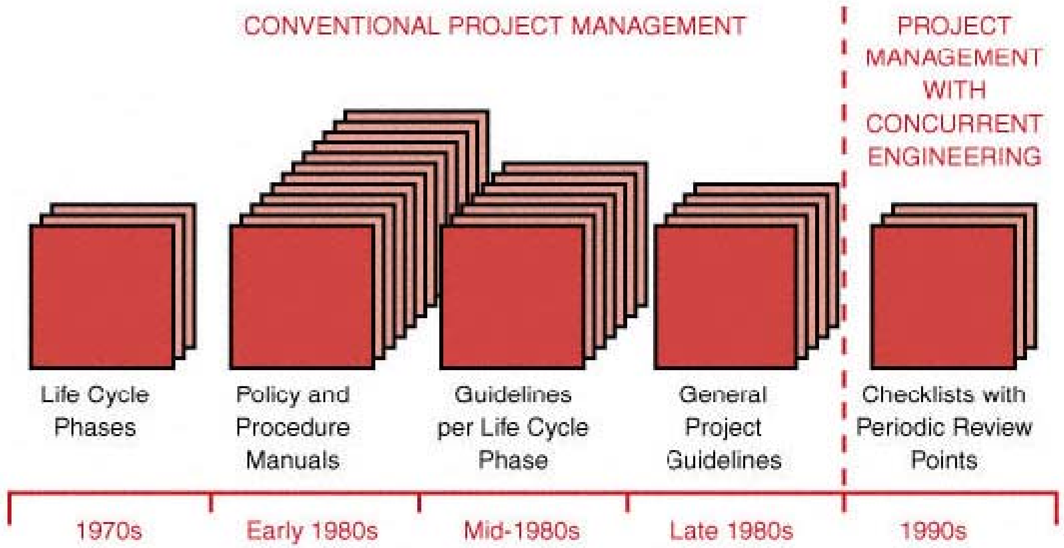


Figure 4.6: Evolution of policies, procedures, and guidelines.

Not all companies have the luxury of using informal project management. Customers often have a strong voice in whether formal or informal project management will be used.

4.8 Organizational Structures:

During the past thirty years there has been a so-called hidden revolution in the introduction and development of new organizational structures. Management has come to realize that organizations must be dynamic in nature; that is, they must be capable of rapid restructuring, if environmental conditions so dictate. These environmental factors evolved from the increasing competitiveness of the market, changes in technology, and a requirement for better control of resources for multiproduct firms. More than thirty years ago, Wallace identified four major factors that caused the onset of the organizational revolution:

- The technology revolution (complexity and variety of products, new materials and processes, and the effects of massive research).
- Competition and the profit squeeze (saturated markets, inflation of wage and material costs, and production efficiency).
- The high cost of marketing.
- The unpredictability of consumer demands (due to high income, wide range of choices available, and shifting tastes).

Much has been written about how to identify and interpret those signs that indicate that a new organizational form may be necessary. According to Grinnell and Apple, there are five general indications that the traditional structure may not be adequate for managing projects:

- Management is satisfied with its technical skills, but projects are not meeting time, cost, and other project requirements.
- There is a high commitment to getting project work done, but great fluctuations in how well performance specifications are met.
- Highly talented specialists involved in the project feel exploited and misused.
- Particular technical groups or individuals constantly blame each other for failure to meet specifications or delivery dates.
- Projects are on time and to specifications, but groups and individuals are not satisfied with the achievement.

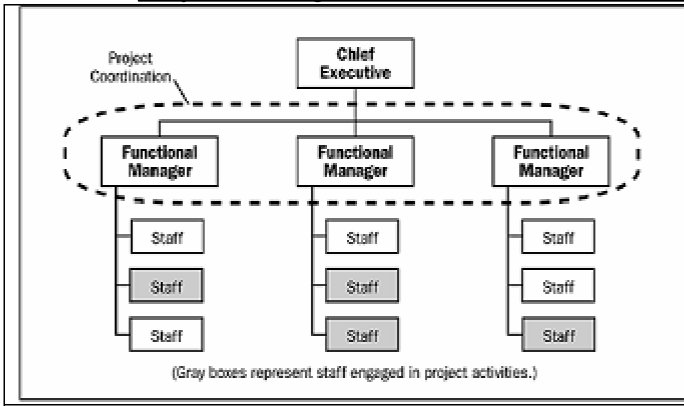


Figure 4.7: Functional Organization

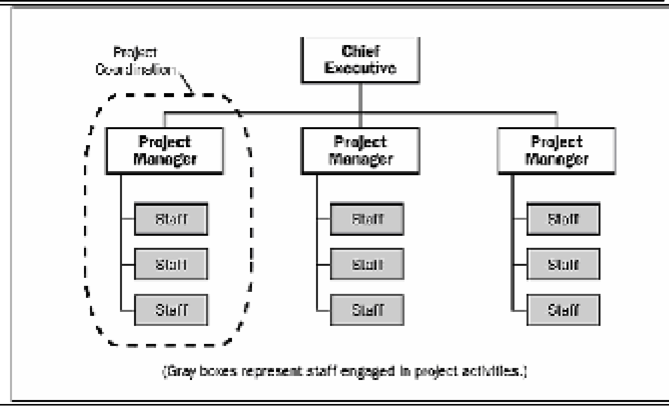


Figure 4.8: Project Organization

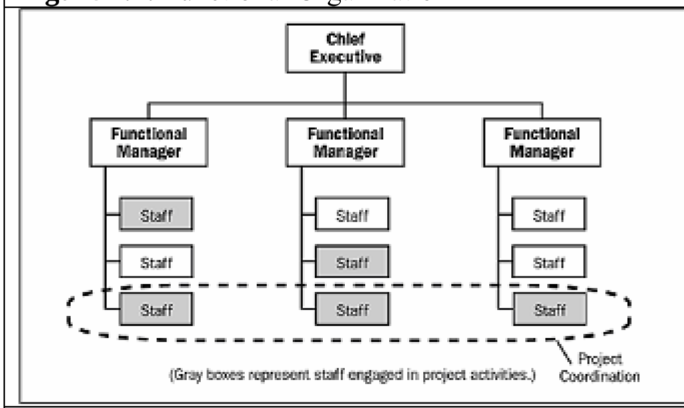


Figure 4.9: Weak Matrix Organization

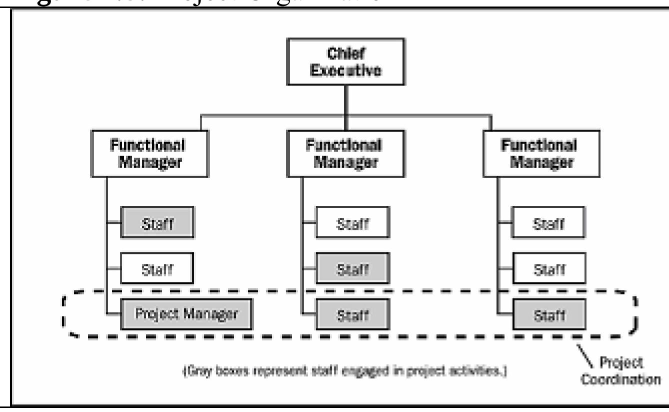


Figure 4.10: Balanced Matrix Organization

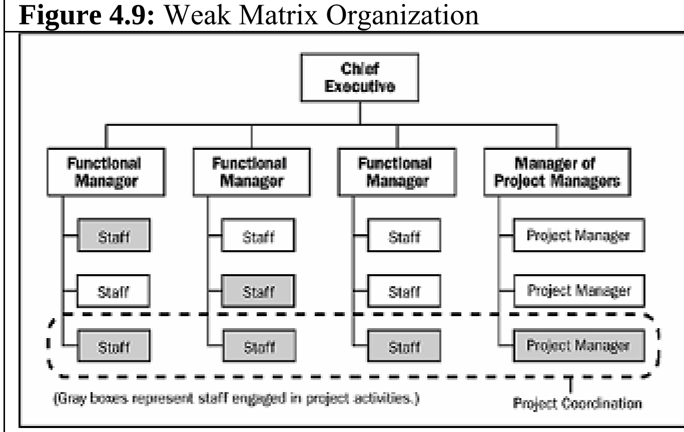


Figure 4.11: Strong Matrix Organization

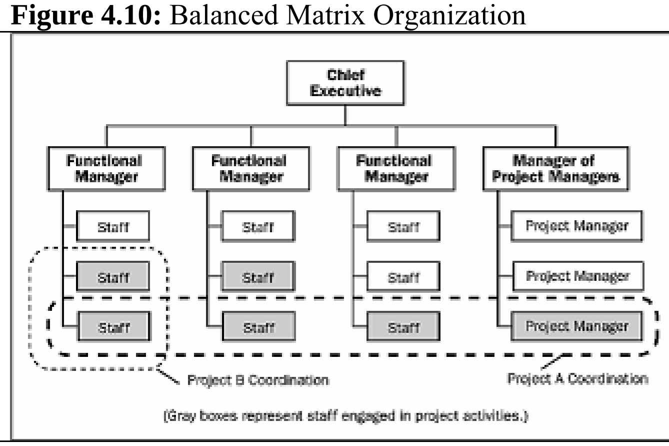


Figure 4.12: Composite Organization

Unfortunately, many companies do not realize the necessity for organizational change until it is too late. Management continually looks externally (i.e., to the environment) rather than internally for solutions to problems. A typical example would be that new product costs are continually rising while the product life cycle may be decreasing. Should emphasis be placed on lowering costs or developing new products?

For each of the organizational structures described in the following sections, advantages and disadvantages are listed. Many of the disadvantages stem from possible conflicts arising from problems in authority, responsibility, and accountability. The reader should identify these conflicts as such.

4.8.1 Traditional (Classical) Organization:

The traditional management structure has survived for more than two centuries. However, recent business developments, such as the rapid rate of change in technology and position in the marketplace, as well as increased stockholder demands, have created strains on existing organizational forms. Fifty years ago companies could survive with only one or perhaps two product lines. The classical management organization was found to be satisfactory for control, and conflicts were at a minimum.

However, with the passing of time, companies found that survival depended on multiple product lines (that is diversification) and vigorous integration of technology into the existing organization. As organizations grew and matured, managers found that company activities were not being integrated effectively, and that new conflicts were arising in the well-established formal and informal channels.

Managers began searching for more innovative organizational forms that would alleviate the integration and conflict problems. The advantages and disadvantages of this type of organizations are listed in tables 4.1 and 4.2 respectively.

- Easier budgeting and cost control are possible.
- Better technical control is possible.
  - Specialists can be grouped to share knowledge and responsibility.
  - Personnel can be used on many different projects.
  - All projects will benefit from the most advanced technology (better utilization of scarce personnel).
- It provides flexibility in the use of manpower.
- It provides a broad manpower base to work with.
- It provides continuity in the functional disciplines; policies, procedures, and lines of responsibility are easily defined and understandable.
- It readily admits mass production activities within established specifications.
- It provides good control over personnel, since each employee has one and only one person to report to.
- Communication channels are vertical and well established.
- Quick reaction capability exists, but may be dependent upon the priorities of the functional managers.

Table 4.1: Advantages of the traditional/classical organization

- No one individual is directly responsible for the total project (i.e., no formal authority; committee solutions).
- It does not provide the project-oriented emphasis necessary to accomplish the project tasks.
- Coordination becomes complex, and additional lead time is required for approval of decisions.
- Decisions normally favor the strongest functional groups.
- There is no customer focal point.
- Response to customer needs is slow.
- There is difficulty in pinpointing responsibility; this is the result of little or no direct project reporting, very little project-oriented planning, and no project authority.
- Motivation and innovation are decreased.
- Ideas tend to be functionally oriented with little regard for ongoing projects.

Table 4.2: Disadvantages of the traditional/classical organization

4.8.2 Line–Staff Organization (Project Coordinator):

It soon became obvious that control of a project must be given to personnel whose first loyalty is directed toward the completion of the project. For this purpose, the project management position must be separated from any controlling influence of the functional managers. Two possible situations can exist with this form of line–staff project control. In the first situation, the project manager serves only as the focal point for activity control, that is, a center for information. The prime responsibility of the project manager is to keep the division manager informed of the status of the project and to attempt to "influence" managers into completing activities on time.

The amount of authority given to the project manager posed serious problems. Almost all upper level and division managers were from the classical management schools and therefore maintained serious reservations about how much authority to relinquish. Many of these managers considered it a demotion if they had to give up any of their long-established powers.

4.8.3 Pure Product (Projectized) Organization:

The pure product organization develops as a division within a division. As long as there exists a continuous flow of projects, work is stable and conflicts are at a minimum. The major advantage of this organizational flow is that one individual, the program manager, maintains complete line authority over the entire project. Not only does he assign work, but he also conducts merit reviews. Because each individual reports to only one person, strong communication channels develop that result in a very rapid reaction time.

In pure product organizations, long lead times became a thing of the past. Trade-off studies could be conducted as fast as time would permit without the need to look at the impact on other projects (unless, of course, identical facilities or equipment were required). Functional managers were able to maintain qualified staffs for new product development without sharing personnel with other programs and projects.

The responsibilities attributed to the project manager were entirely new. First of all, his authority was now granted by the vice president and general manager. The program manager handled all conflicts, both those within his organization and those involving other projects. Interface management was conducted at the program manager level. Upper-level management was now able to spend more time on executive decision making than on conflict arbitration. Advantages and disadvantages of Projectized organizations are listed in tables 4.3 and 4.4 respectively.

- It provides complete line authority over the project (i.e., strong control through a single projec authority).
- The project participants work directly for the project manager. Unprofitable product lines are easily identified and can be eliminated.
- There are strong communications channels.
- Staffs can maintain expertise on a given project without sharing key personnel.
- Very rapid reaction time is provided.
- Personnel demonstrate loyalty to the project; better morale with product identification.
- A focal point develops for out-of-company customer relations.
- There is flexibility in determining time (schedule), cost, and performance trade-offs.
- Interface management becomes easier as unit size is decreased.
- Upper-level management maintains more free time for executive decision making.

Table 4.3: Advantages of the Projectized organization

- Cost of maintaining this form in a multiproduct company would be prohibitive due to duplication of effort, facilities, and personnel; inefficient usage.
- There exists a tendency to retain personnel on a project long after they are needed. Upper-level management must balance workloads as projects start up and are phased out.
- Technology suffers because, without strong functional groups, outlook of the future to improve company's capabilities for new programs would be hampered (i.e., no perpetuation of technology).
- Control of functional (i.e., organizational) specialists requires top-level coordination.
- There is a lack of opportunities for technical interchange between projects.
- There is a lack of career continuity and opportunities for project personnel.

Table 4.4: Disadvantages of the Projectized organization

4.8.4 Matrix Organizational Form:

The matrix organizational form is an attempt to combine the advantages of the pure functional structure and the product organizational structure. This form is ideally suited for companies, such as construction, that are "project-driven." Each project manager reports directly to the vice president and general manager. Since each project represents a potential profit center, the power and authority used by the project manager come directly from the general manager. The project manager has total responsibility and accountability for project success.

The functional departments, on the other hand, have functional responsibility to maintain technical excellence on the project. Each functional unit is headed by a department manager whose prime responsibility is to ensure that a unified technical base is maintained and that all available information can be exchanged for each project. Department managers must also keep their people aware of the latest technical accomplishments in the industry.

Project management is a "coordinative" function, whereas matrix management is a collaborative function division of project management. In the coordinative or project organization, work is generally assigned to specific people or units who "do their own thing." In the collaborative or matrix organization, information sharing may be mandatory, and several people may be required for the same piece of work. In a project organization, authority for decision making and direction rests with the project leader, whereas in a matrix it rests with the team.

Certain ground rules exist for matrix development. These are:

- Participants must spend full time on the project; this ensures a degree of loyalty.
- Horizontal as well as vertical channels must exist for making commitments.
- There must be quick and effective methods for conflict resolution.
- There must be good communication channels and free access between managers.
- All managers must have input into the planning process.
- Both horizontally and vertically oriented managers must be willing to negotiate for resources.
- The horizontal line must be permitted to operate as a separate entity except for administrative purposes.

These ground rules simply state some of the ideal conditions that matrix structures should possess. Each ground rule brings with it advantages and disadvantages that are described in tables 4.5 and 4.6 respectively.

• The project manager maintains maximum project control (through the line managers) over all resources, including cost and personnel.

• Policies and procedures can be set up independently for each project, provided that they do not contradict company policies and procedures.

• The project manager has the authority to commit company resources, provided that scheduling does not cause conflicts with other projects.

• Rapid responses are possible to changes, conflict resolution, and project needs (as technology or schedule).

• The functional organizations exist primarily as support for the project.

• Each person has a "home" after project completion. People are susceptible to motivation and end-item identification. Each person can be shown a career path.

• Because key people can be shared, the program cost is minimized. People can work on a variety of problems; that is, better people control is possible.

• A strong technical base can be developed, and much more time can be devoted to complex problem-solving. Knowledge is available for all projects on an equal basis.

• Conflicts are minimal, and those requiring hierarchical referrals are more easily resolved.

• There is a better balance between time, cost, and performance.

• Rapid development of specialists and generalists occurs.

• Authority and responsibility are shared.

• Stress is distributed among the team (and the functional managers).

Table 4.5: Advantages of the Matrix organization

• Multidimensional information flow.

• Multidimensional work flow.

• Dual reporting.

• Continuously changing priorities.

• Management goals different from project goals.

• Potential for continuous conflict and conflict resolution.

• Difficulty in monitoring and control.

• Company-wide, the organizational structure is not cost-effective because more people than necessary are required, primarily administrative.

• Each project organization operates independently. Care must be taken that duplication of efforts does not occur.

• More effort and time are needed initially to define policies and procedures, compared to traditional form.

• Functional managers may be biased according to their own set of priorities.

• Balance of power between functional and project organizations must be watched.

• Balance of time, cost, and performance must be monitored.

• Although rapid response time is possible for individual problem resolution, the reaction time can become quite slow.

• Employees and managers are more susceptible to role ambiguity than in traditional form.

• Conflicts and their resolution may be a continuous process (possibly requiring support of an organizational development specialist).

• People do not feel that they have any control over their own destiny when continuously reporting to multiple managers.

Table 4.6: Disadvantages of the Matrix organization

4.8.4.1 Modification of Matrix Structures:

The matrix structure can take many forms, but there are basically three common varieties. Each type represents a different degree of authority attributed to the program manager and indirectly identifies the relative size of the company. This type of arrangement works best for small companies that have a minimum number of projects and assume that the general manager has sufficient time to coordinate activities between his project managers. In this type of arrangement, all conflicts between projects are hierarchically referred to the general manager for resolution.

As companies grew in size and the number of projects, the general manager found it increasingly difficult to act as the focal point for all projects. A new position was created, that of director of programs, or manager of programs or projects. The director of programs was responsible for all program management. This freed the general manager from the daily routine of having to monitor all programs himself.

The desired span of control, of course, will vary from company to company and must take the following into account:

- The demands imposed on the organization by task complexity
- Available technology
- The external environment
- The needs of the organizational membership
- The types of customers and/or products

These variables influence the internal functioning of the company. Executives must realize that there is no one best way to organize under all conditions. This includes the span of control.

4.9 Selecting the Organizational Form:

Project management has matured as an outgrowth of the need to develop and produce complex and/or large projects in the shortest possible time, within anticipated cost, with required reliability and performance, and (when applicable) to realize a profit. Granted that modern organizations have become so complex that traditional organizational structures and relationships no longer allow for effective management, how can executives determine which organizational form is best, especially since some projects last for only a few weeks or months while others may take years?

To answer such a question, we must first determine whether the necessary characteristics exist to warrant a project management organizational form. Generally speaking, the project management approach can be effectively applied to a one-time undertaking that is:

- Definable in terms of a specific goal
- Infrequent, unique, or unfamiliar to the present organization
- Complex with respect to interdependence of detailed tasks
- Critical to the company

Once a group of tasks is selected and considered to be a project, the next step is to define the kinds of projects. These include individual, staff, special, and matrix or aggregate projects.

Unfortunately, many companies do not have a clear definition of what a project is. As a result, large project teams are often constructed for small projects when they could be handled more quickly and effectively by some other structural form.

Organization Structure / Project Characteristics	Functional	Matrix			Projectized
		Weak Matrix	Balanced Matrix	Strong Matrix	
Project Manager's Authority	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Resource Availability	Little or None	Limited	Low to Moderate	Moderate to High	High to Almost Total
Who controls the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time

Figure 4.13: Project Organizational Structure Influences on Projects

All structural forms have their advantages and disadvantages, but the project management approach appears to be the best possible alternative.

The basic factors that influence the selection of a project organizational form are:
- Project size
- Project length
- Experience with project management organization
- Philosophy and visibility of upper-level management
- Project location
- Available resources
- Unique aspects of the project

This last item requires further comment. Project management (especially with a matrix) usually works best for the control of human resources and thus, may be more applicable to labor-intensive projects rather than capital-intensive projects. Labor-intensive organizations have formal project management, whereas capital-intensive organizations may use informal project management.

Four fundamental parameters must be analyzed when considering implementation of a project organizational form:
- Integrating devices
- Authority structure
- Influence distribution
- Information system

PROJECT LIFE CYCLES

Broad Contents

Life cycle phases of a Product
Life cycle phases of a System
System Costs
Cost Benefit Analysis
Characteristics of Project Life Cycle
Project Management Office
Project Management Officer (PMO)
Difference between Project Manager and Project Management Officer
Some Examples of Project Life Cycle

5.1 Life Cycle Phases of a Product:

Every program, project, or product has certain phases of development. A clear understanding of these phases permits managers and executives to better control total corporate resources in the achievement of desired goals. The phases of development are known as life-cycle phases. However, the breakdown and terminology of these phases differ, depending on whether we are discussing products or projects.

During the past few years, there has been at least partial agreement about the life cycle phases of a product. They include:

- Research and development
- Market introduction
- Growth
- Maturity
- Deterioration
- Death

Today, there is no agreement among industries, or even companies within the same industry, about the life cycle phases of a project. This is understandable because of the complex nature and diversity of projects.

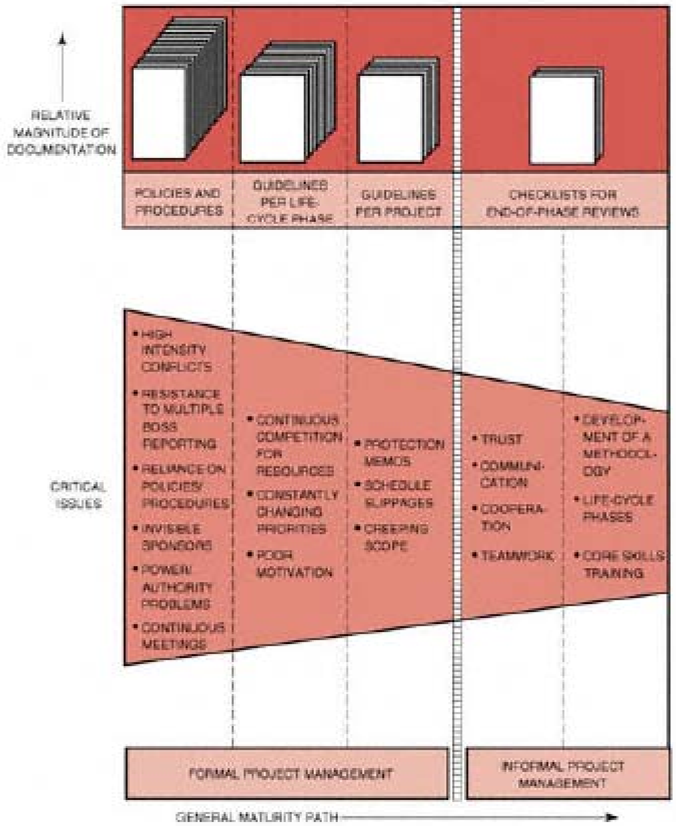


Figure 5.1: Maturity Path

5.2 Life Cycle Phases of a System:

The theoretical definitions of the life cycle phases of a system can be applied to a project. These phases include:

- Conceptual
- Planning
- Testing
- Implementation
- Closure

5.2.1 Conceptual Phase:

The first phase, the conceptual phase, includes the preliminary evaluation of an idea. Most important in this phase is a preliminary analysis of risk and the resulting impact on the time, cost, and performance requirements, together with the potential impact on company resources. The conceptual phase also includes a "first cut" at the feasibility of the effort.

5.2.2 Planning Phase:

The second phase is the planning phase. It is mainly a refinement of the elements described under the conceptual phase. The planning phase requires a firm identification of the resources to be required together with the establishment of realistic time, cost, and performance parameters. This phase also includes the initial preparation of all documentation necessary to support the system. For a project based on competitive bidding, the conceptual phase would include the decision of whether to bid, and the planning phase would include the development of the total bid package (i.e., time, schedule, cost, and performance).

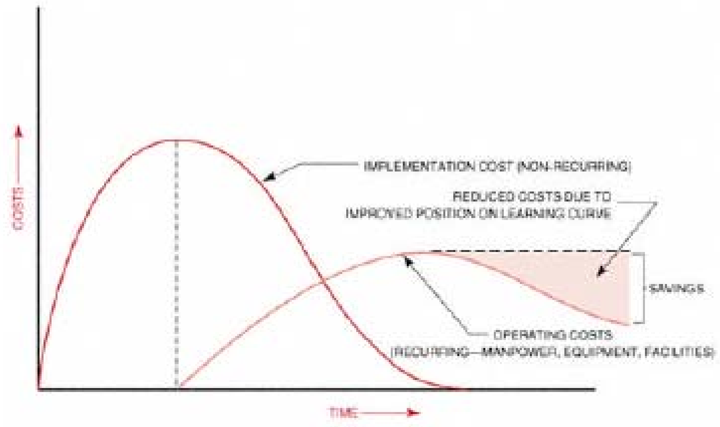


Figure 5.2: System Costs

5.2.2.1 System Costs:

Because of the amount of estimating involved, analyzing system costs during the conceptual and planning phases is not an easy task. As shown in Figure 5.2, most project or system costs can be broken down into operating (recurring) and implementation (nonrecurring) categories. The implementation costs include one-time expenses such as construction of a new facility, purchasing computer hardware, or detailed planning. Operating costs, on the other hand, include recurring expenses such as manpower. The operating costs may be reduced as shown in Figure 5.2, if personnel perform at a higher position on the learning curve. The identification of a learning curve position is vitally important during the planning phase when firm cost positions must be established.

Of course, it is not always possible to know what individuals will be available or how soon they can perform at a higher learning curve position.

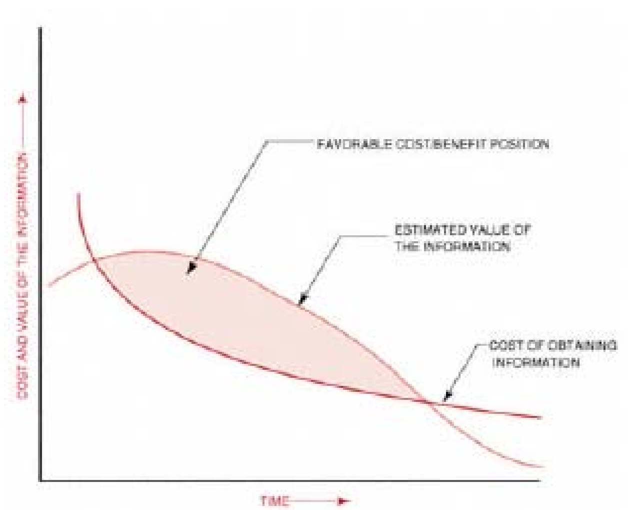


Figure 5.3: Cost Benefit Analysis

5.2.2.2 Cost Benefit Analysis:

Once the approximate total cost of the project is determined, a cost-benefit analysis should be conducted (see Figure 5.3) to determine if the estimated value of the information obtained from the system exceeds the cost of obtaining the information. This analysis is often included as part of a feasibility study.

There are several situations, such as in competitive bidding, where the feasibility study is actually the conceptual and definition phases. Because of the costs that can be incurred during these two phases, top-management approval is almost always necessary before the initiation of such a feasibility study.

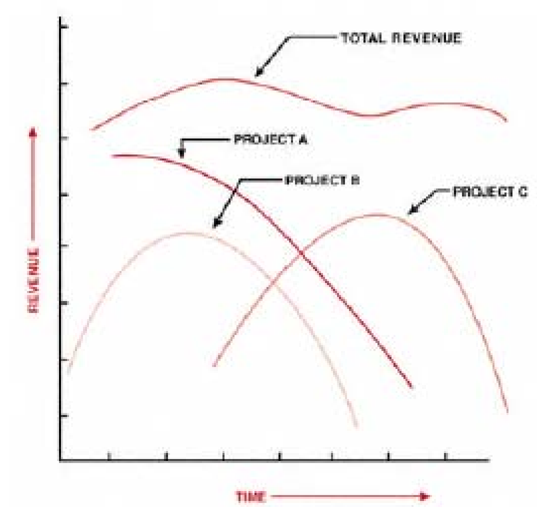


Figure 5.4: A Stream of Projects

5.2.3 Testing Phase:

The third phase— testing— is predominantly a testing and final standardization effort so that operations can begin. Almost all documentation must be completed in this phase.

5.2.4 Implementation Phase:

The fourth phase is the implementation phase, which integrates the project's product or services into the existing organization. If the project was developed for establishment of a marketable product, then this phase could include the product life cycle phases of market introduction, growth, maturity, and a portion of deterioration.

5.2.5 Closure Phase:

The final phase is closure and includes the reallocation of resources. The question to be answered is, "Where the resources should be reassigned?" Consider a company that sells products on the open consumer market. As one product begins, the deterioration and death phases of its life cycle (i.e., the divestment phase of a system), then new products or projects must be established. Such a company would, therefore, require a continuous stream of projects as a necessity for survival, as shown in Figure 5.4. As projects A and B begin their decline, new efforts (project C) must be developed for resource reallocation. In the ideal situation these new projects will be established at such a rate that total revenue will increase and company growth will be clearly visible.

The closure phase evaluates the efforts on the total system and serves as input to the conceptual phases for new projects and systems. This final phase also has an impact on other ongoing projects with regard to priority identification.

Thus, so far no attempt has been made to identify the size of a project or system. Large projects generally require full-time staffs, whereas small projects, although they undergo the same system life cycle phases, may require only part-time people. This implies that an individual can be responsible for multiple projects, possibly with each project existing in a different life cycle phase.

The following questions must be considered in multi-project management:

1. Are the project objectives the same?
   - For the good of the project
   - For the good of the company

2. Is there a distinction between large and small projects?

3. How do we handle conflicting priorities?
   - Critical versus critical projects
   - Critical versus non-critical projects
   - Non-critical versus non-critical projects

5.2.6 Explanation of Various Life Cycle Phases:

Later topics discuss methods of resolving conflicts and establishing priorities.

The phases of a project and those of a product are compared in Figure 5.5. Notice that the life cycle phases of a product generally do not overlap, whereas the phases of a project can and often do overlap.

Table 5.1 identifies the various life cycle phases that are commonly used. Even in mature project management industries such as construction, one could survey ten different construction companies and find ten different definitions for the life cycle phases.

Engineering	Manufacturing	Computer Programming	Construction
• Start-up	• Formation	• Conceptual	• Planning, data gathering and procedures
• Definition	• Buildup	• Planning	• Studies and basic engineering
• Main	• Production	• Definition and design	• Major review
• Termination	• Phase-out	• Implementation	• Detail engineering
	• Final audit	• Conversion	• Detail engineering/ construction overlap
			• Construction
			• Testing and commissioning

Table 5.1: Life Cycle Phase Definitions

The life cycle phases for computer programming, as listed in Table above, are also shown in Figure 5.5 which illustrates how manpower resources can build up and decline during a project. In Figure 5.5, PMO stands for the present method of operations, and PMO' will be the "new" present method of operations after conversion. This life cycle would probably be representative of a twelve-month activity.

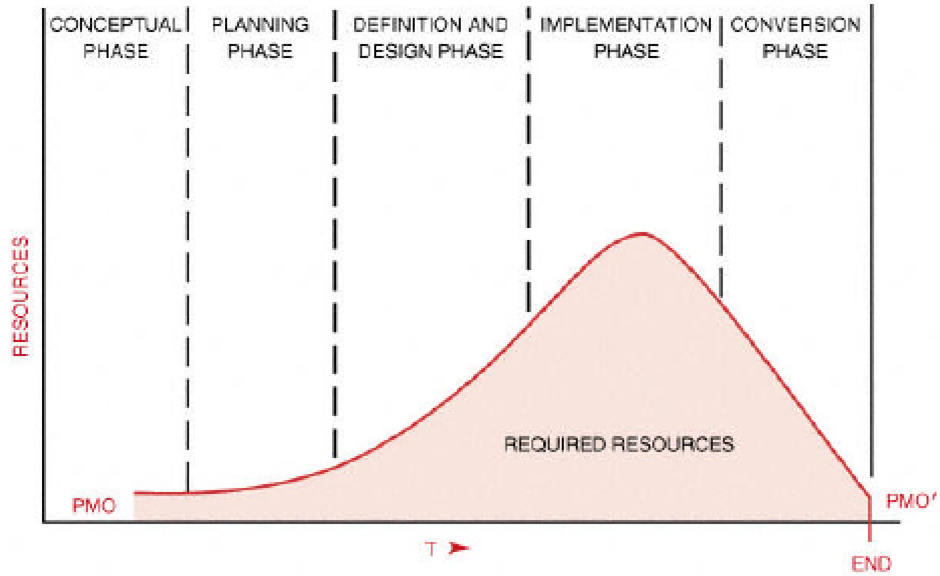


Figure 5.5: Definition of a Project Life Cycle

Most executives prefer short data processing life cycles because computer technology changes at a very rapid rate. An executive of a major utility commented that his company was having trouble determining how to terminate a computer programming project to improve customer service because by the time a package is ready for full implementation, an updated version appears on the scene. Should the original project be canceled and a new project begun? The solution appears to lie in establishing short data processing project life cycle phases, perhaps through segmented implementation. In any case, we can conclude that top management is responsible for the periodic review of major projects. This should be accomplished, at a minimum, at the completion of each life cycle phase.

More and more companies are preparing procedural manuals for project management and for structuring work using life cycle phases. There are several reasons for this trend. These are as follows:

- Clear description of the work to be accomplished in each phase may be possible.
- Pricing and estimating may be easier if well-structured work definitions exist.
- There exists key decision points at the end of each life cycle phase so that incremental funding is possible.

Reader should be aware that not all projects can be simply transposed into lifecycle phases (e.g., Research and Development). In such a case it might be possible (even in the same company) for different definitions of life-cycle phases to exist because of schedule length, complexity, or just the difficulty of managing the phases.

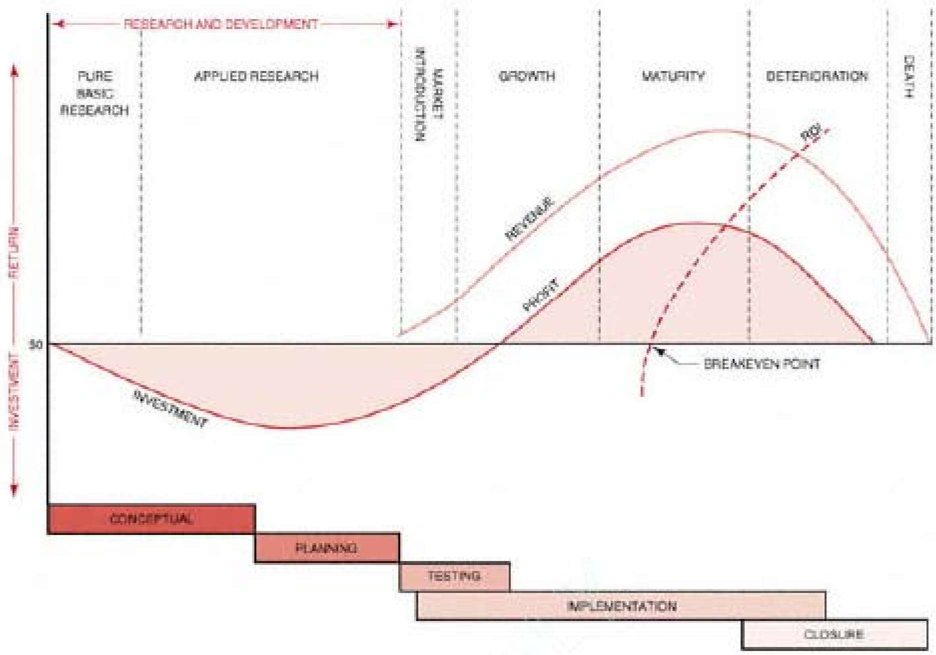


Figure 5.6: System/Product Life Cycles

5.3 Characteristics of Project Life Cycle:

- Project life cycle defines phases that connect beginning and end of the project. After each phase deliverables are reviewed for the completeness in time, accuracy according to defined objectives and their final approval (approval for acceptance) before moving to the next phase.

- As shown in the diagrams in the beginning, phases can be overlapped to save time and to have fast tracking on the life cycle. This technique is used to compress the whole schedule (if required resources are available or manageable)

- There is no way to define Project Life Cycle ideally. Because of this every project management team can define its own way to work on the project. They can use best common practices and can learn new ways of dealing projects by their experiences in detail or in general. Only three phases are always certain to be performed; conceptualization, intermediate phase(s), and closure.

- Generally phases are defined in sequential order by technical information officer.
- Cost and staffing level is defined for every single phase.

- Project may have sub-project(s) and sub-projects may have their own project life cycle.

- In the beginning of the project, level of uncertainty and risk is always high.

- The typical project life cycle – initiating, implementing and closing – has critical decision points where the project may continue, be changed, or be abandoned.

- There are many points within the project life cycle where *Community of Professionals (COPs)* may provide support and guidance. For example, initiating the project involves such activities as identifying the project team members, defining the scope and business objectives of the project and identifying key stakeholders.

- During project close, reassignment and intelligent preservation of resources, knowledge projects (i.e. deliverables), and sharing lessons learned are facilitated.

5.4 Project Management Office:

The Project Management Office sets project standards and oversees the organization's portfolio of projects. This allows the organization to evaluate the use of resources across all projects and resolve conflicts that affect project timelines. The Project Management Office is also a very good place to examine how communities are linked across projects. Using the communities as the linkage point for knowledge transfer is far more efficient for the following several reasons:

- In communities, the evaluation of knowledge is generally done by a broader range of people, ensuring that the ideas are more completely vetted.

- Communities generally exist outside the project framework and trust is already established.

- They can be used as opposed to setting up more formal structures and methods to get the required information transferred to the project.

- In communities, knowledge is transferred from expert to recipient. This includes tacit knowledge transfer as well as explicit knowledge transfer. This is a much more efficient transfer mechanism than is normally used. Generally, documents would be transferred from project to project with minimal expert knowledge available to add value.

- Community transfer shares the knowledge broadly, strengthening the entire organization for future projects.

- As mentioned earlier, Project Management Office and top management are responsible for the periodic review of major projects. This should be accomplished, at a minimum, at the completion of each life cycle phase.

5.5 Project Management Officer (PMO):

Project Management Officer (PMO) centralizes and coordinates management of project under his domain, and oversees management of project and product (system/program) both. Project Management Officer may not be directly related to the project at spot. He/she focuses on coordination planning, prioritization of all resources and deliverables of projects and sub projects. It is the responsibility of Project Management Officer to keep top management and clients/parents organization connected and informed about all projects running or product life cycle. He/she is involved in selection, management and re-deployment of shared projects as much as authorized.
Project Management Officer is generally responsible for:

- Providing monitoring platform for Project Manager.

- Identifying the Project Management Methodology and best practices for specific project.

- Clearing house, i.e. defining and refining project policies, procedures, templates and shared documents.

- Configuration management for all projects under work.

- For developing and keeping repository and risk management for projects.

- Developing Project Management Office for operation and maintaining tools for project management. Normally it includes Enterprise Wide Project Management Software creation and installation.

- Management and coordination and monitoring of communications across the projects, project timelines and budget, quality standards.

- Project Management Officer may be having authority to terminate project anytime when he gets it not feasible anymore.

5.6 Difference Between Project Manager and Project Management Officer:

1. Both have different objectives - driven by different requirements, aligned with strategic needs of organization.

2. Project Manager is responsible for delivering specific project objectives within project constraints, while Project Management Officer is responsible for organizational structure specific mandates having much vast perspective.

3. Project Manager focuses on project objectives, while Project Management Officer focuses on major programs, scope and changes required and authenticated. Project Management Officer considers all potential opportunities to have business goals achieved.

4. Project Manager is constrained with assigned resources for specific project to meet its full objective. On the other hand, Project Management Officer is supposed to optimize the use of shared organizational resources across all projects overall.

5. Project Manager manages scope, schedule, cost, and quality of product, while the Project Management Officer manages overall risk, opportunities, interdependencies and links among different projects.

6. Project Manager reports on project progress/project specific information to the top management, while Project Management Officer provides consolidated reporting/enterprise view of project or all the running projects.

5.7 Some Examples of Project Life Cycle:

There are many variations on the theme of the project phases, influenced by the project's scope of work. The project phase selected in the examples here are arbitrary and serve only to illustrate the technique for different types of projects. The main features to look for are the key issues, key activities, limiting factors, decision and hold points in each phase.

The project life cycle is conveniently represented by a bar chart which clearly indicates the duration of each phase and its overlap (if any) with the other phases.

5.7.1 House Project:

The construction of a house provides a project many of us have personally experienced. Consider here the following simple sub-division into four phases.

The level of effort follows the typical life cycle profile by increasing to a maximum during the building phase before declining during the interior phase.

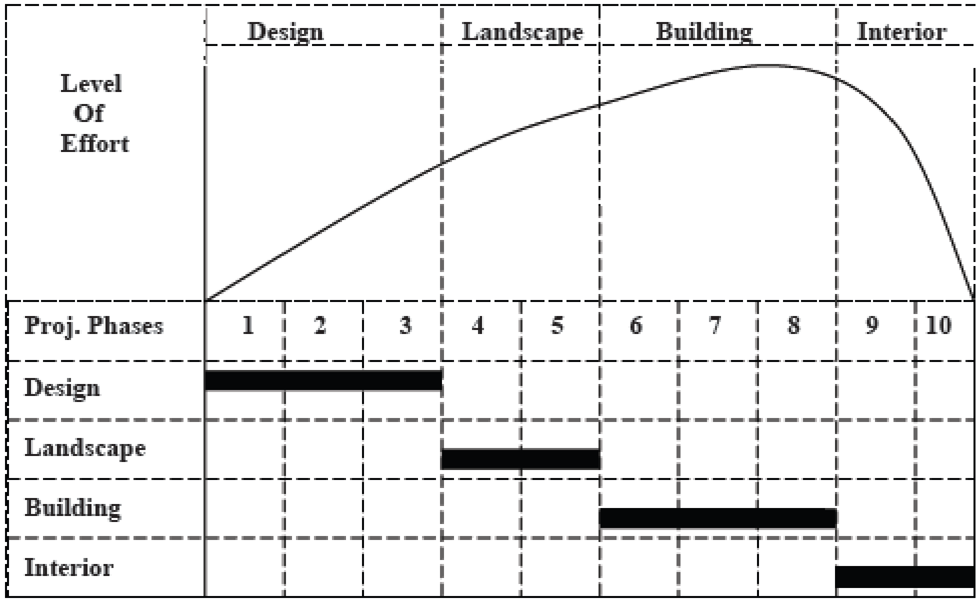


Figure 5.7: Project Life Cycle: House Project

5.7.2 Computer installation:

With the improved cost effectiveness of computer facilities most companies will experience a computer installation project sooner or later.

Note that the training phase overlaps with both system selection and the implementation phase.

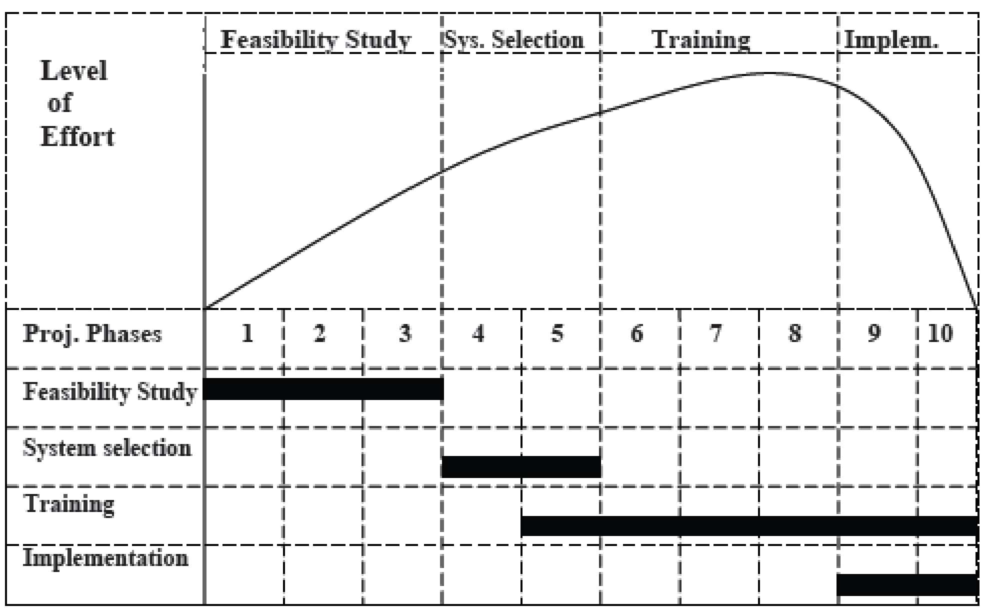


Figure 5.8: Project Life Cycle: Computer Installation

5.7.3 Engineering Project:

An engineering type project is a popular example to illustrate the project phases. Note here that all phases overlap which could indicate a fast tracking.

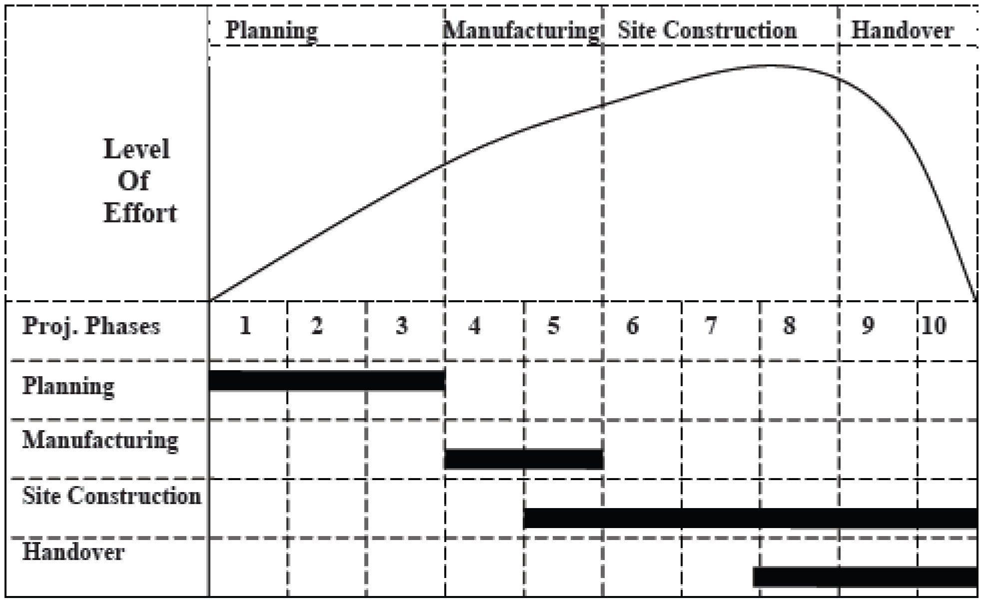


Figure 5.9: Project Life Cycle: Engineering Project

5.7.4 Nuclear Power Station Project:

This project may well span 50 years with the people involved in the initial phases being retired long before the final phases.

The interesting point here is that the environmental constraints have changed significantly over the fifty years between the design phase and the decommissioning phase.

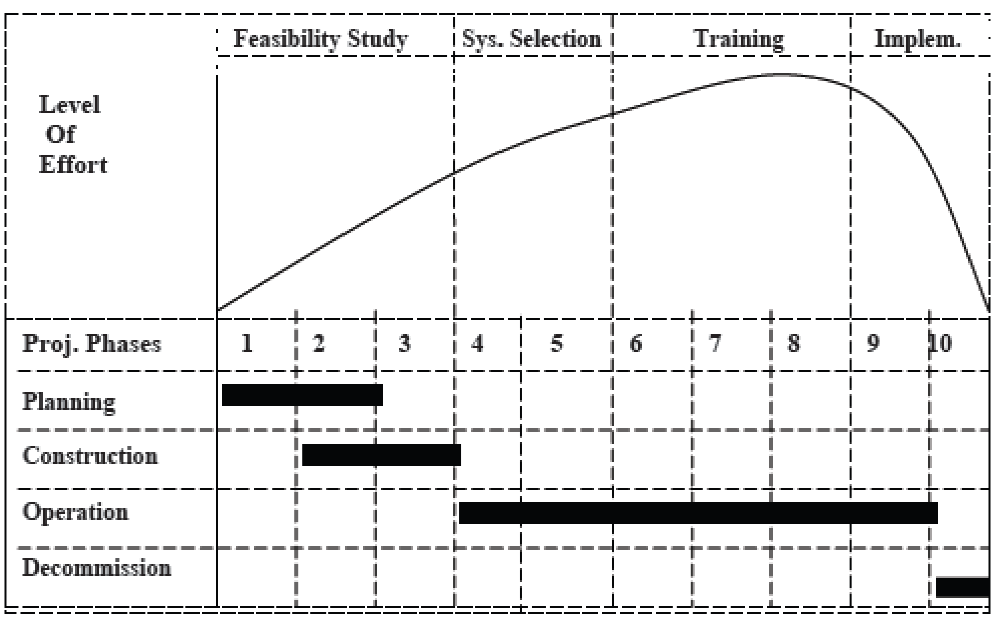


Figure 5.10: Project Life Cycle: Nuclear Power Station Project

THE PROJECT MANAGER

Broad Contents

Skills needed in a Project Manager
Functional Manager versus Project Managers
Selecting the Project Manager
Location, reporting and salary of the Project Manager
Duties and job description of Project Managers
Next generation Project Managers

6.1 Skill Requirements for Project Managers:

Projects are often complex and multifaceted. Managing these projects represents a challenge, requiring skills in team building, leadership, conflict resolution, technical expertise, planning, organization, entrepreneurship, administration, management support, and the allocation of resources.

This section examines these skills relative to Project Management effectiveness. A key factor to good project performance is the Project Manager's ability to integrate personnel from many disciplines into an effective work team. To get results, the Project Manager must relate to:

1. The people to be managed
2. The task to be done
3. The tools available
4. The organizational structure
5. The organizational environment, including the customer community

All work factors are interrelated and operate under the limited control of the Project Manager. With an understanding of the interaction of corporate organization and behavior elements, the manager can build an environment conducive to the working team's needs.

The internal and external forces that impinge on the organization of the project must be reconciled to mutual goals. Thus, the Project Manager must be, both socially and technically aware to understand how the organization functions and how these functions will affect the Project organization of the particular job to be done. In addition, the Project Manager must understand the culture and value system of the organization he is working with. Research and experience show that effective Project Management performance is directly related to the level of proficiency at which these skills are mastered.
Ten specific skills are identified (in no particular order) and discussed in this section:

1. *Team building*
2. *Leadership*
3. *Conflict resolution*
4. *Technical expertise*
5. *Planning*
6. *Organization*
7. *Entrepreneurship*
8. *Administration*
9. *Management support*
10. *Resource allocation*

It is important that the personal management traits underlying these skills operate to form a homogeneous management style. The right mixture of skill levels depends on the project task, the techniques employed, the people assigned, and the organizational structure. To be effective, Project Managers must consider all facets of getting the job done. Their management style must facilitate the integration of multidisciplinary project resources for synergistic operations. The days of the manager who gets by with technical expertise alone or pure administrative skills are gone. The ten specific skills required in a good Project Manager can be discussed as follows:

1. Team Building Skills:

Building the project team is one of the prime responsibilities of the Project Manager. Team building involves a whole spectrum of management skills required to identify, commit, and integrate the various task groups from the traditional functional organization into a single Project Management system.

To be effective, the Project Manager must provide an atmosphere conducive to teamwork. He must nurture a climate with the following characteristics:

- Team members committed to the project
- Good interpersonal relations and team spirit
- The necessary expertise and resources
- Clearly defined goals and project objectives
- Involved and supportive top management
- Good project leadership
- Open communication among team members and support organizations
- A low degree of detrimental interpersonal and inter-group conflict

Three major considerations are involved in all of the above factors aimed towards integration of people from many disciplines into an effective team:

a) Effective communication
b) Sincere interest in the professional growth of team members
c) Commitment to the project

2. Leadership Skills:

An absolutely essential prerequisite for project success is the Project Manager's ability to lead the team within a relatively unstructured environment. It involves dealing effectively with managers and supporting personnel across functional lines with little or no formal authority. It also involves information processing skills, the ability to collect and filter relevant data valid for decision making in a dynamic environment. It involves the ability to integrate individual demands, requirements, and limitations into decisions that benefit overall project performance. It further involves the Project Manager's ability to resolve inter-group conflicts that is an important factor in overall project performance.

Perhaps more than in any other position below the general manager's level, quality leadership depends heavily on the Project Manager's personal experience and credibility within the organization. An effective management style might be characterized this way:

- Clear project leadership and direction
- Assistance in problem solving
- Facilitating the integration of new members into the team
- Ability to handle interpersonal conflict

- Facilitating group decisions
- Capability to plan and elicit commitments
- Ability to communicate clearly
- Presentation of the team to higher management
- Ability to balance technical solutions against economic and human factors

The personal traits desirable and supportive of the above skills are:

- Project management experience
- Flexibility and change orientation
- Innovative thinking
- Initiative and enthusiasm
- Charisma and persuasiveness
- Organization and discipline

3. Conflict Resolution Skills:

Conflict is fundamental to complex task management. It is often determined by the interplay of the Project organization and the larger host organization and its multifunctional components.

Understanding the determinants of conflicts is important to the Project Manager's ability to deal with conflicts effectively. When conflict becomes dysfunctional, it often results in poor project decision making, lengthy delays over issues, and a disruption of the team's efforts, all negative influences to project performance. However, conflict can be beneficial when it produces involvement and new information and enhances the competitive spirit.

A number of suggestions have been derived from various research studies aimed at increasing the Project Manager's ability to resolve conflict and thus, improve overall project performance.

Project managers must:

- Understand interaction of the organizational and behavioral elements in order to build an environment conducive to their team's motivational needs. This will enhance active participation and minimize unproductive conflict.
- Communicate effectively with all organizational levels regarding both project objectives and decisions. Regularly scheduled status review meetings can be an important communication vehicle.
- Recognize the determinants of conflict and their timing in the project life cycle.

Effective project planning, contingency planning, securing of commitments, and involving top management can help to avoid or minimize many conflicts before they impede project performance.

The value of the conflict produced depends on the ability of the Project Manager to promote beneficial conflict while minimizing its potential hazardous consequences. The accomplished manager needs a "sixth sense" to indicate when conflict is desirable, what kind of conflict will be useful, and how much conflict is optimal for a given situation. In the final analysis, he has the sole responsibility for his Project and how conflict will contribute to its success or failure.

4. *Technical Skills:*

The Project Manager rarely has all the technical, administrative, and marketing expertise needed to direct the Project single-handedly. Nor is it necessary or desirable. It is essential, however, for the Project Manager to understand the technology, the markets, and the environment of the business to participate effectively in the search for integrated solutions and technological innovations. More important, without this understanding, the integrated consequences of local decisions on the total Project, the potential growth ramifications, and relationships to other business opportunities cannot be foreseen by the manager. Further technical expertise is necessary to evaluate technical concepts and solutions, to communicate effectively in technical terms with the project team, and to assess risks and make trade-offs between cost, schedule, and technical issues. This is why in complex problem-solving situations so many project managers must have an engineering background.

Taken together, technical expertise is important to the successful management of engineering projects. It is composed of an understanding of the:

- Technology involved
- Engineering tools and techniques employed
- Specific markets, their customers, and requirements
- Product applications
- Technological trends and evolutions
- Relationship among supporting technologies
- People who are part of the technical community

This is normally an excellent testing ground for the future Project Manager. It also allows top management to judge the new candidate's capacity for managing the technological innovations and integration of solutions needed for success.

5. *Planning Skills:*

Planning skills are helpful for any undertaking; they are absolutely essential, however, for the successful management of large complex projects. The project plan is the road map that defines how to get from the start to the final results.

Project planning is an ongoing activity at all organizational levels. However, the preparation of a project summary plan, prior to project start, is the responsibility of the Project Manager. Effective project planning requires particular skills far beyond writing a document with schedules and budgets. It requires communication and information processing skills to define the actual resource requirements and administrative support necessary. It requires the ability to negotiate the necessary resources and commitments from key personnel in various support organizations with little or no formal authority, including the definition of measurable milestones.

Effective planning requires skills in the areas of:

- Information processing
- Communication
- Resource negotiations
- Securing commitments
- Incremental and modular planning
- Assuring measurable milestones
- Facilitating top management involvement

In addition, the Project Manager must assure that the plan remains a viable document. Changes in project scope and depth are inevitable. The plan should reflect necessary changes through formal revisions and should be the guiding document throughout the life cycle of the Project. Nothing is more useless than an obsolete or irrelevant plan.

Finally, Project Managers need to be aware that planning can be overdone. If not controlled, planning can become an end in itself and a poor substitute for innovative work. Individuals retreat to the utopia of no responsibility where innovative actions cannot be taken "because it is not in the plan." It is the responsibility of the Project Manager to build flexibility into the plan and regulate it against such misuse.

6. ***Organizational Skills:***

The Project Manager must be a social architect, that is, he must understand how the organization works and how to work with the organization. Organizational skills are particularly important during project formation and startup when the Project Manager establishes the project organization by integrating people from many different disciplines into an effective work team. It requires far more than simply constructing a project organization chart. At a minimum, it requires defining the reporting relationships, responsibilities, lines of control, and information needs. Supporting skills in the area of planning, communication, and conflict resolution are particularly helpful. A good project plan and a task matrix are useful organizational tools. In addition, the organizational effort is facilitated by clearly defined project objectives, open communication channels, good project leadership, and senior management support.

7. ***Entrepreneurial Skills:***

The Project Manager also needs a general management perspective. For example, economic considerations are one important area that normally affects the organization's financial performance. However, objectives often are much broader than profits. Customer satisfaction, future growth, cultivation of related market activities, and minimum organizational disruptions of other projects might be equally important goals. The effective Project Manager is concerned with all these issues. Entrepreneurial skills are developed through actual experience. However, formal training (MBA type), special seminars, and cross-functional training projects can help to develop the entrepreneurial skills needed by Project Managers.

8. ***Administrative Skills:***

Administrative skills are essential. The Project Manager must be experienced in planning, staffing, budgeting, scheduling, and other control techniques. In dealing with technical personnel, the problem is seldom to make people understand administrative techniques such as budgeting and scheduling, but to impress on them that costs and schedules are just as important as elegant technical solutions.

Particularly on larger projects, managers rarely have all the administrative skills required. While it is important that Project Managers understand the company's operating procedures and available tools, it is often necessary for the program manager to free him/her from administrative details regardless of his/her ability to handle them. He/she has to delegate considerable administrative tasks to support groups or hire a project administrator.

Some helpful tools for the manager in the administration of his project include:

- The meeting
- The report
- The review
- The budget and schedule controls

Project Managers must be thoroughly familiar with these available tools and know how to use them effectively.

9. *Management Support Building Skills:*

The Project Manager is surrounded by a myriad of organizations that either support them or control their activities. An understanding of these interfaces is important to Project Managers as it enhances their ability to build favorable relationships with senior management. Management support is often an absolute necessity for dealing effectively with interface groups. Project organizations are shared power systems with personnel of many diverse interests and "ways of doing things." These power systems have a tendency toward imbalance. Only a strong leader backed by senior management can prevent the development of unfavorable biases.

Four key variables influence the project manager's ability to create favorable relationships with senior management. These are:

1. Their ongoing credibility
2. The visibility of their project
3. The priority of the project relative to other organizational undertakings
4. Their own accessibility

All these factors are interrelated and can be developed by the individual manager. Furthermore, senior management can aid such development significantly.

10. *Resource Allocation Skills:*

A project organization has many bosses. Functional lines often shield support organizations from direct financial control by the project office. Once a task has been authorized, it is often impossible to control the personnel assignments, priorities, and indirect manpower costs. In addition, profit accountability is difficult owing to the interdependencies of various support departments and the often changing work scope and contents.

Effective and detailed project planning may facilitate commitment and reinforce control. Part of the plan is the "Statement of Work," which establishes a basis for resource allocation. It is also important to work out specific agreements with all key contributors and their superiors on the tasks to be performed and the associated budgets and schedules. Measurable milestones are not only important for hardware components, but also for the "invisible" project components such as systems and software tasks. Ideally, these commitments on specifications, schedules, and budgets should be established through involvement by key personnel in the early phases of project formation, such as the proposal phase. This is the time when requirements are still flexible, and trade-offs among performance, schedule, and budget parameters are possible.

6.2 Functional Manager versus Project Manager:

Assuming that the Project and Functional Managers is not the same person, we can identify a specific role for the Functional Manager. There are the following elements to this role:

- The Functional Manager has the responsibility to define *how* the task will be done and *where* the task will be done (i.e., the technical criteria).
- The Functional Manager has the responsibility to provide sufficient resources to accomplish the objective within the project's constraints (i.e., *who* will get the job done).
- The Functional Manager has the responsibility for the deliverable.

The major responsibility of the Project Manager is planning. If project planning is performed correctly, then it is conceivable that the Project Manager will work himself out of a job because the project can run itself. As the architect of the project plan, the Project Manager must provide:

- Complete task definitions
- Resource requirement definitions (possibly skill levels)
- Major timetable milestones
- Definition of end item quality and reliability requirements
- The basis for performance measurement

These factors, if properly established, result in:

- Assurance that functional units will understand their total responsibilities toward achieving project needs.
- Assurance that problems resulting from scheduling and allocation of critical resources are known beforehand.
- Early identification of problems that may jeopardize successful project completion so that effective corrective action and re-planning can be done to prevent or resolve the problems.

Project Manager are responsible for project administration and, therefore, must have the right to establish their own policies, procedures, rules, guidelines, and directives – provided these policies, guidelines etc. conform to overall company policy. Companies with mature project management structures usually have rather loose company guidelines, so project managers have some degree of flexibility in how to control their projects.

6.3 Selecting the Project Manager:

Probably the most difficult decision facing upper level management is the selection of Project Manager. Some Managers work best on long-duration projects where decision making can be slow; others may thrive on short-duration projects that can result in a constant pressure environment.

The new individual is apt to make the same mistakes the veteran made. However, executives cannot always go with the seasoned veterans without creating frustrating career path opportunities for the younger personnel. Project Manager selection is a general management responsibility:

- A Project Manager is given license to cut across several organizational lines. His activities, therefore, take on a flavor of general management, and must be done well.
- Project management will not succeed without good Project Managers. Thus, if general management sees fit to establish a project, it should certainly see fit to select a good man as its leader.
- A Project Manager is far more likely to accomplish desired goals if it is obvious that general management has selected and appointed him.

The selection process for Project Manager is not an easy one. Five basic questions must be considered:

1. What are the internal and external sources?
2. How do we select?
3. How do we provide career development in project management?
4. How can we develop project management skills?
5. How do we evaluate project management performance?

Project management cannot succeed unless a good Project Manager is at the controls. The selection process is an upper level management responsibility because the Project Manager is delegated the authority of the general manager to cut across organizational lines in order to accomplish the desired objectives successfully. It is far more likely that Project Manager will succeed if it is obvious to the subordinates that the general manager has appointed them. Usually, a brief memo to the line managers will suffice.

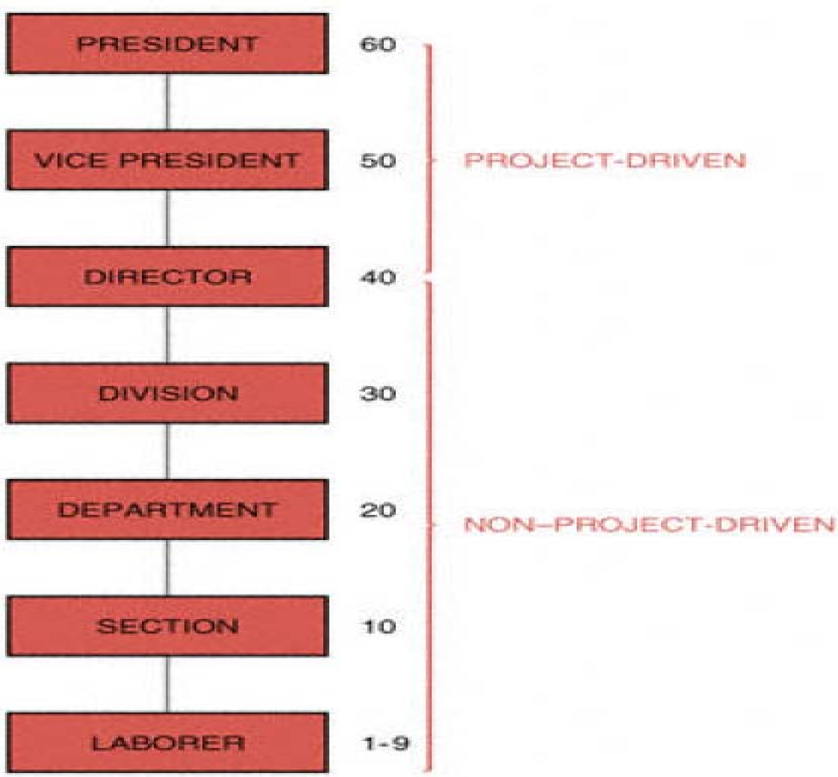


Figure 6.1: Organizational hierarchy

6.5 Duties and Job Descriptions:

Since projects, environments, and organizations differ from company to company as well as project to project, it is not unusual for companies to struggle to provide reasonable job descriptions of the Project Manager and associated personnel. Below is a simple list identifying the duties of a project manager in the construction industry.

6.5.1 Planning:

- Become completely familiar with all contract documents.
- Develop the basic plan for executing and controlling the project.
- Direct the preparation of project procedures.
- Direct the preparation of the project budget.

- Direct the preparation of the project schedule.
- Direct the preparation of basic project design criteria and general specifications.
- Direct the preparation of the plan for organizing, executing, and controlling field construction activities.
- Review plans and procedures periodically and institute changes if necessary.

6.5.2 Organizing:

- Develop organization chart for project.
- Review project position descriptions, outlining duties, responsibilities, and restrictions for key project supervisors.
- Participate in the selection of key project supervisors.
- Develop project manpower requirements.
- Continually review project organization and recommend changes in organizational structure and personnel, if necessary.

6.5.3 Directing:

- Direct all work on the project that is required to meet contract obligations.
- Develop and maintain a system for decision making within the project team whereby decisions are made at the proper level.
- Promote the growth of key project supervisors.
- Establish objectives for Project Manager and performance goals for key Project Supervisors.
- Foster and develop a spirit of project team effort.
- Assist in resolution of differences or problems between departments or groups on assigned projects.
- Anticipate and avoid or minimize potential problems by maintaining current knowledge of overall project status.

6.5.4 Controlling:

- Monitor project activities for compliance with company purpose and philosophy and general corporate policies.
- Interpret, communicate, and require compliance with the contract, the approved plan, project procedures, and directives of the client.
- Maintain personal control of adherence to contract warranty and guarantee provisions.
- Closely monitor project activities for conformity to contract scope provisions. Establish change notice procedure to evaluate and communicate scope changes.
- Maintain effective communications with the client and all groups performing project work.

6.6 Next Generation Project Managers:

The skills needed to be an effective, twenty-first century Project Manager have changed from those needed during the 1980s. Historically, only engineers were given the opportunity to become Project Managers. The belief was that the Project Manager had to have a command of technology in order to make all of the technical decisions. As project management began to grow and as projects became larger and more complex, it became obvious that Project Managers might need simply an understanding rather than a command of technology. This trend will become even more pronounced in the twenty-first century.

The primary skills needed to be an effective project manager in the this century will be:

- Knowledge of the business
- Risk management
- Integration skills

The critical skill is risk management. However, to perform risk management effectively, a sound knowledge of the business is required. Figure 6.2 below shows the changes in project management skills needed between 1985 and 2000. Training in these business skills is on the increase.

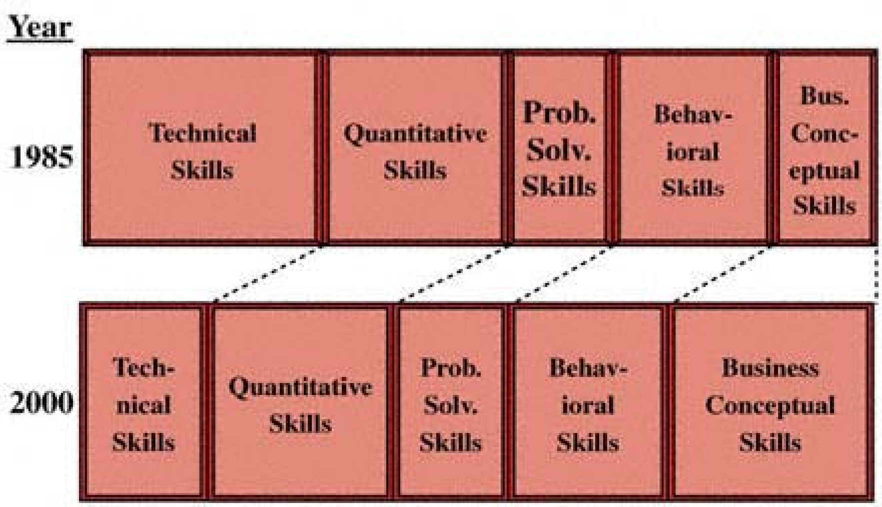


Figure 6.2: Project Management Skills

6.7 Table: Methods and Techniques for Developing Project Managers:

I. Experiential training/on-the-job

Working with experienced professional leader
Working with project team member
Assigning a variety of project management responsibilities, consecutively
Job rotation
Formal on-the-job training
Supporting multifunctional activities
Customer liaison activities

II. Conceptual training/schooling

Courses, seminars, workshops
Simulations, games, cases
Group exercises
Hands-on exercises in using project management techniques
Professional meetings
Conventions, symposia
Readings, books, trade journals, professional magazines

III. Organizational development

Formally established and recognized project management function
Proper project organization
Project support systems
Project charter
Project management directives, policies, and procedures.

THE PROJECT MANAGER (CONTD.)

Broad Contents

Successful Project Manager
Role of Project Manager
Project Champions
Project Manager's Power/ Authority
Functional and Project Organizations

7.1 Successful Project Manager:

A good project management methodology provides a framework with repeatable processes, guidelines, and techniques to greatly increase the odds of success, and therefore, provides value to the project and the Project Manager. However, it should be understood up front that project management is not totally a science, and there is never a guarantee of success. Just the fact that a Project Manager is using a methodology increases the odds of project success. Successful project management is strongly dependent on:

- A good daily working relationship between the Project Manager and those line managers who directly assign resources to projects.
- The ability of functional employees to report vertically to their line manager at the same time that they report horizontally to one or more Project Managers.

These two items become critical. In the first item, functional employees who are assigned to a Project Manager still take technical direction from their line managers. Second, employees who report to multiple managers will always favor the managers who control their purse strings. Thus, most Project Managers appear always to be at the mercy of the line managers.

Classical management has often been defined as a process in which the manager does not necessarily perform things for himself, but accomplishes objectives through others in a group situation. This basic definition also applies to the Project Manager. In addition, a Project Manager must help himself. There is nobody else to help him.

If we take a close look at project management, we will see that the Project Manager actually works for the line managers, not vice versa. Many executives do not realize this. They have a tendency to put a halo around the head of the Project Manager and give him a bonus at project termination, when, in fact, the credit should really go to the line managers, who are continually pressured to make better use of their resources. The Project Manager is simply the agent through whom this is accomplished. So why do some companies glorify the project management position?

7.2 Role of the Project Manager:

A Project Manager is the person who has the overall responsibility for the successful planning and execution of a project. This title is used in the construction industry, architecture, information technology and many different occupations that are based on production of a product or service.

The Project Manager must possess a combination of skills including an ability to ask penetrating questions, detect unstated assumptions and resolve interpersonal conflicts as well as more systematic management skills.

Key amongst his/her duties is the recognition that risk directly impacts the likelihood of success and that this risk must be both formally and informally measured throughout the lifetime of the project.

Risk arises primarily from uncertainty and the successful Project Manager is the one who focuses upon this as the main concern. Most of the issues that impact a project arise in one way or another from risk. A good Project Manager can reduce risk significantly, often by adhering to a policy of open communication, ensuring that every significant participant has an opportunity to express opinions and concerns.

It follows from the above that a Project Manager is one who is responsible for making decisions both large and small, in such a way that risk is controlled and uncertainty minimized. Every decision taken by the Project Manager should be taken in such a way that it directly benefits the project.

Project Managers use project management software, such as Microsoft Project, to organize their tasks and workforce. These software packages allow Project Managers to produce reports and charts in a few minutes, compared to the several hours it can take if they do not use a software package.

7.3 Roles and Responsibilities of Project Manager:

The role of the Project Manager encompasses many activities including:

- Planning and defining scope
- Activity planning and sequencing
- Resource planning
- Developing schedules
- Time estimating
- Cost estimating
- Developing a budget
- Controlling quality
- Managing risks and issues
- Creating charts and schedules
- Risk analysis
- Benefits realization
- Scalability, interoperability and portability analysis
- Documentation
- Team leadership
- Strategic influencing
- Customer liaison

To illustrate the role of the Project Manager, consider the time, cost, and performance constraints shown in the Figure 7.1 below. Many functional managers, if left alone, would recognize only the performance constraint: "Just give me another $50,000 and two more months, and I will give you the ideal technology."

The Project Manager, as part of these communicating, coordinating, and integrating responsibilities, reminds the line managers that there are also time and cost constraints on the project. This is the starting point for better resource control.

Figure 7.1: Overview of Project Management

Success in project management is like a three-legged stool. The first leg is the Project Manager, the second leg is the line manager, and the third leg is senior management. If any of the three legs fail, then even delicate balancing may not prevent the stool from toppling down.
The critical node in project management is the Project Manager–Line Manager interface. At this interface, the project and line managers must view each other as equals and be willing to share authority, responsibility, and accountability. In excellently managed companies, Project Managers do not negotiate for resources but simply ask for the line manager's commitment to executing his portion of the work within time, cost, and performance. Therefore, in excellent companies, it should not matter who the line manager assigns as long as the line manager lives up to his commitments.

Since the project and line managers are "equals," senior management involvement is necessary to provide advice and guidance to the Project Manager, as well as to provide encouragement to the line managers to keep their promises. When executives act in this capacity, they assume the role of project sponsors, as shown in Figure 7.2 below, which also shows that sponsorship need not always be at the executive levels. The exact person appointed as the project sponsor is based on the dollar value of the project, the priority of the project, and who the customer is.

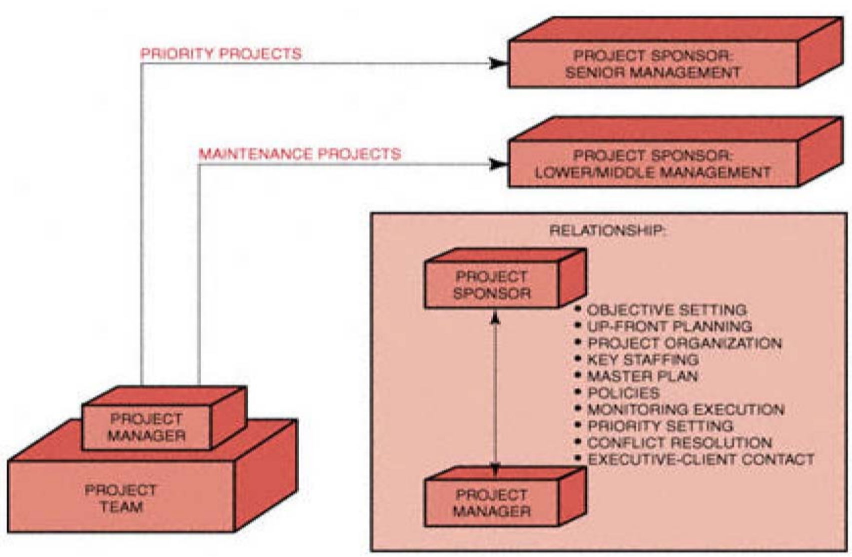


Figure 7.2: The project sponsor interface

The ultimate objective of the project sponsor is to provide behind-the-scenes assistance to project personnel for projects both "internal" to the company, as well as "external," as shown in Figure 7.2 above.

Projects can still be successful without this commitment and support, as long as all work flows smoothly. But in time of crisis, having a "big brother" available as a possible sounding board will surely help.

When an executive is required to act as a project sponsor, then the executive has the responsibility to make effective and timely project decisions. To accomplish this, the executive needs timely, accurate, and complete data for such decisions. The Project Manager must be made to realize that keeping management informed serves this purpose, and that the all-too-common practice of "stonewalling" will prevent an executive from making effective decisions related to the project.

The line manager has to cope with:

- Unlimited work requests (especially during competitive bidding)
- Predetermined deadlines
- All requests having a high priority
- Limited number of resources
- Limited availability of resources
- Unscheduled changes in the project plan
- Unpredicted lack of progress
- Unplanned absence of resources
- Unplanned breakdown of resources
- Unplanned loss of resources
- Unplanned turnover of personnel

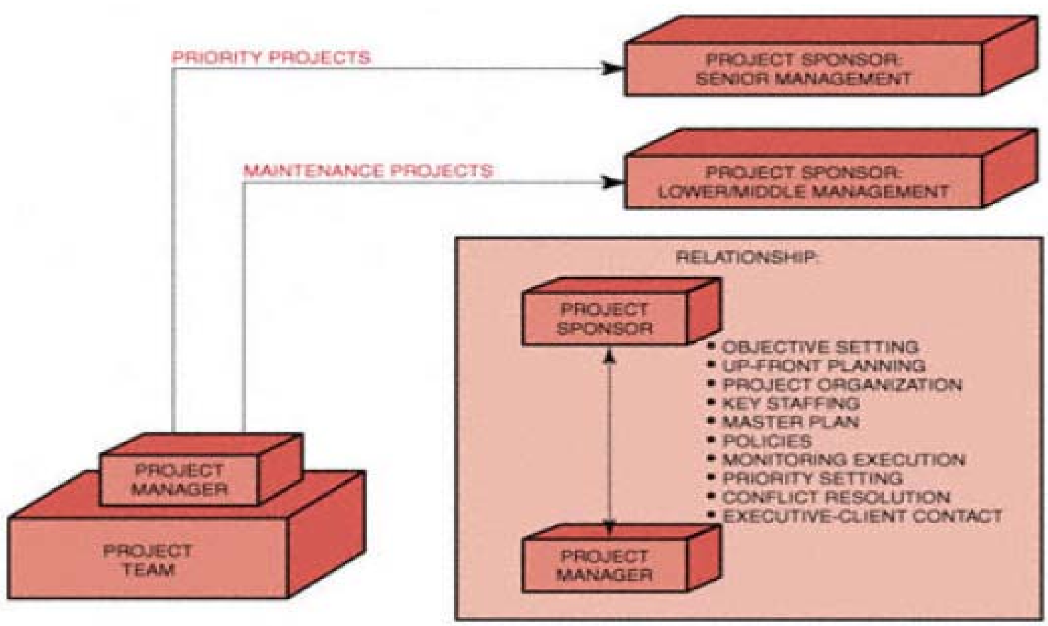


Figure 7.3: Negotiating activities of System Management

The difficulty in staffing, especially for Project Managers or Assistant Project Managers, is in determining what questions to ask during an interview to see if an individual has the necessary or desired characteristics. There are numerous situations in which individuals are qualified to be promoted vertically but not horizontally. An individual with poor communication skills and interpersonal skills can be promoted to a line management slot because of his technical expertise, but this same individual is not qualified for project management promotion.

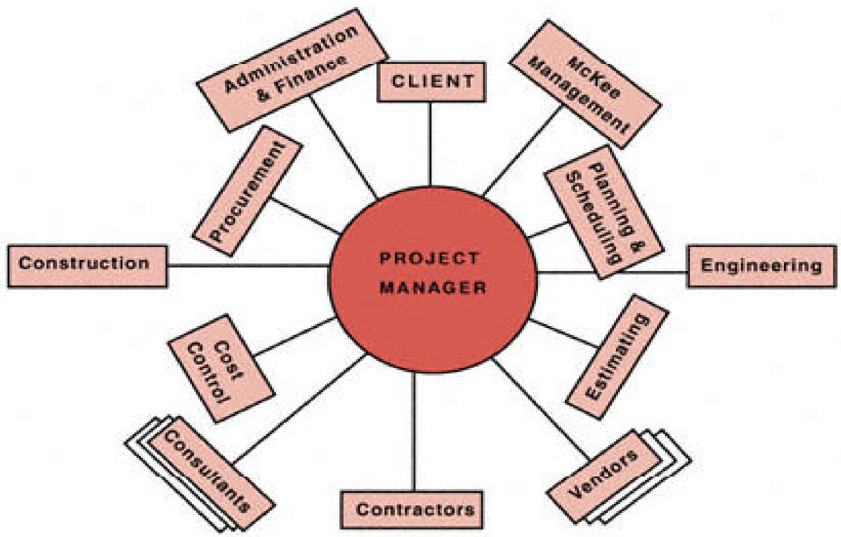


Figure 7.4: Managing the Project

Most executives have found that the best way to interview is by reading each element of the job description to the potential candidate. Many individuals want a career path in project management but are totally unaware of what the Project Manager's duties are.

So far we have discussed the personal characteristics of the Project Manager. There are also job related questions to consider, such as:

- Are feasibility and economic analyses necessary?
- Is complex technical expertise required? If so, is it within the individual's capabilities?
- If the individual is lacking expertise, will there be sufficient backup strength in the line organizations?
- Is this the company's or the individual's first exposure to this type of project and/or client? If so, what are the risks to be considered?
- What is the priority for this project, and what are the risks?
- With whom must the Project Manager interface, both inside and outside the organization?

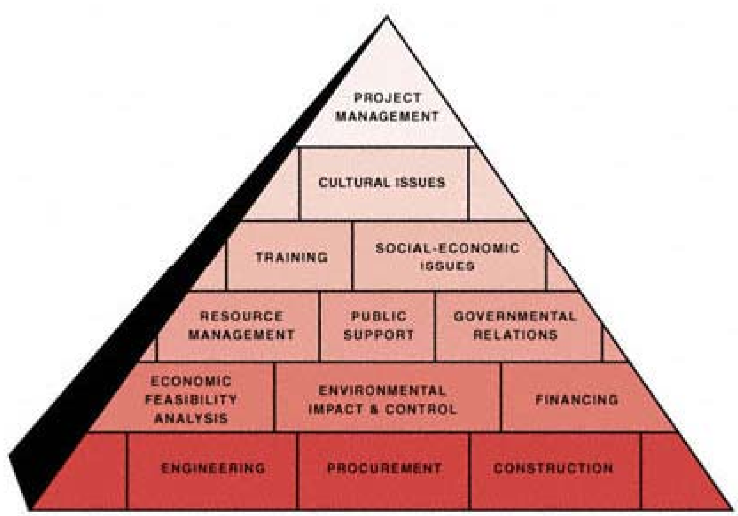


Figure 7.5: Project management responsibilities

Most good Project Managers generally know how to perform feasibility studies and cost-benefit analyses. Sometimes this capability can create organizational conflict. A major utility company begins each computer project with a feasibility study in which a cost-benefit analysis is performed.

The Project Managers, all of whom report to a project management division, perform the study themselves without any direct functional support. The functional managers argue that the results are grossly inaccurate because the functional experts are not involved. The Project Manager, on the other hand, argues that they never have sufficient time or money to perform a complete analysis.

There are also good reasons for recruiting from outside the company. A new Project Manager hired from the outside would be less likely to have strong informal ties to any one line organization and thus, could show impartiality on the project. Some companies further require that the individual spend an apprenticeship period of twelve to eighteen months in a line organization to find out how the company functions, to become acquainted with some of the people, and to understand the company's policies and procedures.

One of the most important but often least understood characteristics of good Project Managers is their ability to understand and know both themselves and their employees in terms of strengths and weaknesses.

7.4 Project Champions:

Corporations encourage employees to think up new ideas that, if approved by the corporation, will generate monetary and non-monetary rewards for the idea generator. One such reward is to identify the individual as a *"Project Champion"*. Unfortunately, all too often the Project Champion becomes the Project Manager, and, although the idea was technically sounds, the project fails.

Project Managers	Project Champions
• Prefer to work in groups	• Prefer working individually
• Committed to their managerial and technical responsibilities	• Committed to technology
• Committed to the corporation	• Committed to the profession
• Seek to achieve the objective	• Seek to exceed the objective
• Are willing to take risks	• Are unwilling to take risks; try to test everything
• Seek what is possible	• Seek perfection
• Think in terms of short time spans	• Think in terms of long time spans
• Manage people	• Manage things
• Are committed to and pursue material values	• Are committed to and pursue intellectual values

Table 7.1: Project Managers versus Project Champions

7.5 Power and Authority of Project Manager:

One form of the Project Manager's authority can be defined as the legal or rightful power to command, act, or direct the activities of others. The breakdown of the Project Manager's authority is shown in Figure 7.6 below. Authority can be delegated from one's superiors. Power, on the other hand, is granted to an individual by his subordinates and is a measure of their respect for him. A manager's authority is a combination of his power and influence such that subordinates, peers, and associates willingly accept his judgment.

In the traditional structure, the power spectrum is realized through the hierarchy, whereas in the project structure, power comes from credibility, expertise, or being a sound decision-maker. Authority is the key to the project management process. The Project Manager must manage across functional and organizational lines by bringing together activities required to accomplish the objectives of a specific project. Project authority provides the way of thinking required to unify all organizational activities toward accomplishment of the project regardless of where they are located.

The Project Manager who fails to build and maintain his alliances will soon find opposition or indifference to his project requirements.

The amount of authority granted to the Project Manager varies according to project size, management philosophy, and management interpretation of potential conflicts with functional managers. There do exist, however, certain fundamental elements over which the Project Manager must have authority in order to maintain effective control.

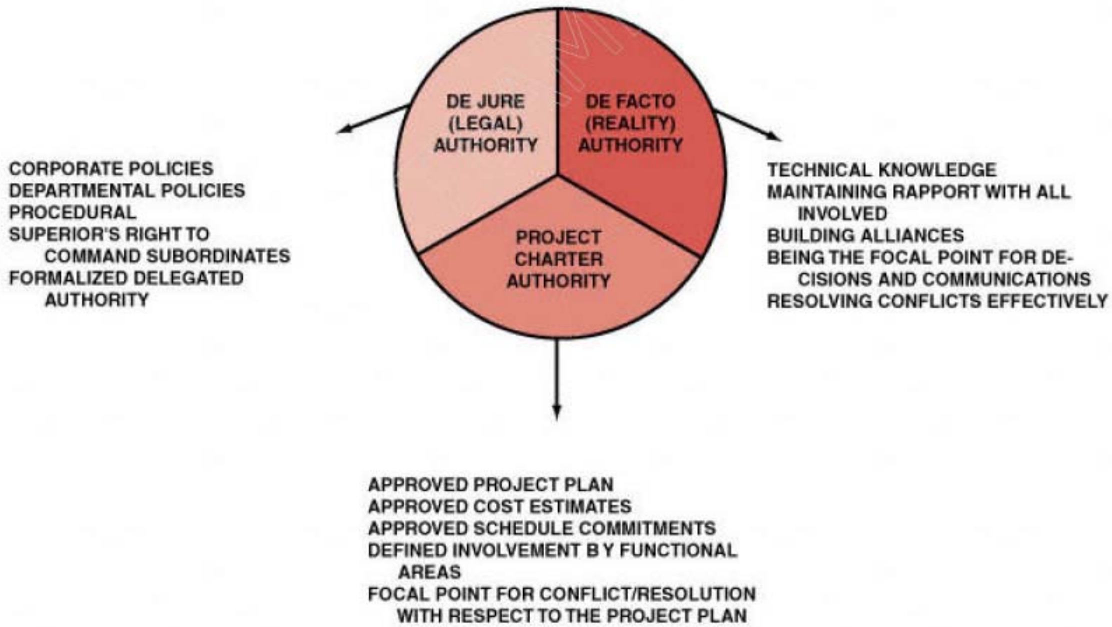


Figure 7.6: Project Authority Breakdown

Generally speaking, a project manager should have more authority than his responsibility calls for, the exact amount of authority usually depending on the amount of risk that the Project Manager must take. The greater the risk, the greater the amount of authority is. A good Project Manager knows where his authority ends and does not hold an employee responsible for duties that he (the Project Manager) does not have the authority to enforce. Some projects are directed by Project Managers who have only monitoring authority. These Project Managers are referred to as influence Project Managers.

Failure to establish authority relationships can result in:

- Poor communication channels
- Misleading information
- Antagonism, especially from the informal organization
- Poor working relationships with superiors, subordinates, peers, and associates
- Surprises for the customer

The following are the most common sources of power and authority problems in a project environment:

- Poorly documented or no formal authority
- Power and authority perceived incorrectly
- Dual accountability of personnel
- Two bosses (who often disagree)
- The project organization encouraging individualism
- Subordinate relations stronger than peer or superior relationships
- Shifting of personnel loyalties from vertical to horizontal lines
- Group decision making based on the strongest group
- Ability to influence or administer rewards and punishment
- Sharing resources among several projects

The project management organizational structure is an arena of continuous conflict and negotiation. Although there are many clearly defined authority boundaries between functional and project management responsibilities, the fact that each project can be inherently different from all others almost always creates new areas where authority negotiations are necessary.

Certain ground rules exist for authority control through negotiations. Negotiations should take place at the lowest level of interaction.
Definition of the problem must be the first priority. This should include:

- The issue
- The impact
- The alternative
- The recommendations

Higher-level authority should be used if, and only if, agreement cannot be reached.

7.6 Functional and Project Organizations:

Functional organization is structure in which authority rests with the functional heads; the structure is sectioned by departmental groups.

7.6.1 Advantages of Functional Structure:

- Simple and clear; coordination left to top management
- Reduces overhead
- Provides clearly marked career paths for hiring and promotion
- Employees work alongside colleagues who share similar interests

7.6.2 Disadvantages of Functional Structure:

- Coordination of functional tasks is difficult; little reward for cooperation with other groups since authority resides with functional supervisor.
- Provides scope for different department heads to pass-off company project failures as being due to the failures of other departments.

7.6.3 Matrix Organizations:

Most organizations fall somewhere between the fully functional and fully projectized organizational structure. These are *matrix organizations*. Three points along the organizational continuum have been defined.

1. **Weak/Functional Matrix:**
A Project Manager (often called a project administrator under this type of organization) with only limited authority is assigned to oversee the cross-functional aspects of the project. The functional managers maintain control over their resources and project areas. The project administrator's role is to enhance communication between functional managers and track overall project progress.

2. **Balanced/Functional Matrix**:
A Project Manager is assigned to oversee the project. Power is shared equally between the Project Manager and the functional managers. Proponents of this structure believe it strikes the correct balance, bringing forth the best aspects of functional and projectized organizations. However, this is the most difficult system to maintain as the sharing of power is a very delicate proposition. This is also the most complex organizational structure to maintain.

3. **Strong/Project Matrix**:
A Project Manager is primarily responsible for the project. Functional managers provide technical expertise and assign resources on an as-needed basis. Because project resources are assigned as necessary, there can be conflicts between the Project Manager and the functional manager over resource assignment. The functional manager has to staff multiple projects with the same experts.

4. **Soft boundaries Matrix:**
A fourth organization type is the "soft boundaries matrix". In this the functional team members provide technical expertise and assign resources on an as-needed basis. Because project resources are assigned as necessary there is no need for Project Managers or a functional manager over resource assignment.

PROJECT CONCEPTION AND PROJECT FEASIBILITY

Broad Contents

Project Conception
Stages of Project Conception
What is Feasibility Assessment?
Types of Feasibility
Tangible and Intangible Benefits

8.1 Project Conception:

Conception of an Industrial Project is the initial step in the process of defining the actual scope of a project. Project conception generally starts with a manifestation of a requirement or an opportunity that will benefit the corporate interests, and culminates when one or more preliminary options have been formulated which will, theoretically, satisfy the company's expectations as originally presented.

The process presented here although illustrated by an industrial project has features directly translatable to conceptual evolution in many diverse applications. The fact that the project in question has been deferred is not uncharacteristic of the fate of many programs during the conceptual phase.

8.2 Stages of Project Conception:

Initial conceptualization of a project has various degrees of complexity, depending on the nature of the specific project and the particular analysis and approval procedures used by a company.

The company's planning strategy may require formulations of programs involving several projects. Conception of the overall program should then precede conception of the individual specific projects.

The conceptual stage involves the following activities:

1. Definition of a requirement or an opportunity that commands the interests of the company.
2. Formulation of a set of preliminary alternatives capable of fulfilling the initial requirement.
3. Selection of alternative(s) that might satisfy the requirements in terms and conditions attractive to the company.

A brief description of each of these activities in a specific situation and in an organized environment follows:

1. Definition of the Requirement of Opportunity:

The continuity of efficient operations and the opening of the new business areas are the main drives for capital investments for industrial firms. Investment opportunities are detected through operational analysis of current performance and by forecasts of the most likely future scenarios.

Initially, the scope of any new investment is likely to be vague. Subsequent definition involves consideration of all available relevant facts, required resource sand constraints associated with the original idea.

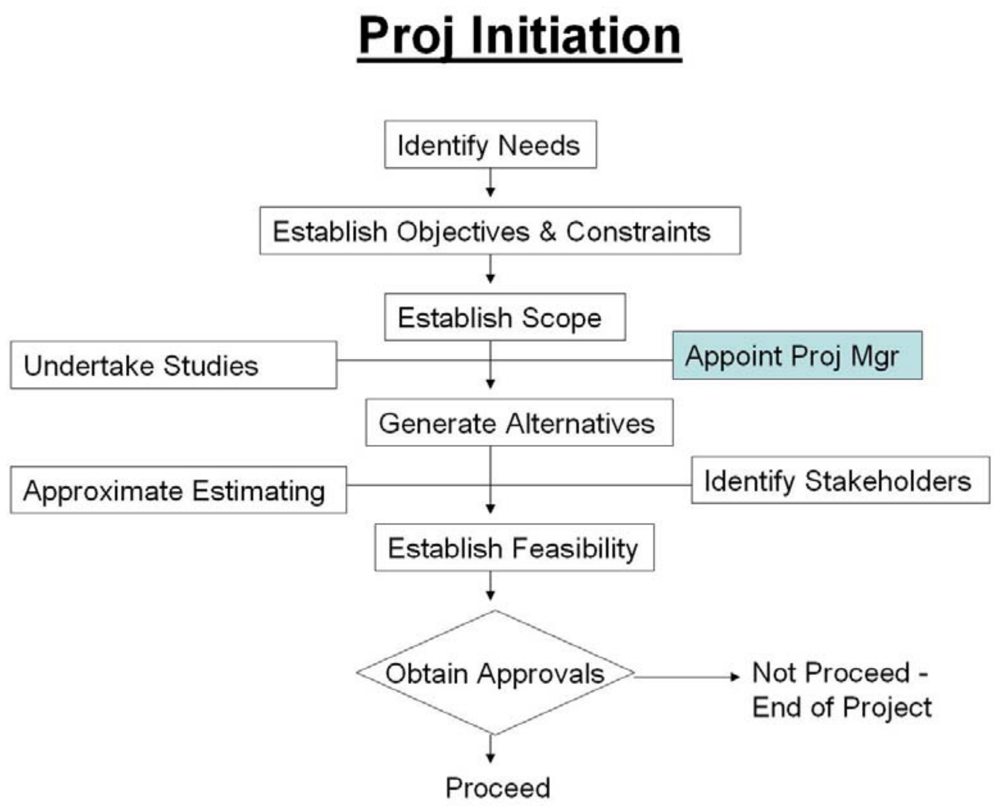


Figure 8.1: Project Initiation

2. **Preliminary Formulation of the Alternatives:**

   Project conception continues with development of alternatives capable of fulfilling the expressed objectives. The preliminary formulation of alternatives is important as it sets the pace of the subsequent definition and elaboration of the project scope. During this phase, the company calls upon the experience and creativity of its technicians, manager and directors to generate an adequate group of alternatives to fulfill the expressed need.

3. **Initial Selection of Alternatives:**

   After the alternatives have been identified, comparative analyses are made in order to select the most beneficial and to reject the least attractive. The selection process employs a basic feasibility analysis of each alternative the establishment of criteria that will allow the identification of the most attractive options. At this point, further consideration of the rejected alternative is terminated along with the need to prepare elaborate definitions for them.

   The cost, schedule, profitability, and other salient advantages and disadvantages of each of the selected alternatives are assessed in terms of order of magnitude. Difference among the options is sought still without establishing precise project parameters.

8.3 Feasibility Analysis:

A feasibility study is an analytical tool used during the project planning process, shows how a business would operate under an explicitly stated set of assumptions. These assumptions include the technology used (the facilities, types of equipment, manufacturing process, etc.) and the financial aspects of the project (capital needs, volume, cost of goods, wages etc.).

8.4 What is Feasibility Assessment?

As the name implies, a feasibility study is an analysis of the viability of an idea. The feasibility study focuses on helping answer the essential question of “should we proceed with the proposed project idea?” All activities of the study are directed toward helping answer this question.

Feasibility studies can be used in many ways but primarily focus on proposed business ventures. Farmers and others with a business idea should conduct a feasibility study to determine the viability of their idea before proceeding with the development of the business. Determining early on that a business idea will not work saves time, money and heartache later.

A feasible business venture is one where the business will generate adequate cash flow and profits, withstand the risks it will encounter, remain viable in the long-term and meet the goals of the founders. The venture can be a new start-up business, the purchase of an existing business, an expansion of current business operations or a new enterprise for an existing business. Information file, a feasibility study outline is provided to give guidance on how to proceed with the study and what to include. Also, information file, how to use and when to do a feasibility study helps through the process and also to get the most out of the study.

A feasibility study is only one step in the business idea assessment and business development process. Reviewing this process and reading the information below will help put the role of the feasibility study in perspective.

A feasibility study is usually conducted after producers have discussed a series of business ideas or scenarios. The feasibility study helps to “frame” and “flesh-out” specific business alternatives so they can be studied in-depth. During this process the number of business alternatives under consideration is usually quickly reduced.

During the feasibility process you may investigate a variety of ways of organizing the business and positioning your product in the marketplace. It is like an exploratory journey and you may take several paths before you reach your destination. Just because the initial analysis is negative does not mean that the proposal does not have merit if organized in a different fashion or if there are market conditions that need to change for the idea to be viable. Sometimes limitations or flaws in the proposal can be corrected.

A pre-feasibility study may be conducted first to help sort out relevant alternatives. Before proceeding with a full-blown feasibility study, you may want to do some pre-feasibility analysis of your own. If you find out early on that the proposed business idea is not feasible, it will save you time and money.

However, if the findings lead you to proceed with the feasibility study, your work may have resolved some basic issues. A consultant may help you with the pre-feasibility study, but you should be involved. This is an opportunity for you to understand the issues of business development.

A market assessment may be conducted to help determine the viability of a proposed product in the marketplace. The market assessment will help you identify opportunities in a market or market segment. If no opportunities are found, there may be no reason to proceed with a feasibility study. If opportunities are found, the market assessment can give focus and direction to the construction of business alternatives to investigate in the feasibility study. A market assessment will provide much of the information for the marketing section of the feasibility study.

The conclusions of the feasibility study should outline in depth the various alternatives examined and the implications and strengths and weaknesses of each. The project leaders need to study the feasibility study and challenge its underlying assumptions. This is the time to be skeptical.

Do not expect one alternative to “jump off the page” as being the best one. Feasibility studies do not suddenly become positive or negative. As you accumulate information and investigate alternatives, neither a positive nor negative outcome may emerge. The decision of whether to proceed often is not clear-cut. Major stumbling blocks may emerge that negate the project. Sometimes these weaknesses can be overcome. Rarely does the analysis come out overwhelmingly positive. The study will help you assess the tradeoff between the risks and rewards of moving forward with the business project.

Remember, it is not the purpose of the feasibility study or the role of the consultant to decide whether or not to proceed with a business idea; it is the role of the project leaders.

The go/no-go decision is one of the most critical in business development. It is the point of no return. Once you have definitely decided to pursue a business venture, there is usually no turning back. The feasibility study will be a major information source in making this decision. This indicates the importance of a properly developed feasibility study.

A feasibility study is not a business plan. The separate roles of the feasibility study and the business plan are frequently misunderstood. The feasibility study provides an investigating function. It addresses the question of “Is this a viable business venture?” The business plan provides a planning function. The business plan outlines the actions needed to take the proposal from “idea” to “reality.”

The feasibility study outlines and analyzes several alternatives or methods of achieving business success. So, the feasibility study helps to narrow the scope of the project to identify the best business model. The business plan deals with only one alternative or model. The feasibility study helps to narrow the scope of the project to identify and define two or three scenarios or alternatives. The consultant conducting the feasibility study may work with the group to identify the “best” alternative for their situation. This becomes the basis for the business plan.

The feasibility study is conducted before the business plan. A business plan is prepared only after the business venture has been deemed to be feasible. If a proposed business venture is considered to be feasible, then a business plan constructed that provides a “roadmap” of how the business will be created and developed. The business plan provides the “blueprint” for project implementation. If the venture is deemed not to be feasible, efforts may be made to correct its deficiencies, other alternatives may be explored, or the idea is dropped.

Project leaders may find themselves under pressure to skip the “feasibility analysis” step and go directly to building a business. Individuals from within and outside of the project may push to skip this step.

Reasons given for not doing feasibility analysis include:

- We know it is feasible. An existing business is already doing it.
- Why do another feasibility study when one was done just a few years ago?
- Feasibility studies are just a way for consultants to make money.
- The feasibility analysis has already been done by the business that is going to sell us the equipment.
- Why not just hire a general manager who can do the study?
- Feasibility studies are a waste of time. We need to buy the building, tie up the site and bid on the equipment.

The reasons given above should not dissuade you from conducting a meaningful and accurate feasibility study. Once decisions have been made about proceeding with a proposed business, they are often very difficult to change. You may need to live with these decisions for a long time.

From a financial perspective, project selection is basically a two -part process. First, the organization will conduct a feasibility study to determine whether the project *can* be done. The second part is to perform a benefit-to-cost analysis to see whether the company *should* do it. The purpose of the feasibility study is to validate that the project meets feasibility of cost, technological, safety, marketability, and ease of execution requirements. It is possible for the company to use outside consultants or Subject Matter Experts (SMEs) to assist in both feasibility studies and benefit-to-cost analyses. A project manager may not be assigned until after the feasibility study is completed.

As part of the feasibility process during project selection, senior management often solicits input from Subject Matter Experts (SMEs) and lower level managers through rating models. The rating models normally identify the business and/or technical criteria against which the ratings will be made. Once feasibility is determined, a benefit-to-cost analysis is performed to validate that the project will, if executed correctly, provide the required financial and non-financial benefits. Benefit-to-cost analyses require significantly more information to be scrutinized than is usually available during a feasibility study. This can be an expensive proposition.

8.5 Types of Feasibility:

Feasibility is of the following types:

1. **Technical Feasibility:**
   This area reviews the engineering feasibility of the project, including structural, civil and other relevant engineering aspects necessitated by the project design. The technical capabilities of the personnel as well as the capability of the projected technologies to be used in the project are considered. In some instances, particularly when projects are in third world countries, technology transfer between geographical areas and cultures needs to be analyzed to understand productivity loss (or gain) and other implications due to differences in topography, geography, fuels availability, infrastructure support and other issues.

2. **Managerial Feasibility:**
   Demonstrated management capability and availability, employee involvement, and commitment are key elements required to ascertain managerial feasibility. This addresses the management and organizational structure of the project, ensuring that the proponent’s structure is as described in the submittal and is well suited to the type of operation undertaken.

3. **Economic Feasibility:**
   This involves the feasibility of the proposed project to generate economic benefits. A benefit-cost analysis (addressing a problem or need in the manner proposed by the project compared to other, the cost of other approaches to the same or similar problem) is required. A breakeven analysis when appropriate is also a required aspect of evaluating the economic feasibility of a project. (This addresses fixed and variable costs and utilization/sales forecasts). The tangible and intangible aspects of a project should be translated into economic terms to facilitate a consistent basis for evaluation. Even when a project is non-profit in nature, economic feasibility is critical.

4. Financial Feasibility:

Financial feasibility should be distinguished from economic feasibility. Financial feasibility involves the capability of the project organization to raise the appropriate funds needed to implement the proposed project. In many instances, project proponents choose to have additional investors or other sources of funds for their projects. In these cases, the feasibility, soundness, sources and applications of these project funds can be an obstacle. As appropriate, loan availability, credit worthiness, equity, and loan schedule still be reviewed as aspects of financial feasibility analysis. Also included in this area are the review of implications of land purchases, leases and other estates in land.

5. Cultural Feasibility:

Cultural feasibility deals with the compatibility of the proposed project with the cultural environment of the project. In labor-intensive projects, planned functions must be integrated with the local cultural practices and beliefs. For example, religious beliefs may influence what an individual is willing to do or not do.

6. Social Feasibility:

Social feasibility addresses the influences that a proposed project may have on the social system in the project environment. The ambient social structure may be such that certain categories of workers may be in short supply or nonexistent. The effect of the project on the social status of the project participants must be assessed to ensure compatibility. It should be recognized that workers in certain industries may have certain status symbols within the society.

7. Safety Feasibility:

Safety feasibility is another important aspect that should be considered in project planning. Safety feasibility refers to an analysis of whether the project is capable of being implemented and operated safely with minimal adverse effects on the environment. Unfortunately, environmental impact assessment is often not adequately addressed in complex projects.

8. Political Feasibility:

Political considerations often dictate directions for a proposed project. This is particularly true for large projects with significant visibility that may have significant government inputs and political implications. For example, political necessity may be a source of support for a project regardless of the project's merits. On the other hand, worthy projects may face insurmountable opposition simply because of political factors. Political feasibility analysis requires an evaluation of the compatibility of project goals with the prevailing goals of the political system.

9. Environmental Feasibility:

Often a killer of projects through long, drawn-out approval processes and outright active opposition by those claiming environmental concerns. This is an aspect worthy of real attention in the very early stages of a project. Concern must be shown and action must be taken to address any and all environmental concerns raised or anticipated. This component also addresses the ability of the project to timely obtain and at a reasonable cost, needed permits, licenses and approvals.

10. Market Feasibility:

This area should not be confused with the Economic Feasibility. The market needs analysis to view the potential impacts of market demand, competitive activities, etc. and market share available. Possible competitive activities by competitors, whether local, regional, national or international, must also be analyzed for early contingency funding and impacts on operating costs during the start-up, ramp-up, and commercial start-up phases of the project.

8.6 Tangible and Intangible Benefits:

Estimating benefits and costs in a timely manner is very difficult. Benefits are often defined as:

- Tangible benefits for which dollars may be reasonably quantified and measured.
- Intangible benefits that may be quantified in units other than dollars or may be identified and described subjectively.

Costs are significantly more difficult to quantify, at least in a timely and inexpensive manner. The minimum costs that must be determined are those that specifically are used for comparison to the benefits. These include:

- The current operating costs or the cost of operating in today's circumstances.
- Future period costs that are expected and can be planned for.
- Intangible costs that may be difficult to quantify. These costs are often omitted if quantification would contribute little to the decision-making process.

There must be careful documentation of all known constraints and assumptions that were made in developing the costs and the benefits. Unrealistic or unrecognized assumptions are often the cause of unrealistic benefits. The go or no-go decision to continue with a project could very well rest upon the validity of the assumptions.

LESSON 09

PROJECT FEASIBILITY (CONTD.)

Broad Contents

What is a Feasibility Study?
Why is a Feasibility Study done?
What a Feasibility Study is not?
Scope of a Feasibility Study
Elements of a Feasibility Study

9.1 What is a Feasibility Study?

A feasibility study is essentially a process for determining the viability of a proposed initiative or service and providing a framework and direction for its development and delivery. It is a process for making sound decisions and setting direction. It is also a process which:

- Is driven by research and analysis
- Usually involves some form of consultation with stakeholders, community, users, etc.
- Focuses on analyzing, clarifying and resolving key issues and areas of concern or uncertainty
- Very often involves basic modeling and testing of alternative concepts and approaches

There is no universal format for a feasibility study. Feasibility studies can be adapted and shaped to meet the specific needs of any given situation.

A feasibility study is designed to provide an overview of the primary issues related to a business idea. The purpose is to identify any "make or break" issues that would prevent your business from being successful in the marketplace. In other words, a feasibility study determines whether the business idea makes sense.

A thorough feasibility analysis provides a lot of information necessary for the business plan. For example, a good market analysis is necessary in order to determine the project's feasibility. This information provides the basis for the market section of the business plan.

Because putting together a business plan is a significant investment of time and money, you want to make sure that there are no major roadblocks facing your business idea before you make that investment. *Identifying such roadblocks is the purpose of a feasibility study.*

A feasibility study looks at three major areas:

a) Market issues
b) Organizational/technical issues
c) Financial issues

Again, this is meant to be a "first cut" look at these issues. For example, a feasibility study should not do in-depth long-term financial projections, but it should do a basic break-even analysis to see how much revenue would be necessary to meet your operating expenses.

9.2 Why Do Feasibility Studies?

Developing any new business venture is difficult. Taking a project from the initial idea through the operational stage is a complex and time-consuming effort. Most ideas, whether from a cooperative or an investor owned business, do not develop into business operations. If these ideas make it to the operational stage, most fail within the first 6 months. Before the potential members invest in a proposed business project, they must determine if it can be economically viable and then decide if investment advantages outweigh the risks involved.

Many cooperative business projects are quite expensive to conduct. The projects involve operations that differ from those of the members' individual business. Often, cooperative businesses' operations involve risks with which the members are unfamiliar. The study allows groups to preview potential project outcomes and to decide if they should continue. Although the costs of conducting a study may seem high, they are relatively minor when compared with the total project cost. The small initial expenditure on a feasibility study can help to protect larger capital investments later.

Feasibility studies are useful and valid for many kinds of projects. Evaluation of a new business ventures, both from new groups and established businesses, is the most common, but not the only usage. Studies can help groups decide to expand existing services, build or remodel facilities, change methods of operation, add new products, or even merge with another business. A feasibility study assists decision makers whenever they need to consider alternative development opportunities.

Feasibility studies permit planners to outline their ideas on paper before implementing them. This can reveal errors in project design before their implementation negatively affects the project. Applying the lessons gained from a feasibility study can significantly lower the project costs.

The study presents the risks and returns associated with the project so the prospective members can evaluate them. There is no "magic number" or correct rate of return a project needs to obtain before a group decides to proceed. The acceptable level of return and appropriate risk rate will vary for individual members depending on their personal situation.

The proposed project usually requires both risk capital from members and debt capital from banks and other financers to become operational. Lenders typically require an objective evaluation of a project prior to investing. A feasibility study conducted by someone without a vested interest in the project outcome can provide this assessment.

General requirements and potential benefits of conducting feasibility study include:

- Developing any new business venture is difficult.
- Taking a project from initiation of idea to operational stage is a complex and time consuming effort.
- Most ideas, whether from cooperative or investor-owned businesses, do not develop into business operations.
- If these ideas make it to the operational stage, majority of them fail within first six months.
- Projects involve business operations that differ from Individual business.
- These operations involve risks of unfamiliar.
- Feasibility study allows groups developing a business idea to preview potential project outcomes and decide if they want to continue developing the project.
- Though the cost of conducting a study can seem high, almost always, these costs are relatively minor when compared to the total project cost.
- Small initial expenditure on a feasibility study by a group can help to protect larger capital investments later.
- Feasibility study is a useful tool and is valid for many kinds of projects.

9.3 What a Feasibility Study is not:

Feasibility studies are conducted on "real-world" projects. They are not academic or research papers. Simulations or projection models, though useful on some projects, do not replace a feasibility study. The study should not be a "cookie cutter" approach to a project. The study should not merely be a generic source of information. Once completed, a study should permit a group to make better decisions for the strategic issues of their specific project.

A feasibility study is not a business plan. A business plan is elaborated later in the project development process than the feasibility study. The main purpose of a business plan is to function as a blueprint for the group's business operations. The business plan presents the group's intended responses to the critical issues raised in the feasibility study. The feasibility study results forms the basis for developing a business plan.

The purpose of a feasibility study is not to identify new ideas or concepts for a project. These ideas should be clearly identified before a study is initiated. The group need accomplish a number of steps, before feasibility study is instituted. The closer the assumptions lie to the "real-world", the more value feasibility study will hold for the group.

A feasibility study should not be conducted as a forum merely to support a desire that the project will be successful. The study should be an objective evaluation of the project's chance for success. Negative results can be just as useful for decision-makers as positive results.

Financers may require a feasibility study before providing loans, but this should not be the only purpose of a study. A feasibility study should enhance a banker's ability to evaluate a project; but the primarily goal should be to aid a group's decision-making, not to secure financing.

A feasibility study will not determine whether or not a project should be undertaken. The potential members have to decide if the economic returns justify the risks involved in their continuing the project. The results of the feasibility study assist them in this.

A feasibility study serves as an analytical tool to present the basic assumptions of a project idea, shows how results vary when these assumptions change, and provides guidance as to critical elements of a project. It provides a group with project specific information to assist in making decisions. Groups using feasibility studies should lower the risks in proceeding with a project.

9.4 Scope of Feasibility Analysis:

In general terms, the elements of a feasibility analysis for a project should cover the following:

1. Need Analysis:

This indicates recognition of a need for the project. The need may affect the organization itself, another organization, the public, or the government. A preliminary study is then conducted to confirm and evaluate the need. A proposal of how the need may be satisfied is then made. Pertinent questions that should be asked include:

- Is the need significant enough to justify the proposed project?
- Will the need still exist by the time the project is completed?
- What are the alternate means of satisfying the need?
- What are the economic, social, environmental, and political impacts of the need?

2. Process Work:

This is the preliminary analysis done to determine what will be required to satisfy the need. The work may be performed by a consultant who is an expert in the project field.

The preliminary study often involves system models or prototypes. For technology oriented projects, artist's conception and scaled-down models may be used for illustrating the general characteristics of a process. A simulation of the proposed system can be carried out to predict the outcome before the actual project starts.

3. ***Engineering and Design:***
This involves a detailed technical study of the proposed project. Written quotations are obtained from suppliers and subcontractors as needed. Technology capabilities are evaluated as needed. Product design, if needed, should be done at this time.

4. ***Cost Estimate:***
This involves estimating project cost to an acceptable level of accuracy. Levels of around -5% to +15% are common at this level of a project plan. Both the initial and operating costs are included in the cost estimation. Estimates of capital investment and of recurring and nonrecurring costs should also be contained in the cost estimate document. Sensitivity analysis can be carried out on the estimated cost values to see how sensitive the project plan is to the estimated cost values.

5. ***Financial Analysis:***
This involves an analysis of the cash flow profile of the project. The analysis should consider rates of return, inflation, sources of capital, payback periods, breakeven point, residual values, and sensitivity. This is a critical analysis since it determines whether or not and when funds will be available to the project. The project cash flow profile helps to support the economic and financial feasibility of the project.

6. ***Project Impacts:***
This portion of the feasibility study provides an assessment of the impact of the proposed project. Environmental, social, cultural, political, and economic impacts may be some of the factors that will determine how a project is perceived by the public. The value added potential of the project should also be assessed. A value added tax may be assessed based on the price of a product and the cost of the raw material used in making the product. The tax so collected may be viewed as a contribution to government coffers.

7. ***Conclusions and Recommendations:***
The feasibility study should end with the overall outcome of the project analysis. This may indicate an endorsement or disapproval of the project. Recommendations on what should be done should be included in this section of the feasibility report.

9.5 Elements of a Feasibility Assessment:

As a first step, a feasibility assessment should define the business idea, be it a new project, product or service. The project or business idea feasibility can then be determined. The feasibility needs to account for the current circumstances of the proponent. For example, for a business intender it should take into account personal readiness, skills, resources, knowledge and goals. For established businesses, linkages to existing lines of business, customers, suppliers, employees and other stakeholders need to be accounted for.

A feasibility report should have the following structure:

1. **Executive Summary:**
It provides a quick overview of the main points of the assessment, helping to form a picture of the proposal along with the recommendations. It should be concise and include the major findings covered in the main body of the report.

2. **Need Analysis:**

Need Analysis information provide a context to the business proposition. It analyzes the justification of the idea, with a study of possible alternatives. It links the business idea to the current circumstances and helps to inform evaluation of the business idea.

3. **Engineering:**
Description of the technical aspects of the business idea, including any changes needed to be made to existing processes or the need to add items to existing range of products and services.

4. **Advantages and Disadvantages:**
Advantages and disadvantages of the business idea compared to alternatives, such as competing products; or for a new concept, its relevance to current practices, and to unmet or potential demand.

5. **Market for the Product Offerings**:
State the number of customers, expected frequency and size of average purchase, and any reduction in costs across the business arising from the new product or service. Any assumptions about customer purchase behavior should be identified so that they can be evaluated in terms of likelihood of being achieved or exceeded. For changes in business operations, the payoff may come from competitive advantages such as increased market share, cost savings or higher prices. Research should focus on:

- ***Customers:***
You need to be clear about the type of customer you will target, and why they will respond to your offering.
Identify your target market segments or groups: What knowledge do you have of your market segments or groups? How many are there? What will they buy? How often will they buy? What will be their average purchase?

- ***Products and Services:***
Create a list showing the products/services you will be offering to each segment; how much customers will pay for each product or service.

- ***Competition:***
List your competitors and note their perceived strengths and weaknesses. You need to understand why they are competition to your proposed business.
Ask the question: How can you attract customers from them (i.e. your competitors)? Price should not be the only answer; whole of life value, product features, distribution and promotion strategies, and after sales options may all be part of the purchase decision.

- ***Map:***
Obtain a map and define on it your market boundaries, your location, access routes, your competitors, your suppliers, and demographic information on your market such as population and distribution.

- ***Costing:***
Costing for the implementation of the business idea is done. Assess how long it will take you or your staff to produce or obtain the proposed products or services and to deliver them to your customers and work out the cost of that time. Determine how much it will cost to buy, assemble or produce them. This approach should account for all costs over and above the existing activity. For existing businesses this section should clearly specify if marginal or average costs have been used to determine costing. Assumptions should be stated, for example, assumed raw material prices, availability of supplies, staff skills, plant and equipment etc. Costs

of alternative production/implementation strategies should also be considered in the analysis.

- ***Suppliers:***
  Identify preferred and alternative suppliers; collect their catalogues and price lists.

- ***Location:***
  Identify your site, is it rented, owned or at home? Do you need more room than existing business? Why locate there? What are the advantages and disadvantages?

- ***Resources:***
  Resources such as assets and equipment that will be required, cost of acquiring them, alternative methods of acquisition etc. are assessed. For example, outright purchase versus hire purchase or other forms of leasing.

- ***Staff:***
  What staff will you need? What skills will they need? What will you need to pay them?

6. Financial analysis:
Work out the profits from a given level of operations, the capital required and how the capital will be found to commence operating.

7. Risk analysis of the Preferred Solution:
Risk analysis may take the form of basic break-even analysis, i.e. the level of business operation that will ensure that the business does not incur a loss. Sophisticated analysis may consider various business scenarios based on the assumptions made in costing and market analyses.

8. Comparative Analysis:
Comparative analysis of alternatives should reflect the objectives of the project. For example, decision making may be based on maximizing profit or minimizing of loss for various business scenarios. Some alternatives may be riskier, which will be reflected in higher financial payoffs under certain scenarios and potential losses under other scenarios; while some may be less risky with low financial profits or losses under a wide variety of circumstances. The choice between a "high payoff but high risk of failure" option instead of a "low payoff with associated low risk" option is one that you can then make in the context of your objectives, your market and your financial situation.

9. Recommendations:
Recommendations of the preferred alternative with an associated plan of action; or a decision not to proceed, should be covered in this section. Possible plans of action will be – going back to the drawing board, developing more promising alternatives, further research to minimize possibility of failure or moving forward to develop detailed business plan.

PROJECT FEASIBILITY (CONTD.)

Broad Contents

Characteristics of a Feasibility Study
The Feasibility Study - What Bankers Like to See in Them
The Feasibility Assessment Process
The Process of Feasibility Study
Conclusion – Feasibility Study

10.1 Characteristics of a Feasibility Study:

The feasibility study phase considers the technical aspects of the conceptual alternatives and provides a firmer basis on which to decide whether to undertake the project.

The purpose of the feasibility phase is to:

- Plan the project development and implementation activities.
- Estimate the probable elapsed time, staffing, and equipment requirements.
- Identify the probable costs and consequences of investing in the new project.

If practical, the feasibility study results should evaluate the alternative conceptual solutions along with associated benefits and costs.

The objective of this step is to provide management with the predictable results of implementing a specific project and to provide generalized project requirements. This, in the form of a feasibility study report, is used as the basis on which to decide whether to proceed with the costly requirements, development, and implementation phases.

User involvement during the feasibility study is critical. The user must supply much of the required effort and information, and, in addition, must be able to judge the impact of alternative approaches. Solutions must be operationally, technically, and economically feasible. Much of the economic evaluation must be substantiated by the user.
Therefore, the primary user must be highly qualified and intimately familiar with the workings of the organization and should come from the line operation.

The feasibility study also deals with the technical aspects of the proposed project and requires the development of conceptual solutions. Considerable experience and technical expertise are required to gather the proper information, analyze it, and reach practical conclusions.

Improper technical or operating decisions made during this step may go undetected or unchallenged throughout the remainder of the process. In the worst case, such an error could result in the termination of a valid project — or the continuation of a project that is not economically or technically feasible.

In the feasibility study phase, it is necessary to define the project's basic approaches and its boundaries or scope. A typical feasibility study checklist might include:

- Summary level
- Evaluate alternatives
- Evaluate market potential
- Evaluate cost effectiveness

- Evaluate producibility
- Evaluate technical base
- Detail level
- A more specific determination of the problem
- Analysis of the state-of-the-art technology
- Assessment of in-house technical capabilities
- Test validity of alternatives
- Quantify weaknesses and unknowns
- Conduct trade-off analysis on time, cost, and performance
- Prepare initial project goals and objectives
- Prepare preliminary cost estimates and development plan

The end result of the feasibility study is a management decision on whether to terminate the project or to approve its next phase. Although management can stop the project at several later phases, the decision is especially critical at this point, because later phases require a major commitment of resources. All too often, management review committees approve the continuation of projects merely because termination at this point might cast doubt on the group's judgment in giving earlier approval.
The decision made at the end of the feasibility study should identify those projects that are to be terminated. Once a project is deemed feasible and is approved for development, it must be prioritized with previously approved projects waiting for development (given a limited availability of capital or other resources). As development gets underway, management is given a series of checkpoints to monitor the project's actual progress as compared to the plan.

10.2 The Feasibility Study - What Bankers Like to See in Them:

A cardinal rule in banking is to borrow from a lender who understands your business; or, never to lend money on a business project that you do not understand. For this reason, even though most groups involve their banker early in the process, a feasibility study is often done with an eye towards explaining the project to potential financers. Bankers, as different clients for the feasibility study, can have different requirements for the study than group members. In many cases, the feasibility study is the formal project presentation to a lender. This section summarizes a feasibility study here with the banker in mind.

Many groups work with bankers with whom they already have an established business relationship. This relationship could be with another cooperative project or with their personal business. This can ease the process of obtaining financing for a project. However even when working with a banker, who is familiar with the members, it is important that the banker know and understand the unique aspects of cooperatives.

From the perspective of a banker, or other perspective financer, the feasibility study should contain the information described in the table 10.1 below.

The executive summary should contain:

- Project purpose. What is it and who is involved?
- Repayment capacity. Can the investment to be recovered over a specific time period? Does it give investment (cost) parameters? Can it convince bankers the investment is needed, even if it is marginally feasible?
- Projected Financial Returns. What are projected revenues, operating costs, and net income?
- Economic Benefits. What is the return on investment and the internal rate of return of the project

The financial blueprint package should contain:

- The assets to be financed.
- What is the project's funding potential and repayment terms? What is the rate of conversion to cash-liquidity?
- What are internal (yields, costs, etc.) and external (inflation, energy, etc.) project risks? What if the key assumptions are not perfect? What is the group's risk exposure?
- Evaluate economic consequences. Do net reserves cover capital cost? Does the plan keep the project from capital erosion?
- What are the projected cash flows, operating statements, and balance sheets? What are the source and use of funds
    - Financial commitment of members
    - Documentation. What rationale is used to support the assumptions?

Table 10.1: Information Content of Feasibility Study

This does not mean that a banker or financer is not interested in other aspects of the feasibility study. Each has their own area of interest and concern; however, the following will be needed for most, if not all bankers.

1. Executive Summary:

This should be short, to the point, yet still complete. If the banker cannot read the summary and understand the basics of the project the odds are that project will receive financing. This should contain:

- *Project purpose:* What is the project and who is involved?
- *Repayment possibility:* Does the study show the ability of the investment to be recovered over a specific time period? Does it give investment (cost) parameters? Can it convince bankers the investment is needed, even if it is marginally feasible?
- *Projected Financial Returns:* What are the projected financial scale, the revenues, and the operating costs? What is net the income?
- *Economic Benefits:* What are the Return on Investment (ROI) and the Internal Rate of Return (IRR) of the project?

2. The Financial Package Blueprint:

The banker needs to clearly see what resources the group wants from the bank. The bank will require information to calculate potential project risk and the bank's exposure for any monies loaned to the group. They also want to know the financial commitment to the project from the members. This blueprint should contain the following elements:

- Characteristics of assets to be financed.
- Expected rate of conversion to cash-liquidity – What is the project's funding potential and what repayment terms will be required?
- Risk evaluation data – What are internal (yields, costs, etc) and external (inflation, energy, etc) project risks? What if the key assumptions are not perfect? What is the bank's exposure?
- Evaluating Economic Consequences – Do net reserves cover capital cost? Does the plan keep the project from capital erosion?

- Financial Forecast – What are the next three years projected cash flows, operating statements, and balance sheets? What are the source and use of funds?
- Documentation – What rational is used to support the assumptions?

10.3 The Feasibility Assessment Process:

It is often suggested that feasibility studies should encompass at least two assessments:

- Technical feasibility
- Economic feasibility

The technical feasibility embodies an assessment of the physical, technical and technological dimensions of the project while the economic feasibility assesses the project's economic viability within its defined domain.

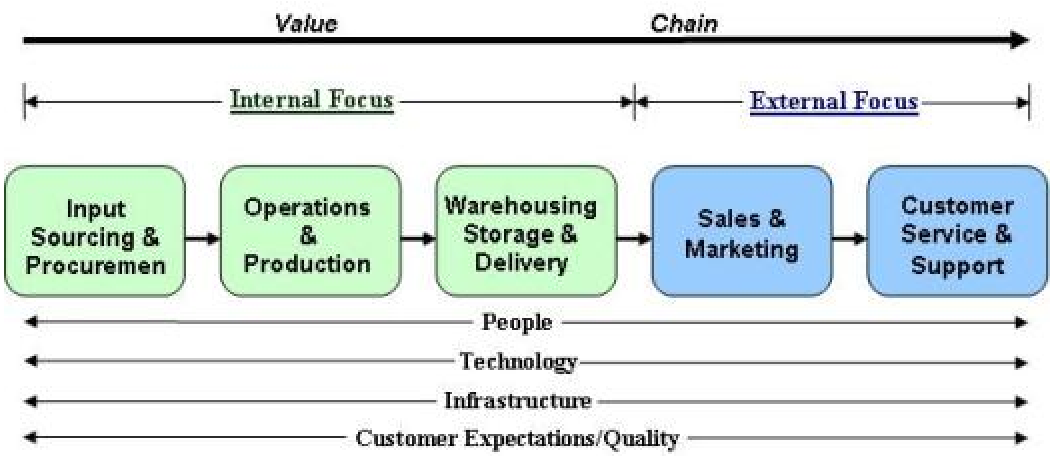


Figure 10.1: The Value Chain Approach to Feasibility Assessment

The value chain approach (shown in Figure 10.1 above) allows the two assessments to be embedded into a single initiative, facilitating an increased understanding and appreciation of the domain's effects on the different stages from input sourcing and procurement to customer service and support. It also facilitates an appreciation of the resources, technology, customer expectations and infrastructure required for the initiative to succeed, allowing an assessment of their level and depth at each subsequent stage in the value chain.

10.3.1 Input Sourcing and Procurement:

We begin conducting the feasibility of the business initiative from the logical point in the value chain, i.e., input sourcing and procurement. The technical dimension of the analysis at this stage encompasses the availability of the required inputs in the appropriate levels of quality and quantity. The assessment of availability involves an evaluation of cycles and trends for both quantity and quality of the inputs. We are also interested in the physical movement of the inputs from their origination points to the facilities where they will be processed. Different sources of supply are evaluated for their quality and quantity as well as cycles/trends in these characteristics. If specific human resources and technologies are required to facilitate the effectiveness of the input sourcing and procurement stage, their availability is assessed within the domain of the project. Likewise, the infrastructure support for effectively procuring inputs from origination points to processing facility is also assessed.

The economics of input sourcing and procurement emanates directly from the technical assessment. The prevailing market prices of inputs as well as costs associated with the procurement are assessed at the input sourcing and procurement stage. The objective is not to determine the price but the range of prices that have been typical in the domain over a reasonable period of time to allow for the capture of the trends and cycles in the prices. The price trends and cycles can be matched against the quantity and quality trends and cycles to provide insights into potential bottlenecks in the input sourcing and procurement function of the business initiative under consideration.

10.3.2 Operations and Production:

The transformation of inputs into outputs occurs at the operations and production stage of the value chain. This is also the stage that will generally absorb the lion's share of the investment capital. Therefore, from the capital resource allocation perspective, the feasibility requirements at the operations and production stage must be conducted with all the diligence necessary to address all the requisite issues.

The objective of the technical feasibility assessment at operations and production stage of the value chain is to determine if the technology being envisaged for the proposed project is suitable for the desired quantity and quality of product the project wants to present to the marketplace. It also seeks to determine if the equipment and its associated technologies are at the appropriate operational scale. Within the value chain framework, the feasibility assessment of the operations and production technologies is conducted by laying out the physical process from input receipts to packaging and transfer to storage and warehousing and/or delivery.

Because of the level of specialized knowledge required to do justice to the operations and production technical aspects of the feasibility assessment, it is pertinent that the professionals with the required knowledge and experience are recruited to provide the intellectual content for the process. It is important that you do not lock yourself into a technological jam by myopically focusing only on a single technology. Instead, you must encourage your engineering and technical professional input providers to provide you with the full range of their knowledge about the technologies and equipments available. You also need to assess the physical layout of the equipment and its impact on operational efficiency. These professionals must also be encouraged to provide insights into how the different technologies compare with respect to the number of people and their requisite skill levels required to operate them from beginning to end as well as their attendant operational inputs – electricity, natural gas or gasoline, maintenance protocols and shut down protocols, availability and turnaround of technical support, etc.

The previous information provides the foundation for the economic assessment of the alternative technical solutions that can be used in the production process and their attendant operational requirements. The technical efficiencies of the alternative technologies should be weighed against their economic efficiencies to determine their overall effectiveness in the project's feasibility. The best sources of the economic data to support the assessment of the technologies and operations are the suppliers of the equipment.

Such primary data can be collected by providing a detailed description of your product to potential suppliers in a Request for Quote (RFQ) offer. The principal advantage of using a Request for Quote (RFQ) is to improve your knowledge of alternative solutions which you may be unaware of, should you settle on the supplier you know. Given the rate of technical obsolescence, it is imperative that capital investments in technologies are made to maximize their longevity given technical and economic efficiency considerations. You should not overlook the alternative of not making direct investments in operations and production technologies, but seek to assess the possibilities of allying with a company with existing processing and operation capacity.

The technical nature of the operations and production stages of the feasibility assessment requires that unbiased people who are knowledgeable of the processes are hired to help review the responses to the Request for Quote (RFQ). You should arrange for the responding suppliers to make presentations so you and your consultants can ask the necessary questions. Although this process can be cumbersome and time consuming, it is worthwhile if the equipment, buildings and other operational inputs are a significant component of the proposed project's capital outlay.

10.3.3 Warehousing, Storage and Delivery:

Generally, agricultural value-added products are stored or warehoused prior to delivery to customers. Therefore, the feasibility analysis should assess the implications of warehousing, storage and delivery systems for the project. It is important that the feasibility study assesses alternative sources of warehousing and storage – from owning facilities to renting facilities to strategic alliance with others. The objective of these alternatives is to provide the project with realistic alternatives for consideration if the project is found to be feasible. The feasibility assessment should not only focus on the physical facilities but also on the management technologies of warehouse and storage facilities management. The product tracking systems that facilitate maximization of space utilization and turnover are critical components of the assessment process. Additionally, available infrastructures to support the physical movement of products to warehouses or storage, and from there to customers, must also be assessed. For example, transportation systems may influence how consumer ready products can be shipped to improve processor efficiently.

The economics of the physical buildings, location, infrastructure, technologies and other associated resources are brought to bear on the technical options to ensure that the most technically efficient and economically effective alternatives qualify for consideration. The best sources of technical and economic information are suppliers of warehousing and storage services. Trucking and rail companies are often very forthcoming in providing information on delivery charges for specific products from certain locations to certain destinations. The accuracy of the data supplied by these service suppliers is dependent on the clarity and precision of the input information they need to calculate their estimates. Thus, the stepwise process of gathering information is important because it provides the requisite information that feeds into future steps.

10.3.4 Sales and Marketing:

Marketing and sales are often taken for granted in feasibility studies. However, they provide a direct insight into the project's potential market and the *Structure, Conduct and Performance (SCP)* characteristics of the players within the industry. Therefore, the sales and marketing feasibility assessment bridges the intra-firm feasibility dimensions (those inside the firm) with the extra-firm feasibility dimensions (those outside of the firm).

The conceptual backbone for the Structure, Conduct and Performance (SCP) is the assessment of the demand and supply conditions of the product and the behavior of the other firms in the industry. The supply and demand conditions should cover the size and scope economies in the industry, seasonality and trends, availability and strength of substitutes to the product, industry growth rates and demand elasticities.

Industry (market) structure refers to the number and size of the firms (products) in the industry (market) that you intend to enter. Industry conduct describes the pricing behavior and price discovery mechanisms used by firms in the industry. In addition, it assesses product distribution mechanisms and available channels as well as promotional initiatives that are used in the industry. The intensity of research and development and the extent of legal tactics in the industry all provide indications of the depth of the transaction costs emanating from the conduct of firms in the industry. Finally, the industry performance assesses the profitability of firms in the industry. This requires information on prices, product quality, technical progress and industry capacity utilization.

10.3.5 Non-Market Factors:

A technically and economically feasible project can fail when confronted with certain government policies and/or regulations. Therefore, feasibility studies should assess the existing and/or planned regulatory initiatives that impinge on the project. For example, environmental regulations that are in place and their technical and economic compliance effects on the project must be analyzed to assess their implications for technology, location, and other decisions. Similarly, there is need to assess the implications of specific policies targeted to the industry of interest and evaluate changes in these policies. For example, policies that offer significant competitive advantage to the industry but are subject to change by administrative fiat need to be assessed for the potential effect on the viability of the proposed project.

The results of the foregoing analysis form the backdrop for assessing the feasibility of your product in the defined market domain. It helps you position your product within the context of what already exists and how it may differentiate itself to ensure its competitive advantage. The characteristics that are engineered into the product, as well as the pricing, promotion and distribution or placement opportunities are all influenced by a clear understanding and appreciation of the industry's Structure, Conduct and Performance (SCP).

10.3.6 Data Collection:

Information on industry structure and performance may be obtained from various government statistics, such as those developed and maintained by the Department of Commerce. These databases offer information on the number of firms and employees, average wages and benefits, total value of shipments, gross margins, etc. In addition to government databases, specific industries also collect their own statistics and commission reports that may be purchased. Interviews with specific industry experts can also be a major information source. Similarly, significant information may be obtained from industry news in the main media or in industry-specific publications. For example, when industry news reports indicate that plant closures are increasing, it may be logically extrapolated that industry capacity is high and utilization is low. The implication of this for performance is often easily inferred for undifferentiated or commodity industries. Marketing and promotional information may be obtained from special publications focusing on product marketing and promotions. These function-specific publications often discuss the successful initiatives and can provide significant insights into the approaches used in particular industries. Another source of information on industries is academics publications and government documents. Because Structure, Conduct and Performance (SCP) issues present important policy implications, they are the subject of study in many government and academic documents and they can provide important and significant insights on market structure, conduct and performance situation in many industries.

For agricultural value-added initiatives, secondary data can suffice for the input sourcing and procurement segment of the feasibility assessment. The sources of these secondary data include industry and trade publications as well as statistics of industry associations. Additionally, a number of government departments collect, analyze and publish some of these data. In special cases, primary data collection may be necessary and this may be done through formal surveys or interviews. For example, different suppliers may be asked to provide information on their products – prices, quantities and qualities – as well as the stability of their quotes, e.g., the frequency with which they change their prices, quantities and quality. In most cases, when potential suppliers feel the project initiative is credible, they will invest their best efforts to provide the required information.

It is important to note that the effective collection of primary data can be expensive and time consuming. An alternative to primary data when secondary data is not neatly available is to pull them together from different sources, ensuring that measurements and definitions are similar across sources. It may sometimes be necessary to transform data from different sources to comparable units to attain the necessary congruence required for analysis.

10.3.7 Customer Service and Support:

What do customers want? Ask them. The final step in the value chain framework to feasibility assessment is finding out what customers needs are not being satisfied by the current marketplace. The purpose of this is to determine if the proposed project's offer stand to make a difference in satisfying customer needs. The results will provide a credible input into the project's product differentiation index and allow the proponents to identify the appropriate placement and promotional options to employ. Customer service and support research allow the proposed project to gain insights into the nature and structure of its potential market. It can develop market segments at this step, allowing it to refocus other components of the initiative or revisit earlier steps in the feasibility assessment process. Since customers are the final arbiters on the success of a product, assessing how the project addresses their unmet needs is fundamental to the project's economic feasibility.

Information for the customer segment of the feasibility can be obtained from reviewing consumer publications and industry publications for general assessment of needs and how the project's offering addresses them. Direct information may be obtained by conducting focus group interviews, surveys and/or interviews. While these initiatives can be expensive, they are worthwhile if technical and economic assessments thus, far are supportive of the project and more information is required to make the decision. For this reason, it is prudent for the customer segment to be where it is in the value chain, i.e., the end. However, it is important to remember that the process described in this document is hardly linear but rather iterative, using information from one stage to dig deeper into or gather new information gathered from an earlier stage.

10.3.8 The Decision Recommendation:

The purpose of a business feasibility study is to make a decision about whether to proceed with a particular business opportunity. It provides the general internal and external value chain conditions that confront the business initiative and evaluates the proposed initiative's ability to be economically viable if it is found to be technically and operationally feasible. Therefore, the emphasis on the recommendations resulting from the feasibility study is economic or financial.

The easiest approach to the economic decision is to gather all the information at the different stages of the value chain and identify those that require capital expenditure and estimate these expenditures. Additionally, identify the different types of people and skills required to operate each stage of the value chain and determine what their wages, salaries and benefits will be. Finally, identify other project related costs such as infrastructure development or improvements, occupancy, advertising and promotion, office supplies and utility as well as fees and municipal or state development taxes specific to the project. Next, using the production capacity, projected market share growth rates and the estimated market size, in conjunction with price information collected in the various stages of the feasibility study; develop a projected revenue or sales statement. It is important to specifically define all assumptions that drive the income and cash flow projections, e.g., the mean or median wages, salaries and benefits, current price and industry average of plant operating capacity, etc. Also, analyze all the data that were collected to determine their ranges, adjusted for special circumstances and use these to conduct the sensitivity analysis on the economic outcomes of the project.

10.3.9 Cost and Revenue Projections:

The cost and revenue projections together allow the development of the net cash flow emanating from the business over the projected time frame. This statement can then be subjected to capital investment analysis by selecting a reasonable discount rate and estimating the Net Present Value (NPV) and/or estimating the Internal Rate of Return (IRR) associated with the projected cash flow. A positive Net Present Value (NPV) implies an economically feasible project and the larger the positive Net Present Value, the more economically feasible the project, assuming the technical and operational feasibility can be assumed. If the project owners are making a decision based on the Internal Rate of Return, then they need to determine their required rate of return and compare it to the estimated Internal Rate of Return. If the Internal Rate of Return (IRR) exceeds their required rate of return, then the project is economically feasible. On the other hand, if the estimated Internal Rate of Return is less than the proponents' required rate of return, then the project is deemed economically infeasible even if it is both operationally and technically feasible.

10.3.10 Sensitivity Analysis:

It is important that the project cash flow is subjected to the full range of sensitivity analysis under a range of prices based on data that is collected for the feasibility study. This will provide the full range of conditions that support the feasibility of the project. The wider the band of feasible outcomes results from varying the critical assumptions, the more confident you can be about the viability of your project. On the other hand, if the band of feasibility is narrow vis-à-vis the critical variables, then the project's viability is more susceptible to uncertain shifts in its marketplace. For this reason, it is emphasized that the sensitivity analysis of the feasibility analysis be conducted over the full range of the project's industry possibilities. These possibilities may be divided into three blocks – worse case, normal case and best case scenarios. Additionally, the sensitivity analysis must be conducted for different scenarios, for example, best price with worst demand conditions. This provides insights into the critical bottlenecks to the project's viability and allows the proponents to assess the decision recommendations within a more informed framework.

10.4 Conclusion:

The purpose of a feasibility study is to help assess the viability of a business proposition, technically, operationally and economically. The value chain framework for conducting feasibility studies has the unique advantage of laying out the project in its logical configuration – from input procurement to customer service – and assessing the technical, operational and economic feasibility at each stage, and finally putting it all together to assess the total project feasibility. The advantage in this approach is revealed in exposing the bottlenecks to feasibility along the value chain so they can be assessed for possible improvement. The iterative nature of the approach is also helpful because it allows the analyst to revisit previous steps when information from latter steps suggests the need. In the end, the logical and step-wise process for conducting feasibility assessment within the value chain framework helps enhance transparency of the analysis and provide the foundations for better decisions.

The report was laid out to reflect expectation of presentation of a good feasibility report. Thus, it is expected that such a report will cover the input sourcing and procurement, operations and production, warehousing, storage and delivery. These three cover the logistics aspects of the production process and draws on the infrastructure conditions, technological and technical realities, human resource availability, capabilities and skills and customer expectations of quality associated with the product. Marketing, sales and customer service take the analysis into the project's external domain to assess industry structure, conduct and performance characteristics as well as regulatory hurdles that confront the project. The customer service and support component demand of the analyst to determine the specific needs of customers that may be addressed by the project's offering and estimate the product differentiation index.

Pulling all the information together into financial units, the analyst can build the investment, operational costs and revenue projections over a reasonable time frame and estimate the Net Present Value (NPV) and/or the Internal Rate of Return (IRR) to facilitate making decision recommendations. A project returning a positive Net Present Value is deemed feasible and the larger the Net Present Value the better. Project analyst needs to determine the required rate of return that investors in the project would deem acceptable and compare it to the Internal Rate of Return to determine the project's feasibility. If the former is lower than the estimated Internal Rate of Return, then the project is judged to be feasible and vice versa.

LESSON 11

PROJECT SELECTION

Broad Contents

Introduction
Project decisions
Types of project selection models
Criteria for choosing project model
The nature of project selection models
Numeric and non-numeric models

11.1 Introduction:

Project selection is the ***process of choosing a project or set of projects to be implemented by the organization***. Since projects in general require a substantial investment in terms of money and resources, both of which are limited, it is of vital importance that the projects that an organization selects provide good returns on the resources and capital invested. This requirement must be balanced with the need for an organization to move forward and develop. The high level of uncertainty in the modern business environment has made this area of project management crucial to the continued success of an organization with the difference between choosing good projects and poor projects literally representing the difference between operational life and death.

Because a successful model must capture every critical aspect of the decision, more complex decisions typically require more sophisticated models. "There is a simple solution to every complex problem; unfortunately, it is wrong". This reality creates a major challenge for tool designers. Project decisions are often high-stakes, dynamic decisions with complex technical issues—precisely the kinds of decisions that are most difficult to model:

- Project selection decisions are high-stakes because of their strategic implications. The projects a company chooses can define the products it supplies, the work it does, and the direction it takes in the marketplace. Thus, project decisions can impact every business stakeholder, including customers, employees, partners, regulators, and shareholders. A sophisticated model may be needed to capture strategic implications.

- Project decisions are dynamic because a project may be conducted over several budgeting cycles, with repeated opportunities to slow, accelerate, re-scale, or terminate the project. Also, a successful project may produce new assets or products that create time-varying financial returns and other impacts over many years. A more sophisticated model is needed to address dynamic impacts.

- Project decisions typically produce many different types of impacts on the organization. For example, a project might increase revenue or reduce future costs. It might impact how customers or investors perceive the organization. It might provide new capability or learning, important to future success. Making good choices requires not just estimating the financial return on investment; it requires understanding all of the ways that projects add value. A more sophisticated model is needed to account for all of the different types of potential impacts that project selection decisions can create.

11.2 Project Decisions:

Project decisions often entail risk and uncertainty. The significance of a project risk depends on the nature of that risk and on the other risks that the organization is taking. A more sophisticated model is needed to correctly deal with risk and uncertainty.

Project selection is the process of evaluating individual projects or groups of projects, and then choosing to implement some set of them so that the objectives of the parent organization will be achieved. This same systematic process can be applied to any area of the organization's business in which choices must be made between competing alternatives. For example:

- A manufacturing firm can use evaluation/selection techniques to choose which machine to adopt in a part-fabrication process.
- A television station can select which of several syndicated comedy shows to rerun in its 7:30 p.m. weekday time-slot
- A construction firm can select the best subset of a large group of potential projects on which to bid
- A hospital can find the best mix of psychiatric, orthopedic, obstetric, and other beds for a new wing.

Each project will have different costs, benefits, and risks. Rarely are these known with certainty. In the face of such differences, the selection of one project out of a set is a difficult task. Choosing a number of different projects, a ***portfolio,*** is even more complex. In the following sections, we discuss several techniques that can be used to help senior managers select projects. Project selection is only one of many decisions associated with project management.

To deal with all of these problems, we use *decision aiding models.* We need such models because they abstract the relevant issues about a problem from the plethora of detail in which the problem is embedded. Reality is far too complex to deal with in its entirety. An "idealist" is needed to strip away almost all the reality from a problem, leaving only the aspects of the "real" situation with which he or she wishes to deal. This process of carving away the unwanted reality from the bones of a problem is called *modeling the problem.* The idealized version of the problem that results is called a *model.*

The model represents the problem's *structure,* its form. Every problem has a form, though often we may not understand a problem well enough to describe its structure. We will use many models in this book—graphs, analogies, diagrams, as well as *flow graph and network models* to help solve scheduling problems, and *symbolic* (mathematical) models for a number of purposes.

Models may be quite simple to understand, or they may be extremely complex. In general, introducing more reality into a model tends to make the model more difficult to manipulate. If the input data for a model are not known precisely, we often use probabilistic information; that is, the model is said to be *stochastic* rather than *deterministic.*

Again, in general, stochastic models are more difficult to manipulate. We live in the midst of what has been called the "knowledge explosion." We frequently hear comments such as "90 percent of all we know about physics has been discovered since Albert Einstein published his original work on special relativity"; and "80 percent of what we know about the human body has been discovered in the past 50 years." In addition, evidence is cited to show that knowledge is growing exponentially.

Such statements emphasize the importance of the *management of change.* To survive, firms should develop strategies for assessing and reassessing the use of their resources. Every allocation of resources is an investment in the future. Because of the complex nature of most strategies, many of these investments are in projects.

To cite one of many possible examples, special visual effects accomplished through computer animation are common in the movies and television shows we watch daily. A few years ago they were unknown. When the capability was in its idea stage, computer companies as well as the firms producing movies and television shows faced the decision whether or not to invest in the development of these techniques. Obviously valuable as the idea seems today, the choice was not quite so clear a decade ago when an entertainment company compared investment in computer animation to alternative investments in a new star, a new rock group, or a new theme park.

The proper choice of investment projects is crucial to the long-run survival of every firm. Daily we witness the results of both good and bad investment choices. In our daily newspapers we read of Cisco System's decision to purchase firms that have developed valuable communication network software rather than to develop its own software. We read of Procter and Gamble's decision to invest heavily in marketing its products on the Internet; British Airways' decision to purchase passenger planes from Airbus instead of from its traditional supplier, Boeing; or problems faced by school systems when they update student computer labs—should they invest in Windows-based systems or stick with their traditional choice, Apple®. But can such important choices be made rationally? Once made, do they ever change, and if so, how? These questions reflect the need for effective selection models.

Within the limits of their capabilities, such models can be used to increase profits, select investments for limited capital resources, or improve the competitive position of the organization. They can be used for ongoing evaluation as well as initial selection, and thus, are a key to the allocation and reallocation of the organization's scarce resources.

11.2.1 Modeling:

A model is an object or concept, which attempts to capture certain aspects of the real world. The purpose of models can vary widely, they can be used to test ideas, to help teach or explain new concepts to people or simply as decorations. Since the uses that models can be put are so many it is difficult to find a definition that is both clear and conveys all the meanings of the word. In the context of project selection the following definition is useful:
"A model is an explicit statement of our image of reality. It is a representation of the relevant aspects of the decision with which we are concerned. It represents the decision area by structuring and formalizing the information we possess about the decision and, in doing so, presents reality in a simplified organized form. A model, therefore, provides us with an abstraction of a more complex reality". (Cooke and Slack, 1991)

When project selection models are seen from this perspective it is clear that the need for them arises from the fact that it is impossible to consider the environment, within which a project will be implemented, in its entirety. The challenge for a good project selection model is therefore clear. It must balance the need to keep enough information from the real world to make a good choice with the need to simplify the situation sufficiently to make it possible to come to a conclusion in a reasonable length of time.

11.3 Criteria for Choosing Project Model:

When a firm chooses a project selection model, the following criteria, based on Souder (1973), are most important:

1. ***Realism:***
The model should reflect the reality of the manager's decision situation, including the multiple objectives of both the firm and its managers. Without a common measurement system, direct comparison of different projects is impossible.

For example, Project A may strengthen a firm's market share by extending its facilities, and Project B might improve its competitive position by strengthening its technical staff. Other things being equal, which is better? The model should take into account the realities of the firm's limitations on facilities, capital, personnel, and so forth. The model should also include factors that reflect project risks, including the technical risks of performance, cost, and time as well as the market risks of customer rejection and other implementation risks.

2. ***Capability:***
The model should be sophisticated enough to deal with multiple time periods, simulate various situations both internal and external to the project (for example, strikes, interest rate changes), and optimize the decision. An optimizing model will make the comparisons that management deems important, consider major risks and constraints on the projects, and then select the best overall project or set of projects.

3. ***Flexibility:***
The model should give valid results within the range of conditions that the firm might experience. It should have the ability to be easily modified, or to be self-adjusting in response to changes in the firm's environment; for example, tax laws change, new technological advancements alter risk levels, and, above all, the organization's goals change.

4. ***Ease of Use:***
The model should be reasonably convenient, not take a long time to execute, and be easy to use and understand. It should not require special interpretation, data that are difficult to acquire, excessive personnel, or unavailable equipment. The model's variables should also relate one-to-one with those real-world parameters, the managers believe significant to the project. Finally, it should be easy to simulate the expected outcomes associated with investments in different project portfolios.

5. ***Cost:***
Data gathering and modeling costs should be low relative to the cost of the project and must surely be less than the potential benefits of the project. All costs should be considered, including the costs of data management and of running the model.

Here, we would also add a sixth criterion:

6. ***Easy Computerization:***
It should be easy and convenient to gather and store the information in a computer database, and to manipulate data in the model through use of a widely available, standard computer package such as Excel, Lotus 1-2-3, Quattro Pro, and like programs. The same ease and convenience should apply to transferring the information to any standard decision support system.

In what follows, we first examine fundamental types of project selection models and the characteristics that make any model more or less acceptable. Next we consider the limitations, strengths, and weaknesses of project selection models, including some suggestions of factors to consider when making a decision about which, if any, of the project selection models to use. We then discuss the problem of selecting projects when high levels of uncertainty about outcomes, costs, schedules, or technology are present, as well as some ways of managing the risks associated with the uncertainties.

Finally, we comment on some special aspects of the information base required for project selection. Then we turn our attention to the selection of a set of projects to help the organization achieve its goals and illustrate this with a technique called the *Project Portfolio Process.* We finish the chapter with a discussion of project proposals.

11.4 The Nature of Project Selection Models:

There are two basic types of project selection models, ***numeric*** and ***nonnumeric***. Both are widely used. Many organizations use both at the same time, or they use models that are combinations of the two. Nonnumeric models, as the name implies, do not use numbers as inputs. Numeric models do, but the criteria being measured may be either objective or subjective. It is important to remember that the *qualities* of a project may be represented by numbers, and that *subjective* measures are not necessarily less useful or reliable than *objective* measures.

Before examining specific kinds of models within the two basic types, let us consider just what we wish the model to do for us, never forgetting two critically important, but often overlooked facts.

- Models do not make decisions—people do. The manager, not the model, bears responsibility for the decision. The manager may "delegate" the task of making the decision to a model, but the responsibility cannot be abdicated.

- All models, however sophisticated, are only partial representations of the reality they are meant to reflect. Reality is far too complex for us to capture more than a small fraction of it in any model. Therefore, no model can yield an optimal decision except within its own, possibly inadequate, framework.

We seek a model to assist us in making project selection decisions. This model should possess the characteristics discussed previously and, above all, it should evaluate potential projects by the degree to which they will meet the firm's objectives. To construct a selection/evaluation model, therefore, it is necessary to develop a list of the firm's objectives.

A list of objectives should be generated by the organization's top management. It is a direct expression of organizational philosophy and policy. The list should go beyond the typical clichés about "survival" and "maximizing profits," which are certainly real goals but are just as certainly not the only goals of the firm. Other objectives might include maintenance of share of specific markets, development of an improved image with specific clients or competitors, expansion into a new line of business, decrease in sensitivity to business cycles, maintenance of employment for specific categories of workers, and maintenance of system loading at or above some percent of capacity, just to mention a few.

A model of some sort is implied by any conscious decision. The choice between two or more alternative courses of action requires reference to some objective(s), and the choice is thus, made in accord with some, possibly subjective, "model." Since the development of computers and the establishment of operations research as an academic subject in the mid-1950s, the use of formal, numeric models to assist in decision making has expanded. Many of these models use financial metrics such as profits and/or cash flow to measure the "correctness" of a managerial decision. Project selection decisions are no exception, being based primarily on the degree to which the financial goals of the organization are met. As we will see later, this stress on financial goals, largely to the exclusion of other criteria, raises some serious problems for the firm, irrespective of whether the firm is for profit or not-for-profit.

When the list of objectives has been developed, an additional refinement is recommended. The elements in the list should be *weighted.* Each item is added to the list because it represents a contribution to the success of the organization, but each item does not make an equal contribution. The weights reflect different degrees of contribution each element makes in accomplishing a set of goals.

Once the list of goals has been developed, one more task remains. The probable contribution of each project to each of the goals should be estimated. A project is selected or rejected because it is predicted to have certain outcomes if implemented.

These outcomes are expected to contribute to goal achievement. If the estimated level of goal achievement is sufficiently large, the project is selected. If not, it is rejected.

The relationship between the project's expected results and the organization's goals must be understood. In general, the kinds of information required to evaluate a project can be listed under production, marketing, financial, personnel, administrative, and other such categories.

The following table 11.1 is a list of factors that contribute, positively or negatively, to these categories.

In order to give focus to this list, we assume that the projects in question involve the possible substitution of a new production process for an existing one. The list is meant to be illustrative. It certainly is not exhaustive.

Production Factors
1. Time until ready to install
2. Length of disruption during installation
3. Learning curve—time until operating as desired
4. Effects on waste and rejects
5. Energy requirements
6. Facility and other equipment requirements
7. Safety of process
8. Other applications of technology
9. Change in cost to produce a unit output
10. Change in raw material usage
11. Availability of raw materials
12. Required development time and cost
13. Impact on current suppliers
14. Change in quality of output

Marketing Factors
1. Size of potential market for output
2. Probable market share of output
3. Time until market share is acquired
4. Impact on current product line
5. Consumer acceptance
6. Impact on consumer safety
7. Estimated life of output
8. Spin-off project possibilities

Financial Factors
1. Profitability, net present value of the investment
2. Impact on cash flows
3. Payout period
4. Cash requirements
5. Time until break-even
6. Size of investment required
7. Impact on seasonal and cyclical fluctuations

Personnel Factors
1. Training requirements
2. Labor skill requirements
3. Availability of required labor skills
4. Level of resistance from current work force
5. Change in size of labor force
6. Inter- and intra-group communication requirements
7. Impact on working conditions

Administrative and Miscellaneous Factors
1. Meet government safety standards
2. Meet government environmental standards
3. Impact on information system
4. Reaction of stockholders and securities markets
5. Patent and trade secret protection
6. Impact on image with customers, suppliers, and competitors
7. Degree to which we understand new technology
8. Managerial capacity to direct and control new process

Table 11.1: Factors Contributing to Various Organizational Categories

Some factors in this list have a one-time impact and some recur. Some are difficult to estimate and may be subject to considerable error. For these, it is helpful to identify a *range of uncertainty*. In addition, the factors may occur at different times.

And some factors may have *thresholds,* critical values above or below which we might wish to reject the project. We will deal in more detail with these issues later in this chapter.

Clearly, no single project decision needs to include all these factors. Moreover, not only is the list incomplete, it also contains redundant items. Perhaps more important, the factors are not at the same level of generality: *profitability* and *impact on organizational image* both affect the overall organization, but *impact on working conditions* is more oriented to the production system. Nor are all elements of equal importance.

Change in production cost is usually considered more important than *impact on current suppliers.* Shortly, we will consider the problem of generating an acceptable list of factors and measuring their relative importance. At that time we will discuss the creation of a Decision Support System (DSS) for project evaluation and selection.

The same subject will arise once more in the next lecture(s) when we consider project auditing, evaluation, and termination.

Although the process of evaluating a potential project is time-consuming and difficult, its importance cannot be overstated. A major consulting firm has argued (Booz, Allen, and Hamilton, 1966) that the primary cause for the failure of Research and Development (R and D) projects is insufficient care in evaluating the proposal before the expenditure of funds. What is true for such projects also appears to be true for other kinds of projects, and it is clear that product development projects are more successful if they incorporate user needs and satisfaction in the design process (Matzler and Hinterhuber, 1998). Careful analysis of a potential project is a *sine qua non* for profitability in the construction business. There are many horror stories (Meredith, 1981) about firms that undertook projects for the installation of a computer information system without sufficient analysis of the time, cost, and disruption involved.

Later, we will consider the problem of conducting an evaluation under conditions of uncertainty about the outcomes associated with a project. Before dealing with this problem, however, it helps to examine several different evaluation/selection models and consider their strengths and weaknesses. Recall that the problem of choosing the project selection model itself will also be discussed later.

11.5 Types of Project Selection Models:

Of the two basic types of selection models (numeric and nonnumeric), nonnumeric models are older and simpler and have only a few subtypes to consider. We examine them first.

- **Non-Numeric Models:**

These include the following:

1. ***The Sacred Cow:***
In this case the project is suggested by a senior and powerful official in the organization. Often the project is initiated with a simple comment such as, "If you have a chance, why don't you look into . . .," and there follows an undeveloped idea for a new product, for the development of a new market, for the design and adoption of a global database and information system, or for some other project requiring an investment of the firm's resources. The immediate result of this bland statement is the creation of a "project" to investigate whatever the boss has suggested.

The project is "sacred" in the sense that it will be maintained until successfully concluded, or until the boss, personally, recognizes the idea as a failure and terminates it.

2. ***The Operating Necessity:***
If a flood is threatening the plant, a project to build a protective dike does not require much formal evaluation, which is an example of this scenario. XYZ Steel Corporation has used this criterion (and the following criterion also) in evaluating potential projects. If the project is required in order to keep the

system operating, the primary question becomes: Is the system worth saving at the estimated cost of the project? If the answer is yes, project costs will be examined to make sure they are kept as low as is consistent with project success, but the project will be funded.

3. The Competitive Necessity:

Using this criterion, XYZ Steel undertook a major plant rebuilding project in the late 1960s in its steel bar manufacturing facilities near Chicago. It had become apparent to XYZ's management that the company's bar mill needed modernization if the firm was to maintain its competitive position in the Chicago market area. Although the planning process for the project was quite sophisticated, the decision to undertake the project was based on a desire to maintain the company's competitive position in that market.

In a similar manner, many business schools are restructuring their undergraduate and Masters in Business Administration (MBA) programs to stay competitive with the more forward looking schools. In large part, this action is driven by declining numbers of tuition paying students and the need to develop stronger programs to attract them.

Investment in an *operating necessity* project takes precedence over a *competitive necessity* project, but both types of projects may bypass the more careful numeric analysis used for projects deemed to be less urgent or less important to the survival of the firm.

4. The Product Line Extension:

In this case, a project to develop and distribute new products would be judged on the degree to which it fits the firm's existing product line, fills a gap, strengthens a weak link, or extends the line in a new, desirable direction.

Sometimes careful calculations of profitability are not required. Decision makers can act on their beliefs about what will be the likely impact on the total system performance if the new product is added to the line.

5. Comparative Benefit Model:

For this situation, assume that an organization has many projects to consider, perhaps several dozen. Senior management would like to select a subset of the projects that would most benefit the firm, but the projects do not seem to be easily comparable. For example, some projects concern potential new products, some concern changes in production methods, others concern computerization of certain records, and still others cover a variety of subjects not easily categorized (e.g., a proposal to create a daycare center for employees with small children).

The organization has no formal method of selecting projects, but members of the selection committee think that some projects will benefit the firm more than others, even if they have no precise way to define or measure "benefit."

The concept of comparative benefits, if not a formal model, is widely adopted for selection decisions on all sorts of projects. Most United Way organizations use the concept to make decisions about which of several social programs to fund. Senior management of the funding organization then examines all projects with positive recommendations and attempts to construct a portfolio that best fits the organization's aims and its budget.

PROJECT SELECTION (CONTD.)

Broad Contents

Q-Sort Model
Pay-back Period
Average Rate of Return
Discounted Cash Flow
Internal Rate of Return (IRR)

12.1 Types of Project Selection Models (Continued):

- **Non-Numeric Models:**

  - **Q-Sort Model:**
    Of the several techniques for ordering projects, the Q-Sort (Helin and Souder, 1974) is one of the most straightforward. First, the projects are divided into three groups—*good, fair*, and *poor*—according to their relative merits. If any group has more than eight members, it is subdivided into two categories, such as *fair-plus* and *fair-minus*. When all categories have eight or fewer members, the projects within each category are ordered from best to worst. Again, the order is determined on the basis of relative merit. The rater may use specific criteria to rank each project, or may simply use general overall judgment. (See Figure 12.1 below for an example of a Q-Sort.)

Steps

1. For each participant in the exercise, assemble a deck of cards, with the name and description of one project on each card.
2. Instruct each participant to divide the deck into two piles, one representing a high priority, the other a low-priority level. (The piles need not be equal.)
3. Instruct each participant to select cards from each pile to form a third pile representing the medium-priority level.
4. Instruct each participant to select cards from the high-level pile to yield another pile representing the very high level of priority; select cards from the low-level pile representing the very low level of priority.
5. Finally, instruct each participant to survey the selections and shift any cards that seem out of place until the classifications are satisfactory.

Results at Each Step

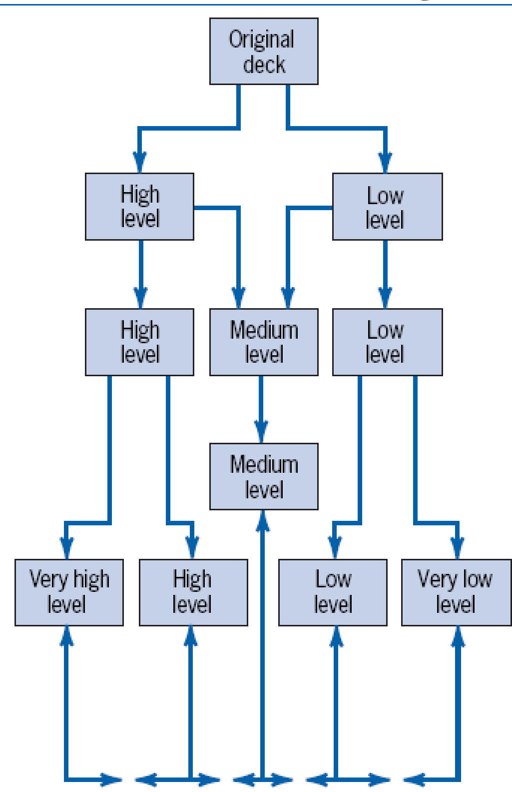


Figure 12.1: Example of a Q-Sort

The process described may be carried out by one person who is responsible for evaluation and selection, or it may be performed by a committee charged with the responsibility. If a committee handles the task, the individual rankings can be developed anonymously, and the set of anonymous rankings can be examined by the committee itself for consensus. It is common for such rankings to differ somewhat from rater to rater, but they do not often vary strikingly because the individuals chosen for such committees rarely differ widely on what they feel to be appropriate for the parent organization.

Projects can then be selected in the order of preference, though they are usually evaluated financially before final selection.

There are other, similar nonnumeric models for accepting or rejecting projects. Although it is easy to dismiss such models as unscientific, they should not be discounted casually. These models are clearly goal-oriented and directly reflect the primary concerns of the organization.

The sacred cow model, in particular, has an added feature; sacred cow projects are visibly supported by "the powers that be." Full support by top management is certainly an important contributor to project success (Meredith, 1981). Without such support, the probability of project success is sharply lowered.

- **Numeric Models: Profit/Profitability**

As noted earlier, a large majority of all firms using project evaluation and selection models use profitability as the sole measure of acceptability. We will consider these models first, and then discuss models that surpass the profit test for acceptance.

1. Payback Period:

The payback period for a project is the initial fixed investment in the project divided by the estimated annual net cash inflows from the project. The ratio of these quantities is the number of years required for the project to repay its initial fixed investment. For example, assume a project costs $100,000 to implement and has annual net cash inflows of $25,000. Then

$$\text{Payback period} = \$100{,}000/\$25{,}000 = 4 \text{ years}$$

This method assumes that the cash inflows will persist at least long enough to pay back the investment, and it ignores any cash inflows beyond the payback period. The method also serves as an (inadequate) proxy for risk. The faster the investment is recovered, the less the risk to which the firm is exposed.

2. Average Rate of Return:

Often mistaken as the reciprocal of the payback period, t*he average rate of return is the ratio of the average annual profit (either before or after taxes) to the initial or average investment in the project.* Because average annual profits are usually not equivalent to net cash inflows, the average rate of return does not usually equal the reciprocal of the payback period. Assume, in the example just given, that the average annual profits are $15,000:

$$\text{Average rate of return} = \$15{,}000/\$100{,}000 = 0.15$$

Neither of these evaluation methods is recommended for project selection, though payback period is widely used and does have a legitimate value for cash budgeting decisions. The major advantage of these models is their simplicity, but neither takes into account the time-value of money. Unless interest rates are extremely low and the rate of inflation is nil, the failure to reduce future cash flows or profits to their present value will result in serious evaluation errors.

3. *Discounted Cash Flow:*

Also referred to as the Net Present Value (NPV) method, the discounted cash flow method determines the net present value of all cash flows by discounting them by the required rate of return (also known as the hurdle rate, cutoff rate, and similar terms) as follows:

$$\text{NPV (project)} = A_0 + \sum_{t=1}^{n} \frac{F_t}{(1+k)^t}$$

where

F_t = the net cash flow in period t ,

k = the required rate of return, and

A_0 = initial cash investment (because this is an outflow, it will be negative).

To include the impact of inflation (or deflation) where *pt* is the predicted rate of inflation during period *t,* we have

$$\text{NPV (project)} = A_0 + \sum_{t=1}^{n} \frac{F_t}{(1+k+p_t)^t}$$

Early in the life of a project, net cash flow is likely to be negative, the major outflow being the initial investment in the project, *A*0. If the project is successful, however, cash flows will become positive. The project is *acceptable* if the sum of the net present values of all estimated cash flows over the life of the project is positive. A simple example will suffice. Using our \$100,000 investment with a net cash inflow of \$25,000 per year for a period of eight years, a required rate of return of 15 percent, and an inflation rate of 3 percent per year, we have

$$\text{NPV (project)} = \$100{,}000 + \sum_{t=1}^{8} \frac{\$25{,}000}{(1+0.15+0.03)^t}$$
$$= \$1939$$

Because the present value of the inflows is greater than the present value of the outflow— that is, the net present value is positive—the project is deemed acceptable.

For example:

PsychoCeramic Sciences, Inc. (PSI), a large producer of cracked pots and other cracked items, is considering the installation of a new marketing software package that will, it is hoped, allow more accurate sales information concerning the inventory, sales, and deliveries of its pots as well as its vases designed to hold artificial flowers.

The information systems (IS) department has submitted a project proposal that estimates the investment requirements as follows: an initial investment of \$125,000 to be paid up-front to the Pottery Software.

Corporation; an additional investment of $100,000 to modify and install the software; and another $90,000 to integrate the new software into the overall information system. Delivery and installation is estimated to take one year; integrating the entire system should require an additional year.

Thereafter, the IS department predicts that scheduled software updates will require further expenditures of about $15,000 every second year, beginning in the fourth year. They will not, however, update the software in the last year of its expected useful life.

The project schedule calls for benefits to begin in the third year, and to be up-to-speed by the end of that year. Projected additional profits resulting from better and more timely sales information are estimated to be $50,000 in the first year of operation and are expected to peak at $120,000 in the second year of operation, and then to follow the gradually declining pattern shown in the table 12.1 below.

Project life is expected to be 10 years from project inception, at which time the proposed system will be obsolete for this division and will have to be replaced. It is estimated, however, that the software can be sold to a smaller division of PsychoCeramic Sciences, Inc. (PSI) and will thus, have a salvage value of $35,000. The Company has a 12 percent hurdle rate for capital investments and expects the rate of inflation to be about 3 percent over the life of the project. Assuming that the initial expenditure occurs at the beginning of the year and that all other receipts and expenditures occur as lump sums at the end of the year, we can prepare the Net Present Value analysis for the project as shown in the table 12.1 below.

The Net Present Value of the project is positive and, thus, the project can be accepted. (The project would have been rejected if the hurdle rate were 14 percent.) Just for the intellectual exercise, note that the total inflow for the project is $759,000, or $75,900 per year on average for the 10 year project. The required investment is $315,000 (ignoring the biennial overhaul charges). Assuming 10 year, straight line depreciation, or $31,500 per year, the payback period would be:

$$PB = \frac{\$315{,}000}{\$75{,}900 + 31{,}500} = 2.9 \text{ years}$$

A project with this payback period would probably be considered quite desirable.

Year A	Inflow B	Outflow C	Net Flow D = (B − C)	Discount Factor $1/(1+k+p)^t$	Net Present Value D (Disc. Fact.)
2006*	$ 0	$125,000	$−125,000	1.0000	$−125,000
2006	0	100,000	−100,000	0.8696	−86,957
2007	0	90,000	-90,000	0.7561	−68,053
2008	50,000	0	50,000	0.6575	32,876
2009	120,000	15,000	105,000	0.5718	60,034
2010	115,000	0	115,000	0.4972	57,175
2011	105,000	15,000	90,000	0.4323	38,909
2012	97,000	0	97,000	0.3759	36,466
2013	90,000	15,000	75,000	0.3269	24,518
2014	82,000	0	82,000	0.2843	23,310
2015	65,000	0	65,000	0.2472	16,067
2015	35,000		35,000	0.2472	8,651
Total	$759,000	$360,000	$ 399,000		$ 17,997

* t = 0 at the beginning of 2006.

Table 12.1: Net Present Value (NPV) Analysis

4. ***Internal Rate of Return (IRR):***
If we have a set of expected cash inflows and cash outflows, the internal rate of return is the discount rate that equates the present values of the two sets of flows. If At is an expected cash outflow in the period t and Rt is the expected inflow for the period t , the internal rate of return is the value of k that satisfies the following equation (note that the A 0 will be positive in this formulation of the problem):

$$A_0 + A_1/(1+k) + A_2/(1+k)^2 + \ldots + A_n/(1+k)^n = R_1/(1+k) + R_2/(1+k)^2 + \ldots + R_n/(1+k)^n$$

The value of k is found by trial and error.

5. ***Profitability Index:***
Also known as the benefit–cost ratio, the profitability index is the net present value of all future expected cash flows divided by the initial cash investment. (Some firms do not discount the cash flows in making this calculation.) If this ratio is greater than 1.0, the project may be accepted.

6. ***Other Profitability Models:***
There are a great many variations of the models just described. These variations fall into three general categories. These are:

a) Those that subdivide net cash flow into the elements that comprises the net flow.
b) Those that include specific terms to introduce risk (or uncertainty, which is treated as risk) into the evaluation.
c) Those that extend the analysis to consider effects that the project might have on other projects or activities in the organization.

12.1.1 Advantages of Profit-Profitability Numeric Models:

Several comments are in order about all the profit-profitability numeric models. First, let us consider their advantages:

- The undiscounted models are simple to use and understand.
- All use readily available accounting data to determine the cash flows.
- Model output is in terms familiar to business decision makers.

- With a few exceptions, model output is on an "absolute" profit/profitability scale and allows "absolute" go/no-go decisions.
- Some profit models account for project risk.

12.1.2 Disadvantages of Profit-Profitability Numeric Models:

The disadvantages of these models are the following:

- These models ignore all non-monetary factors except risk.
- Models that do not include discounting ignore the timing of the cash flows and the time–value of money.
- Models that reduce cash flows to their present value are strongly biased toward the short run.
- Payback-type models ignore cash flows beyond the payback period.
- The internal rate of return model can result in multiple solutions.
- All are sensitive to errors in the input data for the early years of the project.
- All discounting models are nonlinear, and the effects of changes (or errors) in the variables or parameters are generally not obvious to most decision makers.
- All these models depend for input on a determination of cash flows, but it is not clear exactly how the concept of cash flow is properly defined for the purpose of evaluating projects.

12.1.3 Profit-Profitability Numeric Models – An Overview:

A complete discussion of profit/profitability models can be found in any standard work on financial management—see Ross, Westerfield, and Jordan (1995), for example.

In general, the net present value models are preferred to the internal rate of return models. Despite wide use, financial models rarely include non-financial outcomes in their benefits and costs. In a discussion of the financial value of adopting project management (that is, selecting as a project the use of project management) in a firm, Githens (1998) notes that traditional financial models "simply cannot capture the complexity and value-added of today's process-oriented firm."

The commonly seen phrase "Return on Investment," or ROI, does not denote any *specific* method of calculation. It usually involves Net Present Value (NPV) or Internal Rate of Return (IRR) calculations, but we have seen it used in reference to undiscounted average rate of return models and (incorrectly) payback period models.

In our experience, the payback period model, occasionally using discounted cash flows, is one of the most commonly used models for evaluating projects and other investment opportunities. Managers generally feel that insistence on short payout periods tends to minimize the *risks* associated with outstanding monies over the passage of time. While this is certainly logical, we prefer evaluation methods that discount cash flows and deal with uncertainty more directly by considering specific risks. Using the payout period as a cash-budgeting tool aside, *its primary virtue is its simplicity.*

Real Options: Recently, a project selection model was developed based on a notion well known in financial markets. When one invests, one foregoes the value of alternative future investments. Economists refer to the value of an opportunity foregone as the "opportunity cost" of the investment made.

The argument is that a project may have greater net present value if delayed to the future. If the investment can be delayed, its cost is discounted compared to a present investment of the same amount. Further, if the investment in a project is delayed, its value may increase (or decrease) with the passage of time because some of the uncertainties will be reduced. If the value of the project drops, it may fail the selection process. If the value increases, the investor gets a higher payoff. The real options approach acts to reduce both technological and commercial risk. For a full explanation of the method and its use as a strategic selection tool, see Luehrman (1998a and 1998b). An interesting application of real options as a project selection tool for pharmaceutical Research and Development (R and D) projects is described by Jacob and Kwak (2003). Real options combined with Monte Carlo simulation is compared with alternative selection/assessment methods by Doctor, Newton, and Pearson (2001).

PROJECT PROPOSAL

12.2 Introduction:

Project Proposal is the initial document that converts an idea or policy into details of a potential project, including the outcomes, outputs, major risks, costs, stakeholders and an estimate of the resource and time required.

To begin planning a proposal, remember the basic definition: ***a proposal is an offer or bid to do a certain project for someone.*** Proposals may contain other elements – technical background, recommendations, results of surveys, information about feasibility, and so on. But what makes a proposal a proposal is, that it asks the audience to approve, fund, or grant permission to do the proposed project.

If you plan to be a consultant or run your own business, written proposals may be one of your most important tools for bringing in business. And, if you work for a government agency, non-profit organization, or a large corporation, the proposal can be a valuable tool for initiating projects that benefit the organization or you the employee proposed (and usually both).

A proposal should contain information that would enable the audience of that proposal to decide whether to approve the project, to approve or hire you to do the work, or both. To write a successful proposal, put yourself in the place of your audience – the recipient of the proposal, and think about what sorts of information that person would need to feel confident having you do the project.

It is easy to get confused about proposals. Imagine that you have a terrific idea for installing some new technology where you work and you write up a document explaining how it works and why it is so great, showing the benefits, and then end by urging management to go for it. Is that a proposal? The answer is “No”, at least not in this context. It is more like a feasibility report, which studies the merits of a project and then recommends for or against it. Now, all it would take to make this document a proposal would be to add elements that ask management for approval for you to go ahead with the project. Certainly, some proposals must sell the projects they offer to do, but in all cases proposals must sell the writer (or the writer's organization) as the one to do the project.

12.3 Types of Project Proposals:

Consider the situations in which proposals occur. A company may send out a public announcement requesting proposals for a specific project. This public announcement, called a *Request for Proposal (RFP)*, could be issued through newspapers, trade journals, Chamber of Commerce channels, or individual letters. Firms or individuals interested in the project would then write proposals in which they summarize their qualifications, project schedules and costs, and discuss their approach to the project. The recipient of all these proposals would then evaluate them, select the best candidate, and then work up a contract.

But proposals come about much less formally. Imagine that you are interested in doing a project at work (for example, investigating the merits of bringing in some new technology to increase productivity). Imagine that you visited with your supervisor and tried to convince her of this. She might respond by saying, "Write me a proposal and I will present it to upper management." As you can see from these examples, proposals can be divided into several categories:

1. Internal Proposal:

If you write a proposal to someone within your organization (a business, a government agency, etc.), it is an internal proposal. With internal proposals, you may not have to include certain sections (such as qualifications), or you may not have to include as much information in them.

2. External Proposal:

An external proposal is one written by a separate, independent consultant proposing to do a project for another firm. It can be a proposal from organization or individual to another such entity.

3. Solicited Proposal:

If a proposal is solicited, the recipient of the proposal in some way requested the proposal. Typically, a company will send out requests for proposals (RFPs) through the mail or publish them in some news source. But proposals can be solicited on a very local level. For example, you could be explaining to your boss what a great thing it would be to install a new technology in the office; your boss might get interested and ask you to write up a proposal that offered to do a formal study of the idea.

4. Unsolicited Proposal:

Unsolicited proposals are those in which the recipient has not requested proposals. With unsolicited proposals, you sometimes must convince the recipient that a problem or need exists before you can begin the main part of the proposal.

Solicited vs. Unsolicited Proposals

1. Solicited

An organization (private/public foundation, state/federal agency, etc…) has solicited proposals when it sends out an announcement of a grant/contract/cooperative agreement program and invites other organizations/individuals to submit proposals.

a. Common Solicitations
RFA: request for applications (grant)
RFP: request for proposals (contract –usually)
RFQ: request for quotation (contract)
PA: program announcement (grant)
BAA: broad agency announcement

b. Response to solicitation: your proposal *(application, proposal, quotation: all synonymous)*
Usually includes the following (as outlined in the application request/solicitation):
Scope of work
Work plan, methodology, aims
Key personnel
Resources
Budget
Budget justification

2. Unsolicited

Even if an organization has not solicited proposals, it might accept and fund projects based on an unsolicited proposal.
a. Common unsolicited agreements:
Gifts
Grants
Contracts
Cooperative agreements

b. You initiate the contact.

Many agencies accept unsolicited proposals. Depending on the agency, unsolicited proposals range from lengthy full-proposals, using agency-specific forms, to short letter proposals, which consist of 2-4 pages and are also called letters of inquiry.

Table 12.2: Solicited Versus Unsolicited Proposals

12.3.1 Request for Proposal:

A Request for Proposal (referred to as RFP) is an invitation for suppliers, through a bidding process, to submit a proposal on a specific product or service.

A Request for Proposal (RFP) typically involves more than the price. Other requested information may include basic corporate information and history, financial information (can the company deliver without risk of bankruptcy), technical capability (used on major procurements of services, where the item has not previously been made or where the requirement could be met by varying technical means), product information such as stock availability and estimated completion period, and customer references that can be checked to determine a company's suitability.

In the military, Request for Proposal (RFP) is often raised to fulfill an Operational Requirement (OR), after which the military procurement authority will normally issue a detailed technical specification against which tenders will be made by potential contractors. In the civilian use, Request for Proposal (RFP) is usually part of a complex sales process, also known as enterprise sales.

Request for Proposals (RFPs) often include specifications of the item, project or service for which a proposal is requested. The more detailed the specifications, the better the chances that the proposal provided will be accurate. Generally Request for Proposals (RFPs) are sent to an approved supplier or vendor list.

The bidders return a proposal by a set date and time. Late proposals may or may not be considered, depending on the terms of the initial Request for Proposal. The proposals are used to evaluate the suitability as a supplier, vendor, or institutional partner. Discussions may be held on the proposals (often to clarify technical capabilities or to note errors in a proposal). In some instances, all or only selected bidders may be invited to participate in subsequent bids, or may be asked to submit their best technical and financial proposal, commonly referred to as a Best and Final Offer (BAFO).

12.3.2 Request for Proposal (RFP) Variation:

The Request for Quotation (RFQ) is used where discussions are not required with bidders (mainly when the specifications of a product or service are already known), and price is the main or only factor in selecting the successful bidder. Request for Quotation (RFQ) may also be used as a step prior to going to a full-blown Request for Proposal (RFP) to determine general price ranges. In this scenario, products, services or suppliers may be selected from the Request for Quotation (RFQ) results to bring in to further research in order to write a more fully fleshed out Request for Proposal (RFP).

Request for Proposal (RFP) is sometimes used for a Request for Pricing.

12.3.3 Request for Information (RFI):

Request for Information (RFI) is a proposal requested from a potential seller or a service provider to determine what products and services are potentially available in the marketplace to meet a buyer's needs and to know the capability of a seller in terms of offerings and strengths of the seller. Request for Information (RFIs) are commonly used on major procurements, where a requirement could potentially be met through several alternate means. A Request for Information (RFI), however, is not an invitation to bid, is not binding on either the buyer or sellers, and may or may not lead to a Request for Proposal (RFP) or Request for Quotation (RFQ).

PROJECT PROPOSAL

Broad Contents

Characteristics of a Project Proposal
Preparation for Future Proposal
Proposal Effort for Specific Proposals
Proposal Efforts
Typical Engineering, Procurement and Construction (EPC) Proposal Contents
Modifications to the Standard Proposal

13.1 Characteristics of a Project Proposal:

The more important characteristics of a project proposal are:

1. Proposal projects are high priority, short duration efforts. They must be completed to the owners schedule requirement regardless of the work load and other demands on the contracting organizations.

2. The owner's specifications for the preferred payment method must be adhered to, at least in the basic proposal. Alternates which offer benefits to both parties may be suggested for the owner's consideration.

3. The owner frequently will specify a particular format for the proposal and for presentation of the requested information.

4. The owner may express a clear preference as to the location where the project work will be done. The engineering company may suggest alternate arrangements that give the owner a more cost effective project without sacrificing the required contract. The base proposal however, must be as responsive as possible.

5. The owner may have a preference, openly expressed or merely implied, for the construction labor arrangement. If this preference has not been made clear in the Request for Proposal (RFP) or in the discussions with the owner, it should be determined at the earliest possible time in the proposal effort so that the proper construction program may be planned.

6. A proposal project requires forming a team of the representatives for sales, project management, technical and support functions. Many of these have responsibilities over and above the proposal project. These work loads must be considered and respected insofar as is possible.

7. Proposal projects are normally costed against corporate overhead and therefore will be tightly budgeted and be closely monitored by senior management.

13.2 Preparation for Future Proposal:

Because of the price restraints and the repetitive nature of much of the data used in proposals, it is helpful to collect as much as possible of the proposal information in advance. This is especially true for the following areas:

- Proposal project manager should be identified in advance. In a company with a significant continuing proposals load, a group may be formed consisting of former project managers with verbal skills and the proper personality to allow them to function in the pressure cooking environment of proposal preparation. These individuals must have a high tolerance for working under tight schedules, stringent budgets, with borrowed personnel, and being the object of continual criticism which is not always constructive.

- A proposal publication staff should be in place to be fully effective. These individuals should have skills in editing, use of word processing and reproducing equipment, as well as graphic art capability. They should be able to work effectively with the masses of material in various stages of progress to assure that all of it comes together according to the schedule.

- A technical information data base including the full range of the type of projects offered by the company, including feasibility studies, engineering projects, as well as full scope projects for various types of facilities.

- Standard scope of services should be developed that can be readily customized for the particular project on word processing system. Much of the particular information of various projects is quiet similar and only requires bringing it into conformance with owner's requirements or with those of particular facility of location.

- The company should have developed comprehensive definitions for the various levels of efforts associated with producing cost estimates of various accuracies. This is particularly important for developing proposals for feasibility studies.

- Work plans should also be developed for the various basic types of projects. These can be of general information which can then be modified to conform to the plans for the specified project under consideration.

- A data bank is helpful to standardize commercial terms and conditions together with listing that define those costs included in overhead and those which are not. This is particularly important in reimbursable contracts to control charges to the standard check list and the resultant changes in the reimbursable unit cost.

- Qualification material should be updated frequently in several different standard formats such as:

    - Project performance data, schedule and cost
    - Descriptions of past projects
    - Resumes of key personnel
    - Write ups on support areas such as:
        - Project Controls
        - Procurement Procedures
        - Material Management
        - Quality Assurance Practices

- Typical write ups should be prepared in advance for various other parts of the proposal. These will be modified to suit the Request for Proposal (RFP) or inquiry document. Among other these writings include:
    - Introduction
    - Project Organization
    - Schedule
    - Project Controls
    - Compensation

13.3 Proposal Effort for Specific Proposals:

Preparation of the proposal may start as soon as there has been a positive indication that the company will be included in the bid list and preliminary information is available on the project. Early efforts would include:

- Preliminary assignments for the anticipated proposals would be made based upon the schedule for the Request for Proposal (RFP) release and the due date of the proposal. These assignments would include the proposal project manager, the project manager proposed to head the project, and the proposal publication and technical support personnel. In addition, the lead estimator, the lead scheduler, technical personnel, procurement and construction representatives as indicated by the nature of the effort would be selected.

- The preliminary proposal plan schedule and budget should be blocked out. The proposal plan would define the outline of the proposal and the preliminary assignment of the work. The schedule would indicate dates for completion of the preliminary draft, job hours and cost estimates, the final draft dates, the necessary dates for approval, and the publication and delivery dates.

- A rigorous assessment should be made of the technical aspects of the project to identify the company's strengths and weaknesses. Immediate and specific actions should be planned to boost capability where this is required and to develop the personnel and background information to cover these critical areas.

When Request for Proposal (RFP) is received, it is reviewed and a bid/no bid decision is made.

13.4 Proposal Effort:

1. Assignment of Proposal to Team Members:

As soon as decision to bid has been confirmed, the assignment of team members is finalized.

2. Kick-Off Meeting:

The project manager calls a kick-off meeting, at which the time task assignments and the corresponding schedules are made. At this meeting, technical, legal and compensation considerations are reviewed and assignments of responsibilities are made.

3. Preliminary Review of the Proposal Text:

All material is typed on word processor, with margins for easier editing. Typed drafts should be checked carefully against the original draft to assure that nothing has been inadvertently omitted.

4. Final Review:

When text is essentially in final form and all changes have been incorporated, it is submitted for review of operations management and for final legal review. All major changes from this last text review should be flagged so that the signoff should be obtained quickly.

5. Publication and Signoff

6. Delivery of the Proposal

13.5 Typical Engineering Procurement and Construction (epc) Proposal Contents:

Following is the summary of the typical contents of cost reimbursable proposal for Engineering, Procurement and Construction services.

1. Introduction and Summary:

The Request for Proposal (RFP) conditions are summarized and general approach to the work by the contractor is indicated.

2. Project Description:

This material is largely taken from the Request for Proposal (RFP). It may also include information that has been obtained by site visits, during pre-bid conference, and in other contacts with the owner of other knowledgeable sources.

3. Scope of Services:

This section details the services the owner will provide. It includes the services that will be performed and the documents that will be produced. All services should be well defined, not opened, even in reimbursable proposals. All of the documents that are to be furnished as part of the services of the contractor should be listed in detail. A brief description of what each will include should also be provided.

4. Work Plan and Schedule:

The project work plan is developed in response to the stated objectives of the owner or as defined by the sales representatives and the objectives of the contracting firm for the specific proposal. It may be presented in graphic form for showing the interrelationship between various activities.

5. Project Organization:

This describes the proposed project organization, and details the responsibilities of each of the key member of the project team. An organization chart depicting the proposed project team will be drawn. The interface with the supplier of technology should be carefully defined, and the technical review responsibilities should be carefully defined.

6. Estimates, Hours, Costs:

All of the information presented in the previous sections of the proposal must be taken into account in preparing the estimates of work. The cost estimates will include salaries of all technical and non – technical personnel, as well as indirect costs such as travel, communication, computer use and reproduction.

7. Compensation:

After the estimates have been reviewed, the commercial terms are finalized by adding those discretionary figures such as burdens, contingencies, overlays and fees required by the format of the bid. This information is presented in the compensation section of the bid.

8. Qualifications:

The qualification section of the proposal contains all relevant material arranged in proper manner to strengthen confidence as to the contractor's capability in the mind of the owner's management. It must always be reviewed to ensure that the information presented is accurate, pertinent and forceful.

13.6 Modifications to the Standard Proposal:

Many owners have a very specific format which requires that the contractor depart from a standard proposal format. It is best to follow the specified format as it will help to simplify the proposal evaluation process in the owner's office.

PROJECT PROPOSAL (CONTD.)

Broad Contents

Common Sections in a Proposal
Organization of winning proposals
Formats of Proposals
Some tips for writing and presenting proposals

14.1 Common Sections in Proposals:

The following is a review of the sections you will commonly find in proposals. Do not assume that each one of them has to be in the actual proposal you write, nor that they have to be in the order they are presented here, plus you may discover that other kinds of information not mentioned here must be included in your particular proposal.

1. Introduction:

Plan the introduction to your proposal carefully. Make sure it caters to all of the following things (but not necessarily in this order) that apply to your particular proposal:

- Indicate that the document to follow is a proposal.
- Refer to some previous contact with the recipient of the proposal or to your source of information about the project.
- Find one brief motivating statement that will encourage the recipient to read on and to consider doing the project.
- Give an overview of the contents of the proposal.

Remember that you may not need *all* of these elements, and some of them can combine neatly into single sentences. The introduction ought to be brisk and to the point and not feel as though it is trudging laboriously through each of these elements.

2. Background on the Opportunity:

Often occurring just after the introduction, the background section discusses what has brought about the need for the project; what problem, what opportunity there is for improving things, what the basic situation is. An owner of pine timberland may want to get the land productive of saleable timber without destroying the ecology.

It is true that the audience of the proposal may know the problem very well, in which case this section might not be needed. Writing the background section still might be useful, however, in demonstrating your particular view of the problem. And, if the proposal is unsolicited, a background section is almost a requirement; you will probably need to convince the audience that the problem or opportunity exists and that it should be addressed.

3. Benefits and Feasibility of the Proposed Project:

Most proposals discuss the advantages or benefits of doing the proposed project. This acts as an argument in favor of approving the project. Also, some proposals discuss the likelihood of the project's success. In the forestry proposal, the proposer is recommending that the landowner make an investment; at the end of the proposal, he explores the question of what return there will be on that investment, how likely those returns are. In the unsolicited proposal, this section is particularly important as you are trying to "sell" the audience on the project.

4. Description of the Proposed Work (Results of the Project):

Most proposals must describe the finished product of the proposed project. In this course, that means describing the written document you propose to write, its audience and purpose; providing an outline; and discussing such things as its length, graphics, binding, and so forth.) In the scenario you define, there may be other work such as conducting training seminars or providing an ongoing service. Add that too.

5. Method, Procedure, Theory:

In most proposals, you will want to explain how you will go about doing the proposed work, if approved to do it. This acts as an additional persuasive element; it shows the audience you have a sound, well-thought-out approach to the project. Also, it serves as the other form of background some proposals need. Remember that the background section (the one discussed above) focused on the problem or need that brings about the proposal. However, in this section, we will discuss the technical background relating to the procedures or technology you plan to use in the proposed work. For example, in the forestry proposal, the writer gives a bit of background on how timber management is done. Once again, this gives the proposal writer a chance to show that you know what you are talking about, and build confidence in the audience that you are a good choice to do the project.

6. Schedule:

Most proposals contain a section that shows not only the projected completion date but also key milestones for the project. If you are doing a large project spreading over many months, the timeline would also show dates on which you would deliver progress reports. And if you cannot cite specific dates, cite amounts of time or time spans for each phase of the project.

7. Qualifications:

Most proposals contain a summary of the proposing individual's or organization's qualifications to do the proposed work. It is like a mini-resume contained in the proposal. The proposal audience uses it to decide whether you are suited for the project. Therefore, this section lists work experience, similar projects, references, training, and education that show familiarity with the project.

8. Costs, Resources Required:

Most proposals also contain a section detailing the costs of the project, whether internal or external. With external projects, you may need to list your hourly rates, projected hours, costs of equipment and supplies, and so forth, and then calculate the total cost of the complete project. With internal projects, there probably would not be a fee, but you should still list the project costs: for example, hours you will need to complete the project, equipment and supplies you will be using, assistance from other people in the organization, and so on.

9. Conclusions:

The final paragraph or section of the proposal should bring readers back to a focus on the positive aspects of the project (you have just showed them the costs). In the final section, you can end by urging them to get in touch to work out the details of the project, to remind them of the benefits of doing the project, and maybe to put in one last plug for you or your organization as the right choice for the project.

10. Special Project-Specific Sections:

Remember that the preceding sections are typical or common in written proposals, not absolute requirements. Similarly, some proposals may require other sections not discussed above. Do not let your proposal planning be dictated by the preceding discussion. Always ask yourself what else might my audience need to understand the project, the need for it, the benefits arising from it, my role in it, my qualifications to it, What else might my readers need to be convinced to allow me to do the project? What else do they need to see in order to approve the project and to approve me to do the project?

14.2 Organization of Winning Proposals:

As for the organization of the content of a proposal, remember that it is essentially a sales, or promotional document. Here are the basic steps it goes through:

1. You introduce the proposal, telling the readers its purpose and contents.
2. You present the background – the problem, opportunity, or situation that brings about the proposed project. Get the reader concerned about the problem, excited about the opportunity, or interested in the situation in some way.
3. State what you propose to do about the problem, how you plan to help the readers take advantage of the opportunity, how you intend to help them with the situation.
4. Discuss the benefits of doing the proposed project, the advantages that come from approving it.
5. Describe exactly what the completed project would consist of, what it would look like, how it would work – describe the results of the project.
6. Discuss the method and theory or approach behind that method; enable readers to understand how you will go about the proposed work.
7. Provide a schedule, including major milestones or checkpoints in the project.
8. Briefly list your qualifications for the project; provide a mini-resume of the background you have that makes you right for the project.
9. Now (and only now), list the costs of the project, the resources you will need to do the project.
10. Conclude with a review of the benefits of doing the project (in case the shock from the costs section was too much), and urge the audience to get in touch or to accept the proposal.

Notice the overall logic of the movement through these section: you get them concerned about a problem or interested in an opportunity, then you get them excited about how you will fix the problem or do the project, then you show them what good qualifications you have – *then* hit them with the costs, but then come right back to the good points about the project.

14.3 Format Of Proposals:

Following are the options for the format and packaging of your proposal. It does not matter which you use as long as you use the memorandum format for internal proposals and the business letter format for external proposals.

- **Cover Letter With Separate Proposal:**
  In this format, you write a brief "cover" letter and attach the proposal proper after it. The cover letter briefly announces that a proposal follows and outlines the contents of it. In fact, the contents of the cover letter are pretty much the same as the introduction (discussed in

the previous section). Notice, however, that the proposal proper that follows the cover letter repeats much of what you see in the cover letter. This is because the letter may get detached from the proposal or the recipient may not even bother to look at the letter and just dive right into the proposal itself.

- **Cover Memo with Separate Proposal:**
  In this format, you write a brief "cover" memo and attach the proposal proper after it. The cover memo briefly announces that a proposal follows and outlines the contents of it. In fact, the contents of the cover memo are pretty much the same as the introduction (discussed in the previous section). This is because the memo may get detached from the proposal or the reader may not even bother to look at the memo and just dive right into the proposal itself.

- **Business-Letter Proposal:**
  In this format, you put the entire proposal within a standard business letter. You include headings and other special formatting elements as if it were a report.

- **Memo Proposal:**
  In this format, you put the entire proposal within a standard office memorandum. You include headings and other special formatting elements as if it were a report.

If we are in a competitive bid situation, usually price, schedule, financial stability, quality of experience and resources and financing offer (if any) are relevant. However, many contract awards are made on a negotiated basis. While success may depend on some or all of the above features, two others many come into strategic play:

1. Interpersonal relationships with people of the prospective client
2. The written word in the proposal. Conveying the real proposal message with effective writing is essential.

Below is a list of seven key ingredients of a winning proposal.

i) Message:

That we understand the project, the owner's real wants, and are prepared to satisfy them with our resources and company commitment.

ii) Response:
Complete and direct response to the Request for Proposal (RFP) or the bidding documents. The client wrote them, or at least approved them, and expects to see them addressed in their entirety.

iii) Disclosure:
Comprehensive documentation of all relevant company experience. Careful attention to personnel resumes, rewriting them to emphasize pertinent experience.

iv) Creativity:
Something unique or innovative to set us apart from the competition.

v) Price:
Usually but not always a significant factor in competitive proposals on bids.

vi) Financing:
More than ever, an important consideration, even a requirement. Bids are usually adjusted by financing terms offered, so the product of price and financing determines the "bottom line".

vii) Style:

Well composed, concisely written, logically organized, properly referenced, and attractively presented.

In preparing the proposal strategy, all of the homework already accomplished needs to be woven into the plan. Some Request for Proposals (RFPs) (most for engineering work) include an evaluation system to award proposals a number of points in selected categories. Typical evaluation criteria may include a point distribution as shown below:

- Qualification of proposed personnel, particularly the project manager: Up to 50%
- Experience on similar projects: Range of 25-35%
- Proposed work plan and approach: Range of 25-35%

Cost or level of estimated effort in terms of man-hour or man-months may well be the deciding factor. If so, in times of a strong U.S. dollar it very definitely places a U.S. firm at a disadvantage overseas.

Obviously, if evaluation criteria are specified, every effort needs to be made to achieve the maximum possible score.

Various techniques are employed in proposal writing, i.e., getting the message across. Aside from outlines, schedules and tables of contents, one technique, which has come into wide use, is called the ***"story board"***.

It employs modules organized for each strategic message intended for the proposal. Each module is composed of:

1. A topical sentence describing the module theme
2. A theme expressing the strategic message in, say 400 –800 words
3. Graphic or artwork to illustrate the theme

Modules from their earlier skeleton form and further developed during the proposal preparation process are posted on the wall of a control room. When finished they tell the complete story.

This technique permits early organization of the proposal contents, allows continuous management overview, directs the tone of the proposal toward its strategic objectives, clearly establishes writing assignments, and produces a balance of content.

A carefully conceived financing package is often a proposal requirement. This subject is covered in separate former oral presentations, in addition to written proposals, sometimes are important steps in the process. However, overseas clients generally are less interested in receiving them than in the United States.

What about post proposal strategies? Continuous contact with the perspective client, in an effort to answer his questions and to further demonstrate our commitment to his project, can be worthwhile. If our proposal was not selected, a postmortem will be of value to determine how we went wrong or how the competition outdid us.

14.4 Some Tips for Writing and Presenting Proposals:

The following tried and tested tips are to encourage the 100%ers to write more proposals and the low raters to take heart and give it another try.

1. **Ask Questions:**
Before starting your proposal, take some time to make sure you know exactly what you are proposing. If you are unclear about any part of the project, ask your potential client a few meaningful questions. If anything seems vague in their description of "what they want", ask for clarification and then give them a list of possible options as to what you think they might have meant. For your sake, when preparing to give a price, it is important that you and the client both have the same amount of work in mind. Note that if you decide to include a list of questions along with your proposal, include an educated guess as to what their answers would be. Make it clear that your price is based on you having made the correct guesses to the proposed questions and that if anything needs clarifying or if anything is missed, you can adjust your quote accordingly.

2. **Summarize the Project:**
Take all the information on the project that you have received from the client thus far and summarize it briefly, using your own words, in an opening paragraph. This not only helps you get a clearer concept of the project in your own mind but also gives the client confidence that you have given it thought and you understand what they want. It also provides a solid opportunity for them to clarify encase you did not understand.

3. **Break Down the Project into a Nice "To Do" List**:
After your summary, follow-up with a solid "To Do" list, that is very useful for both you and your client. List everything that they have requested so far as well as your standard work on the project. For designers, this would include listing the initial drafts, etc. For programmers, this would include planning the database, building it, etc. Be thorough in your list. It will help give the client a strong sense that you know what you are doing and that you will do the job well. It will also help you make sure nothing slips through the cracks. Use the list in your project updates and cross things off as you move along.

4. **Split the Project into Phases:**
After your "to do" list split the project up into a number of clearly defined phases. It is recommended starting out with a minimum of three. Your first phase might be the "Initial First Draft". During this phase, you begin work on the project and end the phase by sending the client a first draft for testing and revision. Your next phase, in a simple 3 phase project, could be "Bug Squashing and Customizing". During this phase the project is tested and revisions are made until the client is happy with the work and it is ready for action. Your last phase is "Finalization". Once the work is finished, you send them an invoice, ask for referrals, collect payment, and end with a virtual handshake, all parties satisfied with a job well done. Bonus: A useful strategy to keep in mind when it comes to pricing is splitting up a long to-do list into meaningful project phases and then pricing each of the "phases" individually. This can be especially useful for isolating features that require additional time and energy and being sure the client recognizes the work involved when it comes time to give them the price.

5. **Give Your Clients a Timeline:**
Once you have gone over the project phases, let your clients know approximately how long you expect the project to take. Be generous (overestimate if need be, but gently) and then strive to finish up ahead of time. While a project may only take you a few hours to finish up, keep in mind that there will be waiting time between the initial drafts and the finished project as the client reviews the work and provides feedback. If the client is in a rush, let them know exactly when it can be finished and be sure to go over in detail exactly what, if anything needs to be done on their part to make that deadline possible.

6. **Estimate Your Time Involved**:
While not useful for all project types, giving an estimate of time involved is useful for most and not only gives the client a sense of what to expect and that you know what you are doing, but also helps you know exactly what to plan ahead for. A large design/programming project, for example, with a high dollar amount, can be an excellent opportunity to detail the hours involved in each step of the to-do list. Be generous, but honest. The last thing you want is word getting around that it takes you several hours to do what takes the average freelancer 15 minutes.

7. **Use the Multiple Choice Price Strategy**:
Now that all the details have been clearly laid out and your client is confident in your understanding of the project and your ability to see it through, it's time to give them the price. Calculate your predicted time involved and be sure that nothing is overlooked. Then, give them the total number of hours along with your standard hourly rate followed by a discounted "flat rate". Let us say you estimate about 5-8 hours involved in the project and your hourly rate is $40 an hour. Your proposal would then read something like this: "At around 5-8 hours of work, you are welcome to my basic hourly rate of $40 an hour or a discounted flat rate of $250." 9 times out of 10 the client will choose the flat rate over the hourly and will be happy with having had the freedom to choose. Note that as an honest freelance artist whose abilities are constantly improving, you will often reach a point where what once took you 5 hours now takes you an hour. Once that happens, the multiple price strategy is no longer needed. Give them your flat rate and do an excellent job. Be sure that, along with your price, you give them your options for accepting payment.

8. **Offer a Satisfaction Guarantee:**
Once you have given them the price, be sure to include your satisfaction guarantee. Let them know that you are committed to working on the project until they are fully satisfied and then, once they have accepted your proposal, stick to it. There is always the possibility that it can backfire with a client who just does not ever seem to be satisfied (we can talk about dealing with them another day), but the vast majority of the time a solid guarantee will give your clients an extra vote of confidence and help to close the deal. There is always the possibility of a project costing you more time than it is worth, but no matter. Give the project your absolute best and learn everything that you can. Satisfied customers often end up being repeat customers and they are more than worth the time spent on those who may not appreciate your work.

9. **End With a Call to Action**:
Finally, after all the details have been made clear, and the price and guarantee given, end with "what happens next." Let them know exactly what they need to do to get started. If you require payment upfront, let them know where to send the money. If everything prior has gone well, you now have a client who is excited and eager to see their project come to life and you want to make sure that they know what needs to happen next.

10. **Write and Format Professionally:**
Nothing says "unprofessional" like a bunch of "misspellings", grammatical errors, and "IM Style" typing. Take the extra time to proof read your proposal and fix any little errors that may have slipped in. Use spacing between your paragraphs and divide your various sections (Project Summary, Timeline, Price Quote, etc.) with subheadings. For extra points, put your proposal up on a password protected page (make sure the password works) within your website. Remember if you are struggling with style or would just like some extra ideas/opinions, put together an example proposal and share it with family and friends along with a request for feedback.

Once the proposal has been accepted and the project complete, be sure to always ask the client if they have any suggestions for how you can improve and do even better work in the future. Ask them if your proposal was clear and ask if you were able, what the deciding factor was in choosing you to do the work. Take note of all you learn and apply it to the next proposal you write. Although not directly related to "proposal writing", here are two other tips that are worth mentioning:

1. **Pre-Screen your Clients:**
   To save both you and your client's time and energy, it is important to be sure that they are as informed and as prepared as possible before they contact you. This is where your website can step in and do its job. After they have browsed through your portfolio and decided to go for a price on your services, it is important that you provide a clear path to follow. Create a page specifically for those interested in working with you. Outline the types of projects that you do and the processes that you use. Do not hide your prices. As well as offering an hourly rate and flat rate estimates for various project types, it is better to mention that you are always open to creative negotiations. You can often end up with "free projects" that more than pay what you would have charged them.

2. **Respond Quickly**:
   While not always possible, when you are able to, respond to your prospective and active clients immediately. If you have an expected delay, let them know that you plan to be unavailable. Be punctual with all your appointments and make sure that you meet your deadlines. If you miss a deadline and you are at fault, take a hit on your earnings. This will let the client know that you mean what you say and it will also help you to make sure it does not happen again.

LESSON 15

PROJECT PLANNING

Broad Contents

Introduction
Project Planning
Plan of Execution
Information Required for Planning Execution of Projects
Early Stage Documentation by Project Manager

15.1 Introduction:

Planning is done to facilitate later accomplishment. Planning techniques covered here are intended to smooth the path from idea to accomplishment. Project planning is a complicated process to manage project and planning act as map of this process. Map must have sufficient detail to determine what must be done next but simple enough that workers are not lost in welter of minutiae.

Almost all project planning techniques lead to plans that contain same basic elements. They differ only in ways they approach process of planning. At its best, planning is tortuous. It is iterative process yielding better plans from not-so-good plans, and iterative process of improvement seems to take place in fits and starts. Process may be described formally, but it does not occur formally. Bits and pieces of plans are developed by individuals, by formal group meetings, or by formalized planning teams and then improved by other individuals, groups, or teams, and improved again, and again.

15.2 Project Planning:

In order to do successful project management, (whether it is in response to an in-house project or a customer request), it must utilize effective planning techniques. The quantitative and qualitative tools for project planning must be identified. Management must make effective utilization of resources, from a systems point of view.

A systematic plan is required in which the entire company is considered as one large network that is further subdivided into smaller ones. This would ensure effective utilization over several different types of projects.

In this regard, the first step in total program scheduling is to understand the project objectives. These goals may be to:

- Develop expertise in a given area
- To become competitive
- To modify an existing facility for later use
- To keep key personnel employed.

Both implicitly and explicitly, the objectives are generally not independent and are all interrelated.

The following four questions must be considered, once the objectives are clearly defined:

i) Which functional divisions will assume responsibility for accomplishment of these objectives and the major-element work requirements?
ii) The required corporate and organizational resources available?

iii) What are the major elements of the work required to satisfy the objectives, and how are these elements interrelated?
iv) What are the information flow requirements for the project?

Both the direct as well as the indirect-labor-charging organizational units must accomplish careful planning and analysis, if the project is large and complex. The project organizational structure must be designed to fit the project; work plans and schedules must be established so that maximum allocation of resources can be made; resource costing and accounting systems must be developed; and a management information and reporting system must be established.

Unless all of the necessary information becomes available at project initiation effective total program planning cannot be accomplished. These information requirements are:

- The statement of work (SOW)
- The project specifications
- The milestone schedule
- The work breakdown structure (WBS)

As the name indicates, the statement of work (SOW) is a narrative description of the work to be accomplished. It includes the objectives of the project, a brief description of the work, the funding constraint if one exists, and the specifications and schedule. The schedule is a "gross" schedule and includes such things as the:

- Start date
- End date
- Major milestones
- Written reports (data items)

Report writing is a specialized area. Written reports should always be identified so that if functional input is required, the functional manager will assign an individual who has writing skills. It is no secret who would write the report if the line people did not.

15.3 Planning of Execution:

As described earlier, project planning is a structured sequence of events that lead to a desired set of objectives.

A detailed, written, **"Plan of Execution (P of E) "** for project is drawn up, once project viability has been established and decision to proceed has been made. This plan must show:

a) Who is to do what
b) When
c) How
d) Major decisions requirements

It is essential that the project objectives must be clearly tied to overall mission of the firm. Senior management defines a firm's:

- Intent in undertaking project
- Scope of project
- Project desired results

In this regard, the Plan of Execution:
- Becomes a vehicle for communication with all stakeholders

- Becomes a prerequisite for detailed scheduling of work
- Helps documentation for preparation of "cost estimates"

Project management plans are more comprehensive than either management plans or project plans. The preparation of plans is a simple, straightforward approach designed to promote and ensure comprehensive project planning. The project management plan is a combination of two plans that are often prepared separately: the traditional management plan, which describes operational management systems and approaches, and the project plan, which includes the work breakdown structure (WBS), logic, schedules, and cost estimates. They reflect awareness that the people, the system, and the detailed planning are all critical to project success.

15.4 Information Required From Planning of Execution:

Following information is required:

1. Type of project
2. Its capacity and location(s)
3. Scope of work to be performed
4. Preliminary cost estimation
5. Site visitation report
6. Preliminary schedule of major objectives
7. Pertinent contract requirements
8. Special design and/or construction requirements
9. Climate restrictions
10. Environmental study, feasibility study reports, etc
11. Proposal document

Following are the basis for Project Manager's planning endeavors for planning of execution.

- ***Existing documents:***
  - Client's inquiry
  - Proposal (as modified/amended in negotiation period)
  - Contract and preliminary wok plans (during proposal preparation)

- ***Before Execution Planning:***
  Before Execution Planning, project manager is required to provide the complete scope definition of work.

Planning of Execution provide basis to:

a) Schedules
b) Detailed cost estimation
c) Control budget
d) Quality and performance assurance program

It leads to develop Work Breakdown Structure and integrates work schedule costs into track-able and controllable program. During this phase, performance baselines are also estimated during project planning.

15.5 Early Stage Documentation by Project Manager:

This includes:

1. Coordination Procedure (CP):

- Coordination Procedures or Job Instructions. It includes administrative procedures in projects.

2. *Early Work Schedule (EWS):*

- This helps in tracking activities requiring immediate action.
- Cannot wait for release of formal schedules.
- Early work Schedule (EWS) contains:
  a) Running list of activities started early
  b) Name of responsible individuals
  c) Completion date of an activity.

15.5.1 Emphasis Placed on Early Planning:

As we know that planning does not stop with the initial plan. It is a continuous process which is fine tuned whenever necessary. Many events can potentially adversely affect /disrupt plan targets. In this regard, many a times, corrective actions will be required to restore:

a) Integrity of schedule
b) Budget

15.6 Example of Building House to Common "Activities in Each Phase" of Project Planning:

1. Definition Phase:

Problem defined in request document
House need heating, plumbing, lighting, storage etc.

2. Analysis Phase:

Produces functional specifications (deliverable)
Location of ventilators, air conditioner, outlet for phone etc.

3. Design Phase:

System proposed to solve problem
System divided into functional components
Components are interconnected
Expectation: rooms, ventilation, wiring etc.

4. Programming Phase:

Actual work conducted to bring system into being.
Expected: building of house

5. System Test Phase:

Brings pieces together and tests them as whole
House: test plumbing, electricity, roof, etc.

6. Acceptance Phase:

Customer tests complete system for acceptance/ payment
Minor problems are fixed
Major problems require negotiation
Minor problem may include house buyers ask for repairs to cracked plaster, or outlet
Major problem can be two fireplaces vs. one built.

7. Operations, Installation and Use:

House buyer moves in and lives in house
Problems developed/found upon use are fixed during warranty period

Not included in this are:

a) Maintenance
b) Upgrades
c) Extensions

PROJECT PLANNING (CONTD.)

Broad Contents

Steps in General Planning Process
Initial Project Coordination
Project Planning Checklist

16.1 Steps in General Planning Process:

In simple terms, planning is determining what needs to be done, by whom, and by when; in order to fulfill one's assigned responsibility. There are nine major components of the planning phase:

- *Objective:* A goal, target, or quota to be achieved by a certain time
- *Program:* The strategy to be followed and major actions to be taken in order to achieve or exceed objectives
- *Schedule:* A plan showing when individual or group activities or accomplishments will be started and/or completed
- *Budget:* Planned expenditures required to achieve or exceed objectives
- *Forecast:* A projection of what will happen by a certain time
- *Organization:* Design of the number and kinds of positions, along with corresponding duties and responsibilities, required to achieve or exceed objectives
- *Policy:* A general guide for decision making and individual actions
- *Procedure:* A detailed method for carrying out a policy
- *Standard:* A level of individual or group performance defined as adequate or acceptable

Some of these components require additional comment. Forecasting what will happen may not be easy, especially if predictions of environmental reactions are required. For example, planning is customarily defined as strategic, tactical, or operational. Strategic planning is generally for five years or more, tactical can be for one to five years, and operational is the here and now of six months to one year. Although most projects are operational, they can be considered as strategic, especially if spin-offs or follow-up work is promising. Forecasting also requires an understanding of strengths and weaknesses as found in:

- Competitive situation
- Marketing
- Research and development
- Production
- Financing
- Personnel
- Management structure

These factors may be clearly definable, if project planning is strictly operational. However, if strategic or long-range planning is necessary, then the future economic outlook can vary, say, from year to year, and re-planning must be accomplished at regular intervals because the goals and objectives can change.

Because of their uniqueness, the last three factors, policies, procedures, and standards, can vary from project to project. Each project manager can establish project policies, provided that they fall within the broad limits set forth by top management. Policies are predetermined general courses or guides based on the following principles:

- Subordinate policies are supplementary to superior policies.
- Policies are based upon known principles in the operative areas.
- Policies should be definable, understandable, and preferably in writing.
- Policies should be both flexible and stable.
- Policies should be reasonably comprehensive in scope.

It is essential that the project policies must often conform closely to company policies, and are usually similar in nature from project to project. On the other hand, procedures can be drastically different from project to project, even if the same activity is performed. For example, the signing off of manufacturing plans may require different signatures on two selected projects even though the same end-item is being produced.

We can easily say that planning varies at each level of the organization. At the individual level, planning is required so that cognitive simulation can be established before irrevocable actions are taken. At the working group or functional level, planning must include the following:

- Agreement on purpose
- Assignment and acceptance of individual responsibilities
- Coordination of work activities
- Increased commitment to group goals
- Lateral communications

All the organizational or project level, planning must include:

- Recognition and resolution of group conflict of goals
- Assignment and acceptance of group responsibilities
- Increased motivation and commitment to organizational goals
- Vertical and lateral communications
- Coordination of activities between groups

In order for the alternatives and constraints to be fully understood, the logic of planning requires answers to several questions. An outline for a partial list of questions would include:

- Where are we?
- How and why did we get here?
- Is this where we want to be?
- Where would we like to be (in a year, in five years etc.)?
- Where will we go if we continue as before?
- Is that where we want to go?
- How could we get to where we want to go?
- What might prevent us from getting there?
- What might help us to get there?
- Where are we capable of going?
- What do we need to take us where we want to go?
- What is the best course for us to take?
- What are the potential benefits?
- What are the risks?
- What do we need to do?
- When do we need to do it?
- How will we do it?
- Who will do it?
- Are we on course? If not, why?

- What do we need to do to be on course?
- Can we do it?

It is believed that one of the most difficult activities in the project environment is to keep the planning on target.
Following are typical procedures that can assist project managers during planning activities:

- Establish goals before you plan. Otherwise short-term thinking takes over.
- Set goals for the planners. This will guard against the nonessentials and places your effort where there is payoff.
- Stay flexible. Use people-to-people contact, and stress fast response.
- Keep a balanced outlook. Do not overreact, and position yourself for an upturn.
- Welcome top-management participation. Top management has the capability to make or break a plan, and may well be the single most important variable.
- Beware of future spending plans. This may eliminate the tendency to underestimate.
- Test the assumptions behind the forecasts. This is necessary because professionals are generally too optimistic. Do not depend solely on one set of data.
- Do not focus on today's problems. Try to get away from crisis management and fire fighting.
- Reward those who dispel illusions. Reward the first to come forth with bad news.

16.2 ***Initial Project Coordination:***

It is crucial that project's objectives be clearly tied to overall mission of firm. Senior management should define firm's intent in undertaking project, outline scope of project, and describe project's desired results. Without clear beginning, project planning can easily go astray. It is also vital that senior manager call and be present at initial coordinating meeting as visible symbol of top management's commitment to project.

At the beginning, meeting is conducted in which, project is discussed in sufficient detail that potential contributors develop general understanding of what is needed. If project is one of many similar projects, meeting will be quite short and routine, sort of "touching base" with other interested units. If project is unique in most of its aspects, extensive discussion may be required.

Whatever the process, outcome must be that:

1. Technical objectives are established (though perhaps not "cast in concrete)
2. Basic areas of performance responsibility are accepted by participants
3. Some tentative schedules and budgets are spelled out. It is important that each individual/unit accepting responsibility for portion of project should agree to deliver, before next project meeting, preliminary but detailed plan about how that responsibility will be accomplished. Such plans should contain descriptions of required tasks, budgets and schedules.

After this, these plans are then reviewed by groups and combined into composite project plan. Composite plan, that is still not completely final, is approved by each participating group, by project manager, and then by senior organizational management. Each subsequent approval hardens plan somewhat, and when senior management has endorsed it, any further changes must be made by processing formal change order. However, if project is not large or complex, informal written memoranda can substitute for change order. Main point is that no significant changes in project are made, without written notice, following top management's approval. Definition of "significant" depends on specific situation and people involved.

It is generally the responsibility of the project manager to task responsibility for gathering necessary approvals and assuring that any changes incorporated into plan at higher levels are communicated to, and approved by, units that have already signed off on plan. Nothing is as sure to enrage functional unit managers as to find that they have been committed by someone else to alterations in their carefully considered plans with out being informed. Violation of this procedure is considered betrayal of trust. Several incidents of this kind occurred in firm during project to design line of children's clothing. Anger at this change without communication was so great that two chief designers resigned and took jobs wit competitors.

Project manager should always return to contributing units for consideration and re-approval of plans as modified, because the senior manages are almost certain to exercise their prerogative to change plan. Final, approved result of this procedure is project plan, also known as master plan, or baseline plan.

16.2.1 Outside Clients:

Fundamental planning process is unchanged (except for the fact that specifications cannot be altered without client's permission), when project is to deliver product/service (often referred to as project's deliverables) to outside client(s). Common "planning" problem in these cases is that marketing has promised deliverables that engineering may not know how to produce on schedule that manufacturing may be unable to meet. This sort of problem usually result when various functional areas are not involved in planning process at time original proposal is made to potential client.

In this regard, two objections to such early participation by engineering and manufacturing are likely to be raised by marketing. First sales arm of organization is trained to sell and is expected to be fully conversant with all technical aspects of firm's products/services. Further, salespeople are expected to be knowledgeable about design and manufacturing lead times and schedules. On the other hand, it is widely assumed by marketing (with some justice on occasion) that manufacturing and design engineers do not understand sales techniques, will be argumentative and/or pessimistic about client needs in presence of client, and are generally not "housebroken" when customers are nearby.

Secondly, it is expensive to involve so much technical talent so early in sales process – typically, prior to issuing proposal. It can easily cost firm more than $10,000 to send five technical specialists on trip to consider potential client's needs. Willingness to accept higher sales costs puts even more emphasis on selection process.

It is usually cheaper, faster and easier to do things right first time than to redo them. Thus, rejoinder to such objections is simple. When product/service is complex system that must be installed in larger, more complex system, it is appropriate to treat sale like project. Sale is also a project and deserves same kind of planning. Great many firms that consistently operate in atmosphere typed by design and manufacturing crises have created their own panics. In fairness, it is appropriate to urge that anyone meeting customers face to face should receive some training in tactics of selling.

For a given project plan, approvals really amount to series of authorizations. Project manager is authorized to direct activities, spend monies (usually within preset limits) request resources and personnel, and start project on its way. Senior management's approval not only signals its willingness to fund and support project, but also notifies subunits in organization that they may commit resources to project.

16.3 Project Planning Checklist:

These are described below for different areas of operations:

- **Construction Planning:**

1. Facility turnover sequence
2. Temporary facilities, offices, warehousing, etc
3. Tool and equipment requirements
4. Labor availability and productivity
5. Work week and productivity impact
6. Climatic affects on field work
7. Field engineering assistance required
8. Extent of subcontracting
9. Field organization and staffing

- **Procurement Planning:**

1. Procurement sources (equipment, materials)
2. Home office versus field procurement
3. Long lead time items
4. Logistical planning

- **Engineering Planning:**

1. Source(s) of technology
2. Codes, specifications and standards to be utilized
3. Utilization of consultants
4. Early work
5. Requisitioning priorities
6. Drawing priorities
7. Vendor data requirements
8. Utilization of scale models
9. Manpower requirements
10. Approval requirements
11. Organization and staffing
12. Utilization of prefabricated modules

- **Quality Control Planning:**

1. Audit of design and equipment for conformance to specifications
2. Checking of calculation and drawings
3. Shop inspection of equipment and fabricated items
4. Certification of materials
5. Certificate of welding procedures
6. Receiving and inspection of equipment and materials
7. Jobsite storage and environmental protection of equipment and materials
8. Construction inspection

- **Financial Planning:**

1. Cash flow requirement
2. Progress payments and billing frequency
3. Impact of financial sources

PROJECT PLANNING (CONTD.)

Broad Contents

Elements of a Project Plan
System Integration

17.1 Elements of a Project Plan:

As we know that the process of developing project plan varies from organization to organization. However, any project plan must contain the following elements:

- **Overview:**

  This is short summary of objectives and scope of project. It is directed to top management and contains statement of goals of project; brief explanation of their relationship to firm's objectives, description of managerial structure that will be used for project, and list of major milestones in project schedule.

- **Introduction:**
  This contains more detailed statement of general goals noted in overview section. Statement should include profit and competitive aims as well as technical goals.

- **General Approach:**
  This section describes both managerial and technical approaches to work. Technical discussion describes relationship of project to available technologies. For example, it might note this project is extension of work done by company for earlier project. Subsection on managerial approach takes note of any deviation from routine procedure – for instance, use of subcontractors for some parts of work.

- **Contractual Aspects:**
  This critical section of plan includes complete list and description of all reporting requirements, customer-supplied resources, liaison arrangements, advisory committees, project review and cancellation procedures, proprietary requirements, any specific management agreements (for example, use of subcontractors) as well as technical deliverables and their specifications, delivery schedules, and specific procedures for changing any of above. Completeness is necessity in this section. If in doubt about whether item should be included or not, wise planner will include it.

- **Schedules:**
  This section outlines various schedules and lists all milestones events. Estimated time for each task should be obtained from those who will do work. Project master schedule is constructed from those inputs. Responsible person or department head should sign off on final, agreed-on schedule.

- **Resources:**
  There are two primary aspects to this section. First is budget. Both capital and expense requirements are detailed by task, which makes this project budget. One-time costs are separated from recurring project costs. Second, cost monitoring and control procedures should be described. In additional to usual routine elements, monitoring and control procedures must be designed to cover special resource requirements for project, such as

special machines, test equipment, laboratory usage or construction, logistics, field facilities, and special materials.

- **Personnel:**
  This section lists expected personnel requirements of project. Special skills, types of training needed, possible recruiting problems, legal or policy restrictions on work force composition, and any other special requirement, such as security clearances, should be noted here. (This reference to "security" includes need to protect trade secrets and research targets from competitors as well as need to protect national security). It is helpful to time-phase personnel needs to project needed and in what numbers. These projections are important element of budget, so personnel, schedule, and resources sections can be crosschecked with one another to ensure consistency.

- **Evaluation Methods:**
  Every project should be evaluated against standards and by methods established at project's inception. This section contains brief description of procedure to follow in monitoring, collecting, storing, and evaluating history of project.

- **Potential Problems:**
  Sometimes it is difficult to convince planners to make serious attempt to anticipate potential difficulties. One or more such possible disasters such as subcontractor default, technical failure, strikes, bad weather, sudden required breakthroughs, critical sequences of tasks, tight deadlines, resource limitations, complex coordination requirements, insufficient authority in some areas, and new complex or unfamiliar tasks are certain to occur. Only uncertainties are which ones will occur and when. In fact, timing of these disasters is not random.
  There are times, conditions and events in life of every project when progress depends on subcontractors, or weather, or coordination or resource availability, and plans to deal with unfavorable contingencies should be developed early in project's life cycle. Some project managers disdain this section of plan on grounds that crises cannot be predicted. Further, they claim to be very effective firefighters. It is quite possible that when one finds such project manager, one has discovered arsonist. No amount of current planning can solve current crises, but preplanning may avert some.

These are elements that constitute project plan and are basis for more detailed planning of budgets, schedules, work plan, and general management of project. Once this basic plan is fully developed and approved, it is disseminated to all interested parties.

Below is detailed discussion on some important parts/aspects of a Project Plan.

- **Introduction/Overview:**

The project management plan introduction/overview includes an introduction both to the specific project and to the project management plan document itself. Some background information may be included to set the stage or provide perspective on the information that follows, such as how the project was initiated, who the customer or sponsor is, how the project is funded, or other factors that are important to those who read the plan. Introductions are always short, allowing the reader to move into the plan quickly. Additional external or historical information can be referenced or included in the Appendix.

External factors, such as general or specific economic trends, constraints, or opportunities; political or governmental conditions; population demographics; or internal organizational factors, should be discussed.

- **Mission and Objectives:**

The purpose or mission of the project is stated in one or two paragraphs, followed by a set of concrete objectives. The mission statement is all encompassing, establishing why the project exists. Mission statements can be general or specific. They also reference the customer if the project is being performed under contract or for a third party.

Project objectives are outlined as specific goals to be accomplished and to which status they can be applied. For instance, objectives for a small construction project might include a good location; a modern energy-efficient economic design; a fully furnished facility; a complete set of project documents; compliance with all laws, codes, and requirements; a standard profit margin; and a completion date.

Planning becomes straightforward when objectives are defined for key areas. Objectives can be established for every aspect of the project, including scope of work, organization, management, systems, environment, safety, and overall completion of the project (i.e., final cost and schedule dates). Established objectives in the following areas facilitate detailed planning, systems development, and work performance:

  - Technical objectives
  - Schedule objectives
  - Cost objectives
  - Organizational/personnel-related objectives
  - Quality objectives
  - Environmental safety and health objectives
  - Contracting/procurement objectives
  - Management system objectives

Well-defined objectives enhance the reliability of subsequent planning. Once objectives are stated in concise terms, they allow for the development of the project scope of work and the work breakdown structure.

- **Work Scope:**

The work scope section of the project management plan demonstrates how well the project is understood.

It includes narrative descriptions of all elements of the project’s scope of work. It clearly identifies the products or services to be provided to the customer. The statement of work contains enough information to allow development of the Work Breakdown Structures (WBS), schedules, and cost estimates, as well as assignment of responsibilities.

This section can address the project phases and include special plans associated with those phases, such as the Research and Development plan, engineering/design plans, construction plan, manufacturing plan, facility start-up plan, or transition plan. It may also describe the systems management activities, including systems engineering and integration, to ensure project life cycle perspective. In other words, it shows that the activities necessary to ensure that the design and final products meet customer requirements are all planned and managed properly and can be integrated and operated as intended, and that start up, transition, operation, and completion activities are also planned and managed properly.

To simplify preparation, the work scope can be prepared in outline form, which can then be used to develop the Work Breakdown Structures (WBS). Often the Work Breakdown Structure (WBS) and work scope are prepared in parallel, with the resultant narrative description of the work called a Work Breakdown Structure (WBS) dictionary.

- **Planning Basis:**

The planning basis section provides for the documentation of key approaches, assumptions, requirements, and other factors considered during preparation of the project management plan. The following topics are addressed in this section:

1. ***Project Deliverables/End Products:***

   A list of all products, documents, and services to be delivered to the customer over the life of the project is required.

2. ***Requirements:***

   Requirements are specifications or instructions that must be followed during project performance.

   They may include technical requirements, facilities requirements, data requirements, management requirements, or special instructions. Technical requirements may include codes, standards, laws, engineering or design specifications, models, or examples for mandatory or recommended compliance on the project. When there are mandatory requirements, such as laws, these must be identified and listed, or project performers run the risk of noncompliance and legal prosecution.

   Facilities requirements include an initial assessment of types, amount, and quality of facilities needed for the project, along with related utilities, furniture, and equipment.

   This provides initial bases for estimating quantities and costs associated with those resources. Overlooking facilities issues during project planning leads to schedule slippages, cost overruns, unhappy project participants, and untold headaches for the project managers. For small projects, facility requirements may not be a big issue; for larger projects, they can be critical.

   Functional and operational requirements spell out what the system, facility, or product being produced is intended to do. They provide the basis for the engineering, design, and planning of the system, facility, or product. Where Functional and operational requirements exist, listing or identifying them greatly simplifies and facilitates the design process. Mandatory data requirements, management directives, or special instructions are also identified and documented during the planning process. Special instructions may include directions from the customer or upper management or may be spelled out in contract documents.

3. ***Constraints:***

   Constraints may include known technical limitations, financial ceilings, or schedule "drop dead" dates. Technical constraints may be related to state-of-the-art capabilities, interface requirements with other systems, or user-related issues (e.g., software that must run on certain types of personal computers). Financial and schedule constraints can be introduced by the customer and lead-time associated with procured hardware or funding/ budgetary limits.

4. Approaches/Strategies:

The approach or strategies to be utilized can have a major impact on subsequent planning.

For instance, if all project work is to be performed within the parent (host) organization with minimum subcontract support that approach impacts planning of resources and organizational issues. If work is to be "fast-tracked" by overlapping design and construction activities, or by performing more work in parallel, then that approach can be described. Communication of strategies to project participants can be done effectively by devoting several paragraphs to that topic in this section of the project management plan.

5. Key Assumptions:

Every project is planned under some degree of uncertainty. Therefore, assumptions are required to estimate work scope, schedule durations, resource requirements, and cost estimates. Assumptions are also required when defining the management strategies, systems, and procedures to be utilized.

Major assumptions are to be documented because they can have a significant impact on planning and estimating. This is true on all projects, regardless of size. Large projects, which involve numerous participants and major complexities, generally depend on more key assumptions during project planning than smaller projects. The major reason for documenting key assumptions is to provide the project manager with a basis for revising plans when the assumptions are changed (that is, when a customer changes his or her mind).

6. Specifically Excluded Scope:

This subject may be needed to limit the scope of work. It highlights specific and relatively obvious issues, such as documentation, training, or follow-on support, which customers often assume but which cost money and have not been included in the project plan. Clarification of these scoping questions saves headaches later, in some cases even avoiding litigation.

17.2 **Systems Integration:**

Systems integration (sometimes called systems engineering) plays crucial role in performance aspect of project. We are using this phrase to include any technical specialist in science or art of project who is capable of performing role of integrating technical discipline to achieve customer's objectives, and/or integrating project into customer's system.

As such, system integration is concerned with three major objectives:

1. Performance:

It is what system does. It includes system design, reliability, quality, maintainability, and reparability. Obviously, these are not separate, independent elements of system, but are highly interrelated qualifies. Any of these system performance characteristics is subject to over-design as well as under-design but must fall within design parameters established by client. If client approves, we may give client more than specifications require simply because we have already designed to some capability and giving client over designed system is faster and less expensive than delivering precisely to specification. At time, esthetic qualities of system may be specified, typically through requirement that appearance of system must be acceptable to client.

2. Effectiveness:

Objective is to design individual components of system to achieve desired performance of optimal manner. This is accomplished through following guidelines:

- Require no component performance specifications unless necessary to meet one or more system equipments.
- Every component requirement should be traceable to one or more systems requirements.
- Design components to optimize system performance, not performance of subsystem.

It is not unusual for clients to violate any or all of these seemingly logical dicta. Tolerances specified to far closer limits than any possible system requirement, superfluous "bells and whistles," and "off shelf" components that do not work well with rest of system are so common they seem to be taken for granted by both client and vendor. Causes of these strange occurrences are probably associated with some combination of inherent distrust between buyer and seller, desire to over-specify in order "to be sure" and feeling that "this part will do just as well". These attitudes can be softened and replaced with others that are more helpful to process of systems integration.

3. Cost:

Systems integration considers cost to be design parameter, and costs can be accumulated in several areas. Added design cost may lead to decreased component costs, leaving performance and effectiveness otherwise unchanged. Added design cost may yield decreased production costs and production cost may be traded off against unit cost for materials. Value engineering (or value analysis) examines all these cost tradeoffs and is important aspect of systems integration. It can be used in any project where relevant cost tradeoffs can be estimated. It is simply consistent and thorough use of cost/effectiveness analysis. For application of value engineering techniques applied to disease control projects.

Systems integration plays major role in success or failure of any project. If risky approach is taken by systems integration, it may delay project. If approach is too conservative, we forego opportunities for enhanced project capabilities or advantageous project economies. Good design will take all these tradeoffs avoid locking project into rigid solution with little flexibility or adaptability in case problems occur later on or changes in environmental demand changes in project performance or effectiveness.

LESSON 18

PROJECT PLANNING (CONTD.)

Broad Contents

Sorting Out Projects
Objectives and Reasons of Project Planning
Policies, Procedures and Standards in Projects

18.1 Sorting Out Project:

As we move into consideration of details of project, we need to know exactly what is to be done, by whom, and when. All activities required to complete project must be precisely delineated and coordinated. Necessary resources must be available when and where they are needed, and in correct amounts. Some activities must be done sequentially, but some may be done simultaneously. If large project is to come in on time and within cost, great many things must happen when and how they are supposed to happen. In this section, we propose conceptually simple method to assist in sorting out and planning all this detail.

To accomplish any specified project, several major activities must be completed. First, list them in general order in which they would normally occur. Reasonable number of major activities might be anywhere between two and 20. Break each of these major activities in two to 20 subtasks. There is noting sacred about these limits. Two is minimum possible breakdown and 20 is about largest number of interrelated items that can be comfortably sorted and scheduled at given level of task aggregation. Second, preparing network from this information is much more difficult if number of activities is significantly greater than 20.

It is important to be sure that all items in list are at roughly same level of task generality. In writing book, for example, various chapters tend to be at same level of generality, but individual chapters are divided into finer detail. Indeed, subdivisions of chapter may be divided into finer detail still. It is difficult to overstate significance of this simple dictum. It is central to preparation of most of planning documents that will be described in this chapter and those that follow.

Some times problem arises because some managers tend to think of outcomes (event) when planning and other think of specific tasks (activities). Many mix two. Problem is to develop list of both activities and outcomes that represents exhaustive, non-redundant set of results to be accomplished (outcomes) and work to be done (avidities) in order to complete project.

Procedure proposed here is hierarchical planning system. First, goals must be specified. This will aid planner in identifying set of required activities for goals to be met, project action plan. Each activity has outcome (event) associated with it, and these activities and events can be decomposed into sub-activities and sub-events, which may, in turn, be subdivided again. Project plan is set of these action plans. Advantage of project pan is that it contains all planning information in one document.

Assume, for example, that we have project whose purpose is to acquire and install large machining center in existing plant. In hierarchy of work to be accomplished for installation part of project, we might find such tasks as “Develop plan for preparation of floor site” and “Develop plan to maintain plant output during installation and test period”. These tasks are two of larger set of jobs to be done. Task “ . . . preparation of floor site” is subdivided into its elemental parts, including such items as “get specifics on machine center mounting points”. “Check construction specification on plant floor” and “Present final plan for floor preparation for approval”.

Short digression is in order before continuing this discussion on action plans. Actual form action plan takes is not sacrosanct. In some cases, for example, amounts of specific resources required may not be relevant. On others, "due dates" may be substituted for activity durations. Appearance of action plans differs in different organizations, and may even differ between departments or division of same organization (though standardization of format is usual, and probably desirable in any given firm). In some plans, numbers are used to identify activities; in others, letters. In still others, combinations of letters and numbers used.

Tree diagram can be used to represent hierarchical plan. Professor Andrew Vazsonyi has called this type of diagram *Gozinto Chart* after famous Italian mathematician, Professor Zepartzat, Gozinto, of Vazsonyi's invention (Readers familiar with Bill of Materials in Materials Requirements Planning (MRP) – system will recognize parallel to nested hierarchical planning).

Objective: Career Day

Steps	Responsibility	Time (Weeks)	Prec.	Resources
1. Contact Organizations				
a. Print forms	Secretary	6	-	
b. Contact organizations	Program Manager	15	1. A	
c. Collect display information	Office Manager	4	1. B	
d. Gather college particulars	Secretary	4	1. B	
e. Print programs	Secretary	6	1. D	
f. Print participants' certificates	Graduate Assistant	8	-	

Objective: Career Day

Steps	Responsibility	Time (Weeks)	Prec.	Resources
2. Banquet and Refreshments				
a. Select guest speaker	Program Manager	14	-	
b. Organize food	Program Manager	3	1. b	Caterer
c. Organize liquor	Director	10	1. b	Dept of Liquor Control
d. Organize refreshment	Graduate Assistant	7	1. b	Purchasing

Objective: Career Day

Steps	Responsibility	Time (Weeks)	Prec.	Resources
3. Publicity and Promotion				
a. Send invitations	Graduate Assistant	2	-	World processing
b. Organize gift certificates	Graduate Assistant	5.5	-	
c. Arrange banners	Graduate Assistant	5	1. d	Print shop
d. Contact faculty	Program Manager	1.5	1. d	Word processing
e. Advertise in college paper	Secretary	5	1. d	Newspaper
f. Class announcements	Graduate Assistant	1	3. d	Registrar's office
g. Organize posters	Secretary	4.5	1. d	Print shop

Objective: Career Day				
Steps	Responsibility	Time (Weeks)	Prec.	Resources
4. Facilities				
a. Arrange facility for event	Program Manager	2.5	1. c	
b. Transport materials	Office Manager	.5	4. a	Movers

Table 18.1: **Partial Action Plan for College "Career Day"**

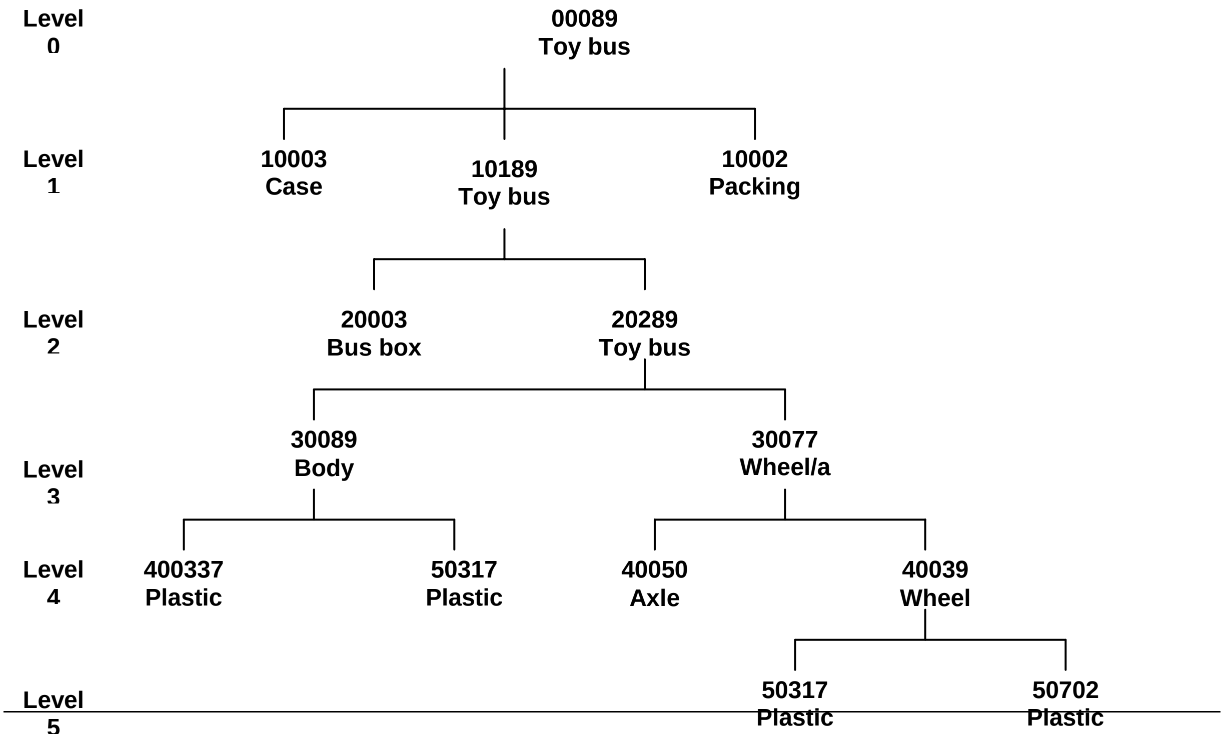


Figure 18.1: **Gozinto Chart for Toy Bus**

Important of careful planning can scarcely be overemphasized. Slevin developed list of ten factors that should be associated with success in implementation projects. Factors split into strategic and tactical clusters. Of interest here are strategic factors:

- **Project Mission:**
  It is important to spell out clearly defined and agreed-upon goals in beginning of project.

- **Top Management Support:**
  It is necessary for top managers to get behind project at outset and make clear to all personnel involved that they support successful completion.

- **Project Schedule or Plan:**
  Detailed plan of required steps in implementation process needs to be developed, including all resource requirements (money, raw materials, staff and so forth).

  At this point, it might be helpful to sum up this section what description of how planning process actually works in may organization. Assume that you as project manager have been given responsibility for developing computer software required to transmit medical X-Ray from one location to another over telephone line. There are several problems that must be solved to accomplish this task. First X-Ray image must be translated into computer language. Second, computerized image must be transmitted and received. Third, image must be displayed (or printed) in way that makes it intelligible to person who must interpret it. You have team of four programmers and couple of assistant programmers as signed to you. You also have specialist in radiology assigned part-time as medical advisor.

S #	Steps	Due Date	Responsible	Precedent
1.	Ajax management advised of changes	24/7	Bob, Van	-
2.	Begin preparing Instat sales dept to sell Ajax consumer Division products effective 1/1/96	24/7	Bob	1
3.	Prepare to create two sales groups: (1) Instat (2) Ajax Builder Group effective 1/1/96	1/8	Bob	1
4.	Advise Instat regional managers of sales division changes	1/8	Bob	2,3
5.	Advise Ajax regional managers of sales division changes	1/8	Van	2,3
6.	Visit Ajax management and plan to discuss merger of operations	1/8	Smith	4,5
7.	Advise Ajax sales personnel and agents	14/8	Smith	6
8.	Visit Instat to coordinate changeover	26/8	Bob Gerard	6
9.	Interview Ajax sales personnel for possible positions	30/8	Instat Regional Manager	7

Table 18.2: **Tabular Action Plan for Ajax-Instat Merger**

Your first action is to meet with programmers and medical advisor in order to arrive at technical requirements for project. From these requirements, project mission statement and detailed specifications will be derived. (Note that original statement of your "responsibility" is too vague to act as acceptable mission statement). Team then develops basic actions needed to achieve technical requirements for project. For example, one technical requirement would be to develop method of measuring density of image at every point on X-Ray and to represent this measurement as numerical input for computer. This is first level of project's action plan.

Responsibility for accomplishing first level tasks is delegated to project team members who are asked to develop their own action plans for each of first level tasks. These are second level action plans. Individual tasks listed in second level plans are then divided further into their level action plans detailing how each second level task will be accomplished. Process continues until lowest level tasks are perceived as "units" or "packages" of work.

18.2 Objectives and Reasons of Project Planning:

One of the objectives of project planning is to completely define all work required (possibly through the development of a documented project plan) so that it will be readily identifiable to each project participant. This is a necessity in a project environment because:

- If the task is well understood prior to being performed, much of the work can be preplanned.
- If the task is not understood, then during the actual task execution more knowledge is gained that, in turn, leads to changes in resource allocations, schedules, and priorities.
- The more uncertain the task, the greater the amount of information that must be processed in order to ensure effective performance.

These considerations are important in a project environment because each project can be different from the others, requiring a variety of different resources, but having to be performed under time, cost, and performance constraints with little margin for error.

Without proper planning, programs and projects can start off "behind the eight ball" because of poorly defined requirements during the initial planning phase.

There are *four basic reasons for project planning*:

- To eliminate or reduce uncertainty
- To improve efficiency of the operation
- To obtain a better understanding of the objectives
- To provide a basis for monitoring and controlling work

There are involuntary and voluntary reasons for planning. Involuntary reasons can be internally mandatory functions of the organizational complexity and an organizational lag in response time; or they can be externally correlated to environmental fluctuations, uncertainty, and discontinuity. The voluntary reasons for planning are attempts to secure efficient and effective operations.

Planning is decision making based upon futurity. It is a continuous process of making entrepreneurial decisions with an eye to the future, and methodically organizing the effort needed to carry out these decisions. Furthermore, systematic planning allows an organization to set goals. The alternative to systematic planning is decision making based on history. This generally results in reactive management leading to crisis management, conflict management, and fire fighting.

18.3 Policies, Procedures and Standards:

A **policy** is a deliberate plan of action to guide decisions and achieve rational outcome(s). The term may apply to government, private sector organizations and groups, and individuals. Presidential executive orders, corporate privacy policies, and parliamentary rules of order are all examples of policy.

A **procedure** is a specification of series of actions, acts or operations, which have to be executed in the same manner in order to always obtain the same result in the same circumstances (for example, emergency procedures). Less precisely speaking, this word can indicate a sequence of activities, tasks, steps, decisions, calculations and processes, that when undertaken in the sequence laid down produces the described result, product or outcome. A procedure usually induces a change.

Standards in the context related to technologies and industries, is the process of establishing a technical specification, called a standard, among competing entities in a market, where this will bring benefits without hurting competition. It can also be viewed as a mechanism for optimizing economic use of scarce resources such as forests, which are threatened by paper manufacture.

18.3.1 Categories of Planning:

Strategic Planning:

Strategic planning produces fundamental decisions and actions that shape and guide what an organization is, what it does, and why it does it. It requires broad scale information gathering, an exploration of alternatives, and an emphasis on the future implications of present decisions. Top-level managers engage chiefly in strategic planning or long range planning. They answer such questions as "What is the purpose of this organization?" "What does this organization have to do in the future to remain competitive?" Top-level managers clarify the mission of the organization and set its goals. The output needed by top management for long range planning is summary reports about finances, operations, and the external environment.

Tactical Plans:

Top-level managers set very general, long-term goals that require more than one year to achieve. Examples of long-term goals include long-term growth, improved customer service, and increased profitability. Middle managers interpret these goals and develop tactical plans for their departments that can be accomplished within one year or less. In order to develop tactical plans, middle management needs detail reports (financial, operational, market, external environment). Tactical plans have shorter time frames and narrower scopes than strategic plans. Tactical planning provides the specific ideas for implementing the strategic plan. It is the process of making detailed decisions about what to do, who will do it, and how to do it.

Operational Plans:

Supervisors implement operational plans that are short term and deal with the day-to-day work of their team. Short-term goals are aligned with the long-term goals and can be achieved within one year. Supervisors set standards, form schedules, secure resources, and report progress. They need very detailed reports about operations, personnel, materials, and equipment. The supervisor interprets higher management plans as they apply to his or her unit. Thus, operational plans support tactical plans. They are the supervisor's tools for executing daily, weekly, and monthly activities. An example is a budget, which is a plan that shows how money will be spent over a certain period of time. Other examples of planning by supervisors include scheduling the work of employees and identifying needs for staff and resources to meet future changes. Resources include employees, information, capital, facilities, machinery, equipment, supplies, and finances. Operational plans include policies, procedures, methods, and rules.

Policies, procedures, and standards vary from project to project due to the uniqueness of every project. Every Project Manager can establish project policies, within broad limits set by the top management.

Although project managers have the authority and responsibility to establish project policies and procedures, they must fall within the general guidelines established by top management. Guidelines can also be established for planning, scheduling, controlling, and communications.

PROJECT PLANNING (CONTD.)

Broad Contents

Identifying Strategic Project Variables

19.1 Identifying Strategic Project Variables:

The project manager must continually monitor the external environment in order to develop a well-structured program that can stand up under pressure (for long-range or strategic projects). These environmental factors play an integral part in planning. The project manager must be able to identify and evaluate these strategic variables in terms of the future posture of the organization with regard to constraints on existing resources.

As we know that in the project environment, strategic project planning is performed at the horizontal hierarchy level, with final approval by upper-level management. There are three basic guidelines for strategic project planning:

- It is extremely important that upper-level management maintain a close involvement with project teams, especially during the planning phase.
- Successful strategic planning must define the authority, responsibility, and roles of the strategic planning personnel.
- Strategic project planning is a job that should be performed by managers, not for them.

In order to ensure the success of the project, all members of the horizontal team must be aware of those strategic variables that can influence the success or failure of the project plan. The analysis begins with the environment, subdivided as internal, external, and competitive, as shown below:

- *Internal Environment*
    - Management skills
    - Resources
    - Wage and salary levels
    - Government freeze on jobs
    - Minority groups
    - Layoffs
    - Sales forecasts

- *External Environment*
    - Legal
    - Political
    - Social
    - Economic
    - Technological

- *Competitive Environment*
    - Industry characteristics
    - Company requirements and goals
    - Competitive history
    - Present competitive activity
    - Competitive planning

— Return on investment
— Market share
— Size and variety of product lines

• *Competitive Resources*

It is important to note here that once the environmental variables are defined, the planning process continues with the following:

- Identification of company strengths and weaknesses
- Understanding personal values of top management
- Identification of opportunities
- Definition of product market
- Identification of competitive edge
- Establishment of goals, objectives, and standards
- Identification of resource deployment

At the program level, complete identification of all strategic variables is not easily obtainable.

However, internal, or operating, variables are readily available to program personnel by virtue of the structure of the organization. The external variables are normally tracked under the perceptive eyes of top management. This presents a challenge for the organization of the system. In most cases, those in the horizontal hierarchy of a program are more interested in the current operational plan than in external factors and tend to become isolated from the environment after the program begins, losing insight into factors influencing the rapidly changing external variables in the process. Proper identification of these strategic variables requires that communication channels be established between top management and the project office.

It is essential that the top-management support must be available for identification of strategic planning variables so that effective decision making can occur at the program level. The participation of top management in this regard has not been easy to implement. Many top-level officers consider this process a relinquishment of some of their powers and choose to retain strategic variable identification for the top levels of management.

It is important to note here that the systems approach to management does not attempt to decrease top management's role in strategic decision-making. The maturity, intellect, and wisdom of top management cannot be replaced. Ultimately, decision-making will always rest at the upper levels of management, regardless of the organizational structure.

Therefore, identification and classification of the strategic variables are necessary to establish relative emphasis, priorities, and selectivity among the alternatives, to anticipate the unexpected, and to determine the restraints and limitations of the program. Universal classification systems are nonexistent because of the varied nature of organizations and projects. However, variables can be roughly categorized as internal and external, as shown in Table 19.1 below.

TABLE STRATEGIC PLANNING VARIABLES IN THE TIRE INDUSTRY

Internal	External
• Operating	• Operating
• Product changes	• Customer requirements
• Volume (economies of scale)	• Capacity of plants
• Wages vs. automation	• Borrowing expenses
• R&D	• Technological advances
• Legal	• Legal
• Product quality	• OSHA noise levels
• Union and safety considerations	• Product liabilities
	• DoT requirements
• Economic	• Economic
• Market indicators	• Forecast of industry
• Division of market	• Inventory (on hand/dealers)
• Production runs (timing)	• Steel and chemical output
• Pricing/promotion policy	• Competition
• Sociopolitical	• Sociopolitical
• Allocation of resources	• Produce what is profitable
• Raw material price/availability	• Primarily third world
• Feasibility of exporting	• Threat of imports
• Productivity levels	• Stability of free market

Table 19.1: Strategic Planning Variables in the Tire Industry

PROJECT PLANNING (CONTD.)

Broad Contents

Life Cycle Phases
Responsibilities of Key Players
Problems in Objective Setting

20.1 Life-Cycle Phases:

To describe it further, project planning takes place at two levels. The first level is the corporate cultural approach; the second method is the individual's approach. The corporate cultural approach breaks the project down into life-cycle phases, such as those shown in Table 20.1. The life-cycle phase approach is *not* an attempt to put handcuffs on the project manager but to provide a methodology for uniformity in project planning. Many companies, including government agencies, prepare checklists of activities that should be considered in each phase. These checklists are for consistency in planning. The project manager can still exercise his own planning initiatives within each phase.

TABLE LIFE-CYCLE PHASE DEFINITIONS

Engineering	Manufacturing	Computer Programming	Construction
• Start-up	• Formation	• Conceptual	• Planning, data gathering and procedures
• Definition	• Buildup	• Planning	• Studies and basic engineering
• Main	• Production	• Definition and design	• Major review
• Termination	• Phase-out	• Implementation	• Detail engineering
	• Final audit	• Conversion	• Detail engineering/ construction overlap
			• Construction
			• Testing and commissioning

Table 20.1: Life-Cycle Phase Definitions

In addition to this, the second benefit of life-cycle phases is control. At the end of each phase there is a meeting between the project manager, sponsor, senior management, and even the customer, to assess the accomplishments of this life-cycle phase and to get approval for the next phase. These meetings are often called critical design reviews, "on-off ramps," and "gates." In some companies, these meetings are used to firm up budgets and schedules for the follow-on phases. In addition to monetary considerations, life-cycle phases can be used for manpower deployment and equipment/facility utilization. Some companies go so far as to prepare project management policy and procedure manuals where all information is subdivided according to life-cycle phasing. Life-cycle phase decision points eliminate the problem where project managers do not ask for phase funding, but rather ask for funds for the whole project before the true scope of the project is known. Several companies have even gone so far as to identify the types of decisions that can be made at each end-of-phase review meeting. They include:

- Proceed with the next phase based on an approved funding level
- Proceed to the next phase but with a new or modified set of objectives

- Postpone approval to proceed based on a need for additional information
- Terminate project

For instance, consider a company that utilizes the following life-cycle phases:

- Conceptualization
- Feasibility
- Preliminary planning
- Detail planning
- Execution
- Testing and commissioning

As the name suggests, the conceptualization phase includes brainstorming and common sense and involves two critical factors:

1. Identify and define the problem, and
2. Identify and define potential solutions

All ideas are recorded and none are discarded in a brainstorming session. The brainstorming session works best if there is no formal authority present and if the time duration is no more than thirty to sixty minutes. Sessions over sixty minutes in length will produce ideas that may begin to resemble science fiction.
The second phase, that is the feasibility study phase, considers the technical aspects of the conceptual alternatives and provides a firmer basis on which to decide whether to undertake the project.

Note that the purpose of the feasibility phase is to:

- Plan the project development and implementation activities.
- Estimate the probable elapsed time, staffing, and equipment requirements.
- Identify the probable costs and consequences of investing in the new project.

If practical, the feasibility study results should evaluate the alternative conceptual solutions along with associated benefits and costs. The objective of this step is to provide management with the predictable results of implementing a specific project and to provide generalized project requirements. This, in the form of a feasibility study report, is used as the basis on which to decide whether to proceed with the costly requirements, development, and implementation phases.

Moving ahead with the life-cycle, the third life-cycle phase is either preliminary planning or "defining the requirements." This is the phase where the effort is officially defined as a project. In this phase, we should consider the following:

- General scope of the work
- Objectives and related background
- Contractor's tasks
- Contractor end-item performance requirements
- Reference to related studies, documentation, and specifications
- Data items (documentation)
- Support equipment for contract end-item
- Customer-furnished property, facilities, equipment, and services
- Customer-furnished documentation
- Schedule of performance
- Exhibits, attachments, and appendices

20.2 Responsibilities of Key Players:

We know that planning simply does not happen by itself. Companies that have histories of successful plans also have employees who fully understand their roles in the planning process. Good up-front planning may not eliminate the need for changes, but may reduce the number of changes required. The responsibilities of the major players are as follows:

1. **Project manager will define:**
   - Goals and objectives
   - Major milestones
   - Requirements
   - Ground rules and assumptions
   - Time, cost, and performance constraints
   - Operating procedures
   - Administrative policy
   - Reporting requirements

2. **Line manager will define:**

   - Detailed task descriptions to implement objectives, requirements, and milestones
   - Detailed schedules and manpower allocations to support budget and schedule
   - Identification of areas of risk, uncertainty, and conflict

3. **Senior management (project sponsor) will:**

   - Act as the negotiator for disagreements between project and line management
   - Provide clarification of critical issues
   - Provide communication link with customer's senior management

Remember that successful planning requires that project, line, and senior management are in agreement with the plan.

20.3 Problems in Objective Setting:

It is not possible to satisfy all objectives every time. At this point, management must prioritize the objectives as to which are strategic and which are not. Typical problems with developing objectives include:

- Project objectives/goals are not agreeable to all parties.
- Project objectives are too rigid to accommodate changing
- Insufficient time exists to define objectives well.
- Objectives are not adequately quantified.
- Objectives are not documented well enough.
- Efforts of client and project personnel are not coordinated.
- Personnel turnover is high.

PROJECT PLANNING (CONTD.)

Broad Contents

The Statement of Work (SOW)
Guideline for Preparing Statement of Work (SOW)

21.1 The Statement of Work (Sow):

As already mentioned in Lecture 15, the Statement of Work (SOW) is a narrative description of the work required for the project. The complexity of the Statement of Work (SOW) is determined by the desires of top management, the customer, and/or the user groups. For projects internal to the company, the Statement of Work (SOW) is prepared by the project office with input from the user groups. The reason for this is that user groups tend to write in such scientific terms that only the user groups understand their meaning. Since the project office is usually composed of personnel with writing skills, it is only fitting that the project office prepares the Statement of Work (SOW) and submit it to the user groups for verification and approval.

In case of projects external to the organization, as in competitive bidding, the contractor may have to prepare the Statement of Work (SOW) for the customer because the customer may not have a team of people trained in its preparation. In this case, as before, the contractor would submit the Statement of Work (SOW) to the customer for approval. It is also quite common for the project manager to rewrite a customer's Statement of Work (SOW) so that the contractor's line managers can price out the effort.

As far as a competitive bidding environment is concerned, the reader should be aware of the fact that there are two Statements of Works (SOWs)— the Statement of Work (SOW) used in the proposal and a "Contract Statement of Work" (CSOW). There might also be a proposal "Work Breakdown Structure" (WBS) and a "Contract Work Breakdown Structure" (CWBS). Special care must be taken by contract and negotiation teams that all discrepancies between the Statement of Work (SOW)/ Work Breakdown Structure (WBS) and Contract Statement of Work (CSOW)/ Contract Work Breakdown Structure (CWBS) are discovered, or additional costs may be incurred. A good (or winning) proposal is *no guarantee* that the customer or contractor understands the Statement of Work (SOW). For large projects, fact-finding is usually required before final negotiations because it is *essential* that both the customer and the contractor understand and agree on the Statement of Work (SOW), what work is required, what work is proposed, the factual basis for the costs, and other related elements. In addition, it is imperative that there be agreement between the final Contract Statement of Work (CSOW) and Contract Work Breakdown Structure (CWBS).

It is important to note that the Statement of Work (SOW) preparation is not as easy as it sounds. Consider the following:

- The Statement of Work (SOW) says that you are to conduct a *minimum* of fifteen tests to determine the material properties of a new substance. You price out twenty tests just to "play it safe." At the end of the fifteenth test, the customer says that the results are inconclusive and that you must run another fifteen tests. The cost overrun is $40,000.
- The Navy gives you a contract in which the Statement of Work (SOW) states that the prototype must be tested in "water." You drop the prototype into a swimming pool to test it. Unfortunately, the Navy's definition of "water" is the Atlantic Ocean, and it costs you $1 million to transport all of your test engineers and test equipment to the Atlantic Ocean.

- You receive a contract in which the Statement of Work (SOW) says that you must transport goods across the country using "aerated" boxcars. You select boxcars that have open tops so that air can flow in. During the trip, the train goes through an area of torrential rains, and the goods are ruined. The customer wanted boxcars that were aerated from below. The court is currently deciding who should be blamed for misinterpretation of the word "aerated."

These three examples show that misinterpretations of the Statement of Work (SOW) can result in losses of hundreds of millions of dollars a year. Common causes of misinterpretation are:

- Mixing tasks, specifications, approvals, and special instructions
- Using imprecise language ("nearly," "optimum," "approximately," etc.)
- No pattern, structure, or chronological order
- Wide variation in size of tasks
- Wide variation in how to describe details of the work
- Failing to get third-party review

Note that misinterpretations of the statement of work can and will occur no matter how hard the quest for perfection during the definition phase. The result is creeping scope, or, as one telecommunications company calls it, "creeping elegance." The best way to control creeping scope is with a good definition of the requirements up front. Unfortunately, this is not always possible.

For example, in some industries, such as aerospace, defense, and Management Information System, creeping scope had become a way of life until recently. In the Information Technology Group of a major appliance manufacturer, the project manager made it clear that she would not accept any scope changes once the definition of the requirement (prepared by the user group) was completed. Midway through the project, the user group tried to change the requirements. The project manager refused to accept the changes and, against the wishes of the user group, put all requests for changes into a follow-on enhancement project that would be budgeted for and scheduled *after* the initial project was completed. When the initial project was completed and installed at the user's location, the users stated that they could live with the original package, and the enhancement project was neither funded nor approved.

Keeping the above-mentioned factors in view, today, both private industry and government agencies are developing manuals on SOW preparation.

21.2 Statement of Work (Sow) Preparation Guidelines:

1. Firstly, every Statement of Work (SOW) that exceeds two pages in length should have a table of contents conforming to the Contract Work Breakdown Structure (CWBS) coding structure. There should rarely be items in the Statement of Work (SOW) that are not shown on the Contract Work Breakdown Structure (CWBS); however, it is not absolutely necessary to restrict items to those cited in the CWBS.
2. For the preparation of Statement of Work (SOW), clear and precise task descriptions are essential. The Statement of Work (SOW) writer should realize that his or her efforts will have to be read and interpreted by persons of varied background (such as lawyers, buyers, engineers, cost estimators, accountants, and specialists in production, transportation, security, audit, quality, finance, and contract management). A good Statement of Work (SOW) states precisely the product or service desired. The clarity of the Statement of Work (SOW) will affect administration of the contract, since it defines the scope of work to be performed. Any work that falls outside that scope will involve new procurement with probable increased costs.

3. One of the most important things to keep in mind when writing a Statement of Work (SOW) is the most likely effect the written work will have upon the reader. Therefore, every effort must be made to avoid ambiguity. All obligations of the government should be carefully spelled out. If approval actions are to be provided by the government, set a time limit. If Government-Furnished Equipment (GFE) and/or services, etc., are to be provided, state the nature, condition, and time of delivery, if feasible.
4. It is essential to remember that any provision that takes control of the work away from the contractor, even temporarily, may result in relieving the contractor of responsibility.
5. Use active rather than passive terminology in specifying requirements. Say that the contractor shall conduct a test rather than that a test should be conducted. In other words, when a firm requirement is intended, use the mandatory term "shall" rather than the permissive term "should."
6. Always remember to limit abbreviations to those in common usage. Provide a list of all pertinent abbreviations and acronyms at the beginning of the Statement of Work (SOW). When using a term for the first time, spell it out and show the abbreviation or acronym in parentheses following the word or words.
7. When it is important to define a division of responsibilities between the contractor, other agencies, etc., a separate section of the Statement of Work (SOW) (in an appropriate location) should be included and delineate such responsibilities.
8. Do not forget to include procedures. When immediate decisions cannot be made, it may be possible to include a procedure for making them (e.g., "as approved by the contracting officer," or "the contractor shall submit a report each time a failure occurs.
9. Do not over-specify. Depending upon the nature of the work and the type of contract, the ideal situation may be to specify results required or end-items to be delivered and let the contractor propose his best method.
10. It is important to describe requirements in sufficient detail to assure clarity, not only for legal reasons, but also for practical application. It is easy to overlook many details. It is equally easy to be repetitious. Beware of doing either. For every piece of deliverable hardware, for every report, for every immediate action, do not specify that something be done "as necessary." Rather, specify whether the judgment is to be made by the contractor or by the government. Be aware that these types of contingent actions may have an impact on price as well as schedule. Where expensive services, such as technical liaison, are to be furnished, do not say, "as required." Provide a ceiling on the extent of such services, or work out a procedure (e.g., a level of effort, pool of man-hours) that will ensure adequate control.
11. Avoid incorporating extraneous material and requirements. They may add unnecessary cost. Data requirements are common examples of problems in this area. Screen out unnecessary data requirements, and specify only what is essential and when. It is recommended that data requirements be specified separately in a data requirements appendix or equivalent.
12. Do not repeat detailed requirements or specifications that are already spelled out in applicable documents. Instead, incorporate them by reference. If amplification, modification, or exceptions are required, make specific reference to the applicable portions and describe the change.

In addition to the guidelines, some preparation documents also contain ***checklists for Statement of Work (SOW) preparation***. A checklist is furnished below to provide considerations that Statement of Work (SOW) writers should keep in mind in preparing statements of work:

1. Is the Statement of Work (SOW), when used in conjunction with the preliminary Contract Work Breakdown Structure (CWBS), specific enough to permit a contractor to make a tabulation and summary of manpower and resources needed to accomplish each SOW task element?

2. Are specific duties of the contractor stated so he will know what is required, and can the contracting officer's representative, who signs the acceptance report, tell whether the contractor has complied?
3. Are all parts of the Statement of Work (SOW) so written that there is no question as to what the contractor is obligated to do, and when?
4. When it is necessary to reference other documents, is the proper reference document described? Is it properly cited? Is all of it really pertinent to the task, or should only portions be referenced? Is it cross-referenced to the applicable Statement of Work (SOW) task element?
5. Are any specifications or exhibits applicable in whole or in part? If so, are they properly cited and referenced to the appropriate Statement of Work (SOW) element?
6. Are directions clearly distinguishable from general information?
7. Is there a time-phased data requirement for each deliverable item? If elapsed time is used, does it specify calendar or work days?
8. Are proper quantities shown?
9. Have headings been checked for format and grammar? Are subheadings comparable? Is the text compatible with the title? Is a multi decimal or alphanumeric numbering system used in the Statement of Work (SOW)? Can it be cross-referenced with the Contract Work Breakdown Structure (CWBS)?
10. Have appropriate portions of procurement regulations been followed?
11. Has extraneous material been eliminated?
12. Can Statement of Work (SOW) task/contract line items and configuration item breakouts at lower levels be identified and defined in sufficient detail so they can be summarized to discrete third-level Contract Work Breakdown Structure (CWBS) elements?
13. Have all requirements for data been specified separately in a data requirements appendix or its equivalent?
14. Have all extraneous data requirements been eliminated?
15. Are security requirements adequately covered if required?
16. Has its availability to contractors been specified?

Lastly, but most importantly, there should be a management review of the Statement of Work (SOW) preparation interpretation. During development of the Statement of Work, the project manager should ensure adequacy of content by holding frequent reviews with project and functional specialists to determine that technical and data requirements specified do conform to the guidelines herein and adequately support the common system objective. The Contract Work Breakdown Structure (CWBS)/ Statement of Work (SOW) (CWBS/SOW) matrix should be used to analyze the Statement of Work (SOW) for completeness. After all comments and inputs have been incorporated, a final team review should be held to produce a draft Statement of Work (SOW) for review by functional and project managers. Specific problems should be resolved and changes made as appropriate. A final draft should then be prepared and reviewed with the program manager, contracting officer, or with higher management if the procurement is a major acquisition. The final review should include a briefing on the total Request for Proposal (RFP) package. If other program offices or other Government agencies will be involved in the procurement, obtain their concurrence also.

WORK BREAKDOWN STRUCTURE

Broad Contents

22.1 Introduction:

In order to successfully accomplish both contract and corporate objectives, a plan is required that defines all effort to be expended, assigns responsibility to a specially identified organizational element, and establishes schedules and budgets for the accomplishment of the work. The preparation of this plan is the responsibility of the program manager, who is assisted by the program team assigned in accordance with program management system directives. The detailed planning is also established in accordance with company budgeting policy before contractual efforts are initiated.

Keeping this in view, in planning a project, the project manager must structure the work into small elements that are:

- Manageable, in that specific authority and responsibility can be assigned
- Independent, or with minimum interfacing with and dependence on other ongoing elements
- Integratable so that the total package can be seen
- Measurable in terms of progress

After project requirements definition, the first major step in the planning process is the development of the Work Breakdown Structure (WBS). A Work Breakdown Structure (WBS) is a product-oriented family tree subdivision of the hardware, services, and data required to produce the end product. The Work Breakdown Structure (WBS) is structured in accordance with the way the work will be performed and reflects the way in which project costs and data will be summarized and eventually reported. Preparation of the Work Breakdown Structure (WBS) also considers other areas that require structured data, such as scheduling, configuration management, contract funding, and technical performance parameters. It is the single most important element because it provides a common framework from which:

- Total program can be described as a summation of subdivided elements
- Planning can be performed
- Costs and budgets can be established
- Time, cost, and performance can be tracked
- Objectives can be linked to company resources in a logical manner
- Schedules and status-reporting procedures can be established
- Network construction and control planning can be initiated
- Responsibility assignments for each element can be established

Note that the Work Breakdown Structure (WBS) acts as a vehicle for breaking the work down into smaller elements, thus providing a greater probability that every major and minor activity will be accounted for.

Although a variety of Work Breakdown Structure (WBS) exist, the most common is the six-level indented structure shown as Figure 22.1 below:

	Level	Description
Managerial levels	1	Total program
	2	Project
	3	Task
Technical levels	4	Subtask
	5	Work package
	6	Level of effort

Figure 22.1: Six-Level Indented Structure

As the figure shows, Level 1 is the total program and is composed of a set of projects. The summation of the activities and costs associated with each project must equal the total program. Each project, however, can be broken down into tasks, where the summation of all tasks equals the summation of all projects, which, in turn, comprises the total program. The reason for this subdivision of effort is simply ease of control. Program management therefore, becomes synonymous with the integration of activities, and the project manager acts as the integrator, using the work breakdown structure as the common framework.

It is important that careful consideration must be given to the design and development of the Work Breakdown Structure (WBS). It can be used to provide the basis for the following:

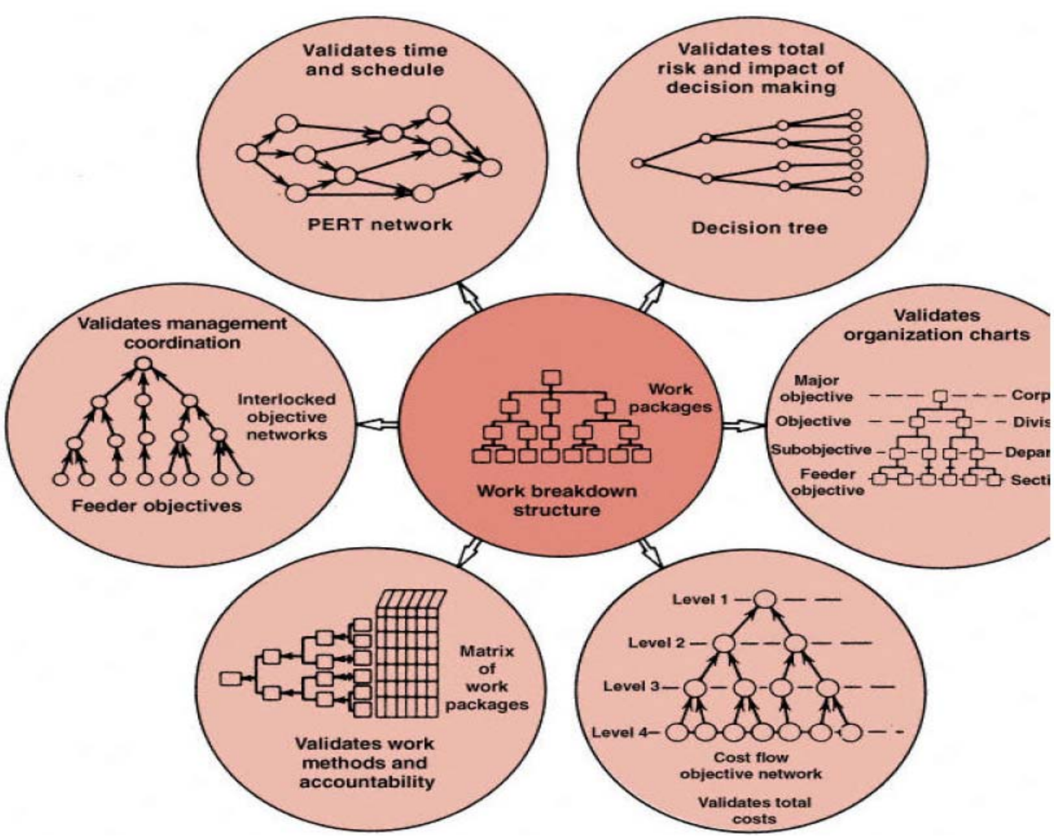


Figure 22.2: Work Breakdown Structure (WBS) for Objective Control and Evaluation

- Responsibility matrix
- Network scheduling
- Costing
- Risk analysis
- Organizational structure
- Coordination of objectives
- Control (including contract administration)

22.2 Characteristics of Various Levels of the Work Breakdown Structure (WBS):

As depicted in Figure 22.1 (above), the upper three levels of the Work Breakdown Structure (WBS) are normally specified by the customer (if part of a Request for Proposal (RFP)/Request for Quotation (RFQ) (i.e. RFP/RFQ) as the summary levels for reporting purposes. The lower levels are generated by the contractor for in-house control. Each level serves a vital purpose: Level 1 is generally used for the authorization and release of all work, budgets are prepared at level 2, and schedules are prepared at level 3. Certain characteristics can now be generalized for these levels:

- Firstly, The top three levels of the Work Breakdown Structure (WBS) reflect integrated efforts and should not be related to one specific department. Effort required by departments or sections should be defined in subtasks and work packages.
- The summation of all elements in one level must be the sum of all work in the next lower level.
- Each element of work should be assigned to one and only one level of effort. For example, the construction of the foundation of a house should be included in one project (or task), not extended over two or three. (At level 5, the work packages should be identifiable and homogeneous.)
- The level at which the project is managed is generally called the work package level. Actually, the work package can exist at any level below level one.
- The Work Breakdown Structure (WBS) must be accompanied by a description of the scope of effort required, or else only those individuals who issue the Work Breakdown Structure (WBS) will have a complete understanding of what work has to be accomplished. It is common practice to reproduce the customer's statement of work as the description for the Work Breakdown Structure (WBS).
- It is often the best policy for the project manager, regardless of his technical expertise, to allow all of the line managers to assess the risks in the Work Breakdown Structure (WBS). After all, the line managers are usually the recognized experts in the organization.

It is normally the duty of the project managers to manage at the top three levels of the Work Breakdown Structure (WBS) and they prefer to provide status reports to management at these levels also. Some companies are trying to standardize reporting to management by requiring the top three levels of the Work Breakdown Structure (WBS) to be the same for every project, the only differences being in levels 4–6. For companies with a great deal of similarity among projects, this approach has merit. For most companies, however, the differences between projects make it almost impossible to standardize the top levels of the Work Breakdown Structure (WBS).

As shown in the Figure 22.1 (above), the work package is the critical level for managing a Work Breakdown Structure (WBS). However, it is possible that the actual management of the work packages are supervised and performed by the line managers with status reporting provided to the project manager at higher levels of the Work Breakdown Structure (WBS).

To explain them further, work packages are natural subdivisions of cost accounts and constitute the basic building blocks used by the contractor in planning, controlling, and measuring contract performance. A work package is simply a low-level task or job assignment. It describes the work to be accomplished by a specific performing organization or a group of cost centers and serves as a vehicle for monitoring and reporting progress of work. Documents that authorize and assign work to a performing organization are designated by various names throughout industry.

Here, it is important to know what a work package is. *"Work package" is the generic term used in the criteria to identify discrete tasks that have definable end results.* Ideal work packages are 80 hours and less than 2–4 weeks. However, this may not be possible on large projects.

It is not necessary that work package documentation contain complete, stand-alone descriptions. Supplemental documentation may augment the work package descriptions. However, the work package descriptions must permit cost account managers and work package supervisors to understand and clearly distinguish one work package effort from another. In the review of work package documentation, it may be necessary to obtain explanations from personnel routinely involved in the work, rather than requiring the work package descriptions to be completely self-explanatory.

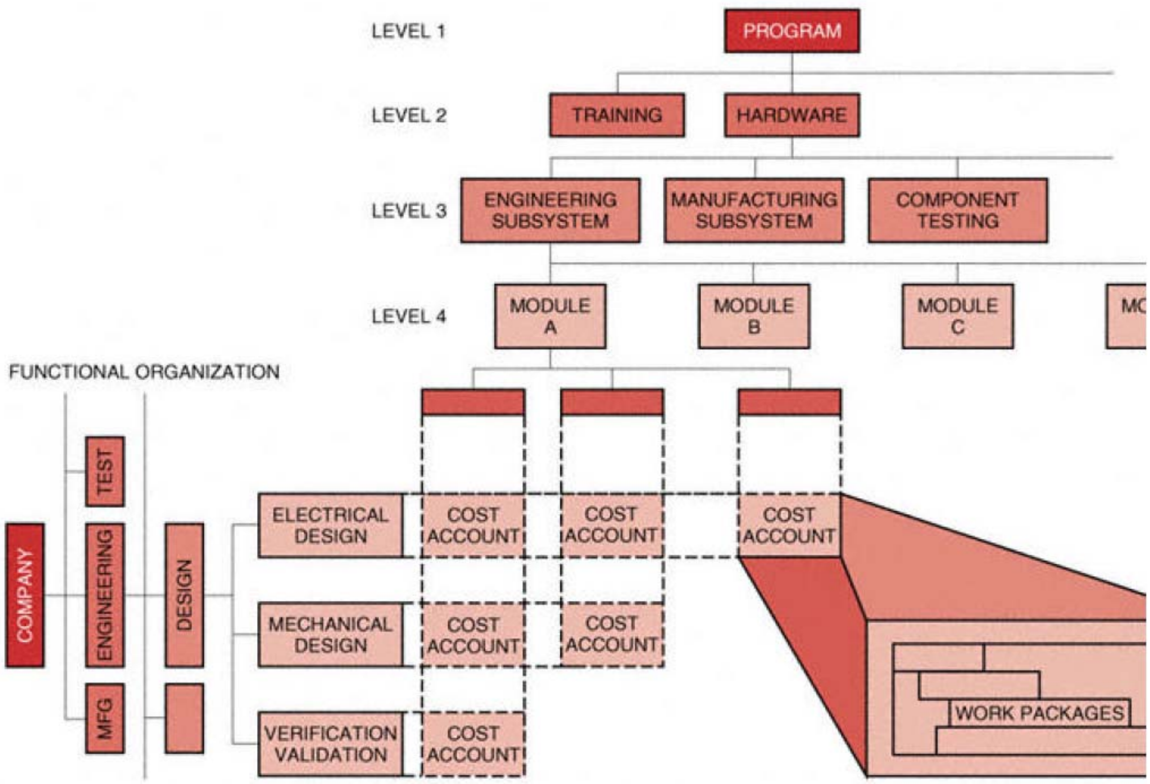


Figure 22.3: The cost account intersection

The desirability of having short-term work packages is a key feature from the standpoint of evaluation accomplishment. This requirement is not intended to force arbitrary cutoff points simply to have short-term work packages. Work packages should be natural subdivisions of effort planned according to the way the work will be done. However, when work packages are relatively short, little or no assessment of work-in-process is required and the evaluation of status is possible mainly on the basis of work package completions. The longer the work packages, the more difficult and subjective the work-in-process assessment becomes unless the packages are subdivided by objective indicators such as discrete milestones with pre-assigned budget values or completion percentages.

Keeping this in view, in setting up the Work Breakdown Structure (WBS), tasks should:

- Have clearly defined start and end dates
- Be usable as a communications tool in which results can be compared with expectations
- Be estimated on "total" time duration, not when the task must start or end
- Be structured so that a minimum of project office control and documentation (that is, forms) is necessary

22.3 Characteristics of Work Package:

In case of large projects, planning will be time phased at the work package level of the Work Breakdown Structure (WBS). The work package has the following characteristics:

- Represents units of work at the level where the work is performed
- Clearly distinguishes one work package from all others assigned to a single functional group
- Contains clearly defined start and end dates that are representative of physical accomplishment
- Specifies a budget in terms of dollars, man-hours, or other measurable units
- Limits the work to be performed to relatively short periods of time to minimize the work-in process effort

The following table (table 22.1) shows a simple Work Breakdown Structure (WBS) with the associated numbering system following the work breakdown. The first number represents the total program (in this case, it is represented by 01), the second number represents the project, and the third number identifies the task. Therefore, number 01-03-00 represents project 3 of program 01, whereas 01-03-02 represents task 2 of project 3. This type of numbering system is not standard; each company may have its own system, depending on how costs are to be controlled.

TABLE . WORK BREAKDOWN STRUCTURE FOR NEW PLANT CONSTRUCTION AND START-UP

Program: New Plant Construction and Start-up	01-00-00
Project 1: Analytical Study	01-01-00
Task 1: Marketing/Production Study	01-01-01
Task 2: Cost Effectiveness Analysis	01-01-02
Project 2: Design and Layout	01-02-00
Task 1: Product Processing Sketches	01-02-01
Task 2: Product Processing Blueprints	01-02-02
Project 3: Installation	01-03-00
Task 1: Fabrication	01-03-01
Task 2: Setup	01-03-02
Task 3: Testing and Run	01-03-03
Project 4: Program Support	01-04-00
Task 1: Management	01-04-01
Task 2: Purchasing Raw Materials	01-04-02

Table 22.1: Work Breakdown Structure (WBS) for New Plant Construction and Start-Up

By now we can say that the preparation of the work breakdown structure is not easy. The Work Breakdown Structure (WBS) is a communications tool, providing detailed information to different levels of management. If it does not contain enough levels, then the integration of activities may prove difficult. If too many levels exist, then unproductive time will be made to have the same number of levels for all projects, tasks, and so on.

It is vital that each major work element should be considered by itself. Remember, the Work Breakdown Structure (WBS) establishes the number of required networks for cost control.

In case of many programs, the customer establishes the Work Breakdown Structure (WBS).

22.4 Guidelines for WBS by Contractor:

To explain this, we take the example of a contractor who is required to develop a Work Breakdown Structure (WBS). He must consider certain guidelines. A partial list is as follows:

- Complexity and technical requirements of the program (i.e., the statement of work)
- Program cost
- Time span of the program
- Contractor's resource requirements
- Contractor's and customer's internal structure for management control and reporting
- Number of subcontracts

Remember that applying these guidelines serves only to identify the complexity of the program. These data must then be subdivided and released, together with detailed information, to the different levels of the organization. The Work Breakdown Structure (WBS) should follow specified criteria because, although the program office performs preparation of the Work Breakdown Structure (WBS), the actual work is performed by the doers, not the planners. Both the doers and the planners must be in agreement as to what is expected.

22.5 Criteria for Developing Work Breakdown Structure (WBS):

Following is a sample listing of criteria for developing a Work Breakdown Structure (WBS):

- The Work Breakdown Structure (WBS) and work description should be easy to understand.
- All schedules should follow the Work Breakdown Structure (WBS).
- No attempt should be made to subdivide work arbitrarily to the lowest possible level. The lowest level of work should not end up having a ridiculous cost in comparison to other efforts.
- Since scope of effort can change during a program, every effort should be made to maintain flexibility in the Work Breakdown Structure (WBS).
- The Work Breakdown Structure (WBS) can act as a list of discrete and tangible milestones so that everyone will know when the milestones were achieved.
- Level of the Work Breakdown Structure (WBS) can reflect the "trust" you have in certain line groups.
- Work Breakdown Structure (WBS) can be used to segregate recurring from nonrecurring costs.
- Most Work Breakdown Structure (WBS) elements (at the lowest control level) range from 0.5 to 2.5 percent of the total project budget.

22.6 Work Breakdown Structure (WBS) Decomposition Problems:

Misconceptions prevail with almost every thing. There is a common misconception that the Work Breakdown Structure (WBS) decomposition is an easy task to perform. In the development of the Work Breakdown Structure (WBS), the top three levels or management levels are usually roll-up levels.

Preparing templates at these levels is becoming common practice. However, at levels 4–6 of the Work Breakdown Structure (WBS), templates may not be appropriate. There are the following reasons for this:

- Firstly, breaking the work down to extremely small and detailed work packages may require the creation of hundreds or even thousands of cost accounts and charge numbers. This could increase the management, control, and reporting costs of these small packages to a point where the costs exceed the benefits. Although a typical work package may be 200–300 hours and approximately two weeks in duration, consider the impact on a large project, which may have more than one million direct labor hours.
- Breaking the work down to small work packages can provide accurate cost control if, and only if, the line managers can determine the costs at this level of detail. Line managers must be given the right to tell project managers that costs *cannot* be determined at the requested level of detail.
- The Work Breakdown Structure (WBS) is the basis for scheduling techniques such as the Arrow Diagramming Method and the Precedence Diagramming Method. At low levels of the Work Breakdown Structure (WBS), the interdependencies between activities can become so complex that meaningful networks cannot be constructed.

To cater to the above-mentioned problems, one solution is to create "hammock" activities, which encompass several activities where exact cost identification cannot or may not be accurately determined. Some projects identify a "hammock" activity called management support (or project office), which includes overall project management, data items, management reserve, and possibly procurement. The advantage of this type of hammock activity is that the charge numbers are under the *direct* control of the project manager.

In addition to this, there is a common misconception that the typical dimensions of a work package are approximately 80 hours and less than two weeks to a month. Although this may be true on small projects, this would necessitate millions of work packages on large jobs and this may be impractical, even if line managers could control work packages of this size.

Cost analysis down to the fifth level is advantageous, from a cost control point of view. However, it should be noted that the cost required to prepare cost analysis data to each lower level might increase exponentially, especially if the customer requires data to be presented in a specified format that is not part of the company's standard operating procedures. The level-5 work packages are normally for in-house control only. Some companies bill customers separately for each level of cost reporting below level 3.

Another aspect is that the Work Breakdown Structure (WBS) can be subdivided into sub objectives with finer divisions of effort as we go lower into the Work Breakdown Structure (WBS). By defining sub objectives, we add greater understanding and, it is hoped, clarity of action for those individuals who will be required to complete the objectives. Whenever work is structured, understood, easily identifiable, and within the capabilities of the individuals, there will almost always exist a high degree of confidence that the objective can be reached.

Also, the Work Breakdown Structure (WBS) can be used to structure work for reaching such objectives as lowering cost, reducing absenteeism, improving morale, and lowering scrap factors. The lowest subdivision now becomes an end-item or sub-objective, not necessarily a work package as described here.

Since we are describing project management, therefore, for the remainder of the text we will consider the lowest level as the work package.

22.7 Uses of Work Breakdown Structure (WBS):

It is important to remember that once the Work Breakdown Structure (WBS) is established and the program is "kicked off," it becomes a very costly procedure to either add or delete activities, or change levels of reporting because of cost control. Many companies do not give careful forethought to the importance of a properly developed Work Breakdown Structure (WBS), and ultimately they risk cost control problems downstream. One important use of the Work Breakdown Structure (WBS) is that it serves as a cost control standard for any future activities that may follow on or may just be similar. One common mistake made by management is the combining of direct support activities with administrative activities. For example, the department manager for manufacturing engineering may be required to provide administrative support (possibly by attending team meetings) throughout the duration of the program. If the administrative support is spread out over each of the projects, a false picture is obtained as to the actual hours needed to accomplish each project in the program. If one of the projects should be canceled, then the support man-hours for the total program would be reduced when, in fact, the administrative and support functions may be constant, regardless of the number of projects and tasks.

It is quite often that the Work Breakdown Structure (WBS) accompanying customer Request for Proposals (RFPs), contains much more scope of effort as specified by the statement of work than the existing funding will support. This is done intentionally by the customer in hopes that a contractor may be willing to "buy in." If the contractor's price exceeds the customer's funding limitations, then eliminating activities from the Work Breakdown Structure (WBS) must reduce the scope of effort. By developing a separate project for administrative and indirect support activities, the customer can easily modify his costs by eliminating the direct support activities of the canceled effort.

Lastly, we should also discuss the usefulness and applicability of the Work Breakdown Structure (WBS) system. Many companies and industries have been successful in managing programs without the use of work breakdown structures, especially on repetitive-type programs.

WORK BREAKDOWN STRUCTURE

BROAD CONTENTS

Preparation Guides for Work Breakdown Structure (WBS)
Checklists for Preparing Work Breakdown Structure (WBS)
Methods for Structuring Work Breakdown Structure (WBS)
Why Do Plans Fail?

23.1 Preparation Guides for Work Breakdown Structure (WBS):

We have already discussed the preparation guides for the Statement of Work (SOW). Similarly there are several preparation guides for the Work Breakdown Structure (WBS). These are as follows:

- Firstly, develop the Work Breakdown Structure (WBS) structure by subdividing the total effort into discrete and logical sub elements. Usually a program subdivides into projects, major systems, major subsystems, and various lower levels until a manageable -size element level is reached. Wide variations may occur, depending upon the type of effort (e.g., major systems development, support services, etc.). Include more than one cost center and more than one contractor if this reflects the actual situation.
- It is important to check the proposed Work Breakdown Structure (WBS) and the contemplated efforts for completeness, compatibility, and continuity.
- Determine that the Work Breakdown Structure (WBS) satisfies both functional (engineering/ manufacturing/ test) and program/project (hardware, services, etc.) requirements, including recurring and nonrecurring costs.
- Remember to check to determine if the Work Breakdown Structure (WBS) provides for logical subdivision of all project work.
- Establish assignment of responsibilities for all identified effort to specific organizations.
- Finally, check the proposed Work Breakdown Structure (WBS) against the reporting requirements of the organizations involved.

23.2 Checklists for Preparing Work Breakdown Structure (WBS):

In addition to the preparation guides, there are also checklists that can be used in the preparation of the Work Breakdown Structure (WBS):

- Focus to develop a preliminary Work Breakdown Structure (WBS) to not lower than the top three levels for solicitation purposes (or lower if deemed necessary for some special reason).
- Remember to assure that the contractor is required to extend the preliminary Work Breakdown Structure (WBS) in response to the solicitation, to identify and structure all contractor work to be compatible with his organization and management system.
- Following negotiations, the Contract Work Breakdown Structure (CWBS) included in the contract should not normally extend lower than the third level.
- It is essential to assure that the negotiated Contract Work Breakdown Structure (CWBS) structure is compatible with reporting requirements.
- Assure that the negotiated Contract Work Breakdown Structure (CWBS) is compatible with the contractor's organization and management system.

- Review the Contract Work Breakdown Structure (CWBS) elements to ensure correlation with the following:
    - The specification tree
    - Contract line items
    - End-items of the contract
    - Data items required
    - Work statement tasks
    - Configuration management requirements

- Also, define Contract Work Breakdown Structure (CWBS) elements down to the level where such definitions are meaningful and necessary for management purposes (WBS dictionary).
- Clearly specify reporting requirements for selected Contract Work Breakdown Structure (CWBS) elements if variations from standard reporting requirements are desired.
- Always assure that the Contract Work Breakdown Structure (CWBS) covers measurable effort, level of effort, apportioned effort, and subcontracts, if applicable.
- Lastly, Assure that the total costs at a particular level will equal the sum of the costs of the constituent elements at the next lower level.

In case of simple projects, the Work Breakdown Structure (WBS) can be constructed as a "tree diagram" or according to the logic flow. The tree diagram can follow the work or even the organizational structure of the company (i.e., division, department, section, unit). The second method is to create a logic flow and cluster certain elements to represent tasks and projects. In the tree method, lower-level functional units may be assigned to one, and only one.

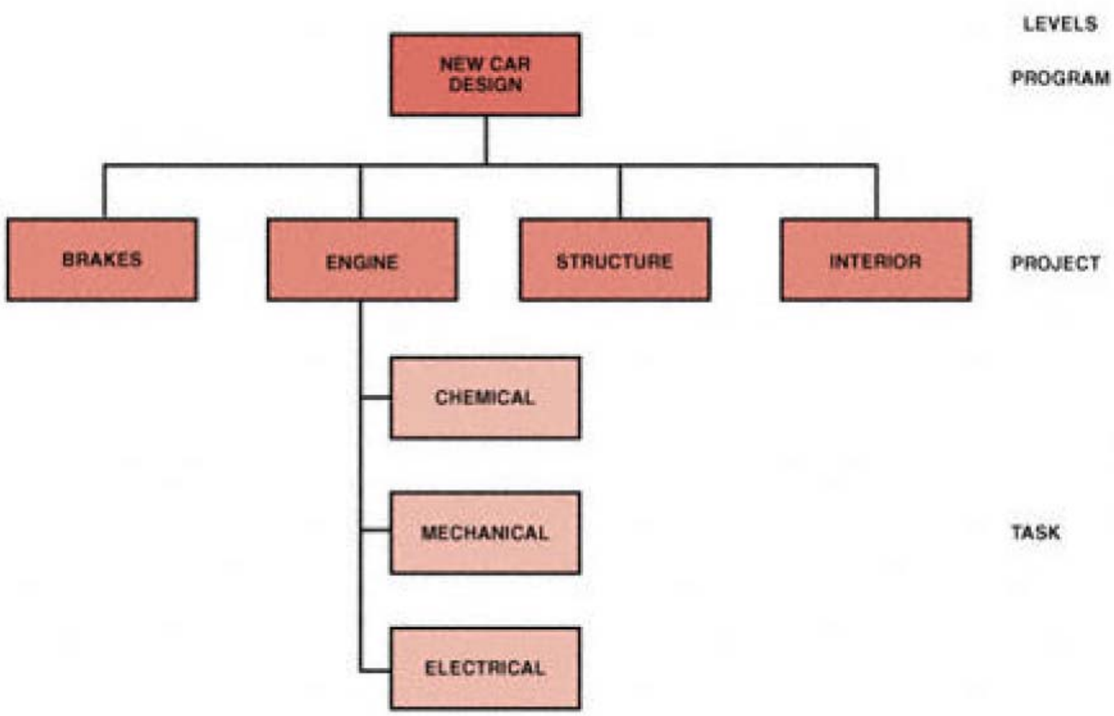


Figure 23.1: Work Breakdown Structure (WBS) Elements

23.3 Methods for Structuring Work Breakdown Structure (WBS):

It is seen that a tendency exists today to develop guidelines, policies, and procedures for project management, but not for the development of the Work Breakdown Structure (WBS). Since it must have flexibility built into it, the tendency is to avoid limiting the way the Work

Breakdown Structure (WBS) must be developed. Some companies have been marginally successful in developing a "generic" methodology for levels 1, 2, and 3 of the Work Breakdown Structure (WBS). In other words, the top three levels of the Work Breakdown Structure (WBS) are the same for all projects. The differences appear in levels 4, 5, and 6.

The following table 23.1 shows the three most common methods for structuring the Work Breakdown Structure (WBS):

		Method	
Level	**Flow**	**Life Cycle**	**Organization**
Program	Program	Program	Program
Project	System	Life cycle	Division
Task	Subsystem	System	Department
Subtask	People	Subsystem	Section
Work package	People	People	People
Level of effort	People	People	People

Table 23.1: Three Common Methods for Structuring the WBS

As the table shows, the flow method breaks the work down into systems and major subsystems. This method is well suited for projects less than two years in length. For longer-duration projects, we use the life-cycle method, which is similar to the flow method. The organization method is used for projects that may be repetitive or require very little integration between functional units.

23.4 Why Do Plans Fail?

Planning is not perfect, no matter how hard we try, and sometimes plans fail. Typical reasons why plans fail include:

- Corporate goals are not understood at the lower organizational levels.
- Plans encompass too much in too little time.
- Financial estimates are poor.
- Plans are based on insufficient data.
- No attempt is made to systematize the planning process.
- Planning is performed by a planning group.
- No one knows the ultimate objective.
- No one knows the staffing requirements.
- No one knows the major milestone dates, including written reports.
- Project estimates are best guesses, and are not based on standards or history.
- Not enough time is given for proper estimating.
- No one bothers to see if there would be personnel available with the necessary skills.
- People are not working toward the same specifications.
- People are consistently shuffled in and out of the project with little regard for schedule.

Now the question arises, why do these situations occur, and who should be blamed? If corporate goals are not understood, it is because corporate executives are negligent in providing the necessary strategic information and feedback. If a plan fails because of extreme optimism, then the responsibility lies with both the project and line managers for not assessing risk. Project managers should ask the line managers if the estimates are optimistic or pessimistic, and expect an honest answer. Erroneous financial estimates are the responsibility of the line manager. If the project fails because of a poor definition of the requirements, then the project manager is totally at fault.

It is important that the project managers must be willing to accept failure. Sometimes, a situation occurs that can lead to failure, and the problem rests with either upper-level management or some other group. As an example, consider the major utility company with a planning group that prepares budgets (with the help of functional groups) and selects projects to be completed within a given time period. A project manager on one such project discovered that the project should have started "last month" in order to meet the completion date. In cases like this, project managers will not become dedicated to the projects unless they are active members during the planning and know what assumptions and constraints were considered in development of the plan.

In some cases, sometimes, the project manager is part of the planning group and as part of feasibility study is asked to prepare, with the assistance of functional managers, a schedule and cost summary for a project that will occur three years downstream, if it is approved at all. Suppose that three years downstream the project is approved. How does the project manager get functional managers to accept the schedule and cost summary that they themselves prepared three years before? It cannot be done, because technology may have changed, people may be working higher or lower on the learning curve, and salary and raw material escalation factors are inaccurate.

Small mistake accumulate to cause big damage. Sometimes project plans fail because simple details are forgotten or overlooked. Examples of this might be:

- Neglecting to tell a line manager early enough that the prototype is not ready and that rescheduling is necessary.
- Neglecting to see if the line manager can still provide additional employees for the next two weeks because it was possible to do so six months ago.

In addition to this, sometimes plans fail because the project manager "bites off more than he can chew," and then something happens, such as his becoming ill. Even if the project manager is effective at doing a lot of the work, overburdening is unnecessary. Many projects have failed because the project manager was the only one who knew what was going on and then got sick.

SCHEDULES AND CHARTS

BROAD CONTENTS

Detailed Schedules and Charts
Guidelines for Preparation of Schedules
Preparation Sequence of Schedules
Master Production Scheduling
Definition of Master Production Schedule (MPS)
Objectives of Master Production Schedule (MPS)
Program Plan

24.1 Detailed Schedules and Charts:

The first major requirement of the program office after the program goes ahead is the scheduling of activities.

If the activity is not too complex, the program office normally assumes full responsibility for activity scheduling. For large programs, functional management input is required before scheduling can be completed.

Depending on program size and contractual requirements, it is not unusual for the program office to maintain, at all times, a program staff member whose responsibility is that of a scheduler. This individual continuously develops and updates activity schedules to provide a means of tracking program work. The resulting information is then supplied to the program office personnel, functional management, and team members, and, last but not least, is presented to the customer.

Note that the activity scheduling is probably the single most important tool for determining how company resources should be integrated so that synergy is produced. Activity schedules are invaluable for projecting time-phased resource utilization requirements as well as providing a basis for visually tracking performance.

In many cases, most programs begin with the development of schedules so that accurate cost estimates can be made. The schedules serve as master plans from which both the customer and management have an up-to-date picture of operations.

24.2 Guidelines for Preparation of Schedules:

Regardless of the projected use or complexity, certain guidelines should be followed in the preparation of schedules. These are as follows:

- Firstly, all major events and dates must be clearly identified. If the customer supplies a statement of work, those dates shown on the accompanying schedules must be included. If for any reason the customer's milestone dates cannot be met, the customer should be notified immediately.
- The exact sequence of work should be defined through a network in which interrelationships between events can be identified.
- Schedules should be directly relatable to the Work Breakdown Structure (WBS). If the Work Breakdown Structure (WBS) is developed according to a specific sequence of work, then it becomes an easy task to identify work sequences in schedules using the same

numbering system as in the Work Breakdown Structure (WBS). The minimum requirement should be to show where and when all tasks start and finish.

- All schedules must identify the time constraints and, if possible, should identify those resources required for each event.

Here we see that although these four guidelines relate to schedule preparation, they do not define how complex the schedules should be. Before preparing schedules, three questions should be considered:

- How many events or activities should each network have?
- How much of a detailed technical breakdown should be included?
- Who is the intended audience for this schedule?

In this regard, most organizations develop multiple schedules: summary schedules for management and planners and detailed schedules for the doers and lower-level control. The detailed schedules may be strictly for interdepartmental activities. Program management must approve all schedules down through the first three levels of the work breakdown structure. For lower-level schedules (that is, detailed interdepartmental), program management may or may not request a sign of approval.

The need for two schedules is clear. In larger complicated projects, planning and status review by different echelons are facilitated by the use of detailed and summary networks. Higher levels of management can view the entire project and the interrelationships of major tasks without looking into the detail of the individual subtasks. Lower levels of management and supervision can examine their parts of the project in fine detail without being distracted by those parts of the project with which they have no interface.

One of the most difficult problems to identify in schedules is a *hedge position*. A hedge position is a situation in which the contractor may not be able to meet a customer's milestone date without incurring a risk, or may not be able to meet activity requirements following a milestone date because of contractual requirements.

24.3 Preparation Sequence of Schedules:

For almost every activity detailed schedules are prepared. It is the responsibility of the program office to marry all of the detailed schedules into one master schedule to verify that all activities can be completed as planned.

According to the sequence, the program office submits a request for detailed schedules to the functional managers then prepare summary schedules, detailed schedules, and, if time permits, interdepartmental schedules. Each functional manager then reviews his schedules with the program office. The program office, together with the functional program team members, integrates all of the plans and schedules and verifies that all contractual dates can be met.

Note that before the schedules are submitted to publications, rough drafts of each schedule and plan should be reviewed with the customer. This procedure accomplishes the following:

- Verifies that nothing has fallen through the cracks
- Prevents immediate revisions to a published document and can prevent embarrassing moments
- Minimizes production costs by reducing the number of early revisions
- Shows customers early in the program that you welcome their help and input into the planning phase

Once the document is published, it should be distributed to all program office personnel, functional team members, functional management, and the customer.

The exact method of preparing the schedules is usually up to the individual performing the activity.

However, the program office must approve all schedules. The schedules are normally prepared in a format that is suitable to both the customer and contractor and is easily understood by all. The schedules may then be used in-house as well as for customer review meetings, in which case the contractor can "kill two birds with one stone" by tracking cost and performance on the original schedules.

In addition to the detailed schedules, the program office, with input provided by functional management, must develop organization charts. The organizational charts tell all active participants in the project who has responsibility for each activity. The organizational charts display the formal (and often the informal) lines of communication.

Linear responsibility charts (LRCs) are also established by the program office. In spite of the best attempts by management, many functions in an organization may overlap between functional units.

The management might also wish to have the responsibility for a certain activity given to a functional unit that normally would not have that responsibility. This is a common occurrence on short duration programs where management desires to cut costs and red tape.

Importantly, care must be taken that project personnel do not forget the reason why the schedule was developed.

Summing this up, the primary objective of detailed schedules is usually to coordinate activities into a master plan in order to complete the project with the:

- Best time
- Least cost
- Least risk

The objective can be constrained by the following obvious reasons:

- Calendar completion dates
- Cash or cash flow restrictions
- Limited resources
- Approvals

In addition to this, there are also secondary objectives of scheduling:

- Studying alternatives
- Developing an optimal schedule
- Using resources effectively
- Communicating
- Refining the estimating criteria
- Obtaining good project control
- Providing for easy revisions

24.4 Master Production Scheduling:

We know that master production scheduling is not a new concept. Earliest material control systems used a "quarterly ordering system" to produce a *Master Production Schedule (MPS)* for plant production.

This system uses customer order backlogs to develop a production plan over a three-month period. The production plan is then exploded manually to determine what parts must be purchased or manufactured at the proper time. However, rapidly changing customer requirements and fluctuating lead times, combined with a slow response to these changes, can result in the disruption of master production scheduling.

24.5 Master Production Schedule (MPS) Definition:

Before going into the details, it is important to know what a Master Production Schedule (MPS) is. A *Master Production Schedule (MPS)* is a statement of what will be made, how many units will be made, and when they will be made. It is a production plan, not a sales plan. The Master Production Schedule (MPS) considers the total demand on a plant's resources, including finished product sales, spare (repair) part needs, and interplant needs. The Master Production Schedule (MPS) must also consider the capacity of the plant and the requirements imposed on vendors. Provisions are made in the overall plan for each manufacturing facility's operation. All planning for materials, manpower, plant, equipment, and financing for the facility is driven by the master production schedule.

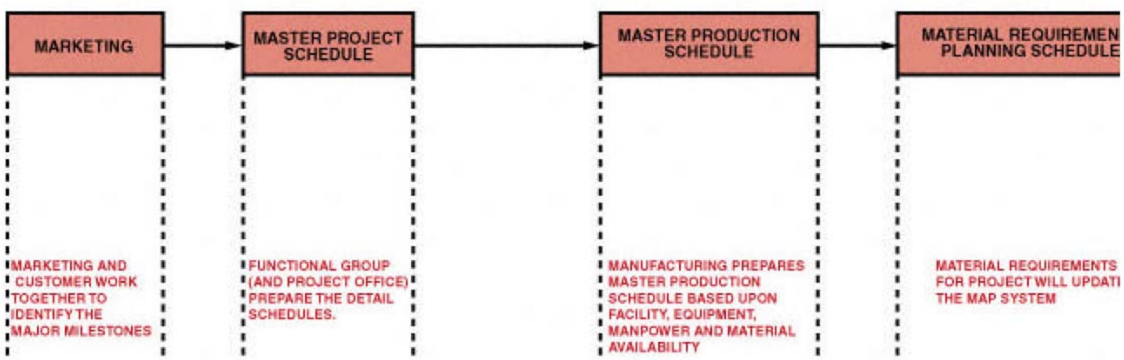


Figure 24.1: Material Requirements Planning Interrelationships

24.6 Objectives of the Master Production Schedule (MPS):

Following are the objectives of Master Production Schedule (MPS):

- To provide top management with a means to authorize and control manpower levels, inventory investment, and cash flow.
- To coordinate marketing, manufacturing, engineering, and finance activities by a common performance objective.
- To reconcile marketing and manufacturing needs
- To provide an overall measure of performance
- To provide data for material and capacity planning

Therefore, the development of a Master Production Schedule (MPS) is a very important step in a planning cycle. It directly ties together personnel, materials, equipment, and facilities as shown in the figure above. Master Production Schedule (MPS) also identify key dates to the customer, should he wish to visit the contractor during specific operational periods.

24.7 Program Plan:

Documented planning in the form of a program plan is fundamental to the success of any project. In an ideal situation, the program office can present the functional manager with a copy of the program plan and simply say, "accomplish it." The concept of the program plan came under severe scrutiny during the 1960s when the Department of Defense required all contractors to submit detailed planning to such extremes that many organizations were wasting talented people by having them serve as writers instead of doers. Since then, because of the complexity of large programs, requirements imposed on the program plan have been eased.

In case of large and often complex programs, customers may require a program plan that documents all activities within the program. The program plan then serves as a guideline for the lifetime of the program and may be revised as often development programs require more revisions to the program plan than manufacturing or construction programs). The program plan provides the following framework:

- Eliminates conflicts between functional managers
- Eliminates conflicts between functional management and program management
- Provides a standard communications tool throughout the lifetime of the program. (It should be geared to the work breakdown structure.)
- Provides verification that the contractor understands the customer's objectives and requirements
- Provides a means for identifying inconsistencies in the planning phase
- Provides a means for early identification of problem areas and risks so that no surprises occur downstream

Note that the development of a program plan can be time-consuming and costly. The input requirements for the program plan depend on the size of the project and the integration of resources and activities. All levels of the organization participate. The upper levels provide summary information, and the lower levels provide the details. The program plan, like activity schedules, does not preclude departments from developing their own planning.

One of the key features of the program plan is that it must identify how the company resources will be integrated. Finalization of the program is an iterative process similar to the sequence of events for schedule preparation, shown in the figure 24.2 below. Since the program plan must explain the events in the figure, additional iterations are required, which can cause changes in a program.

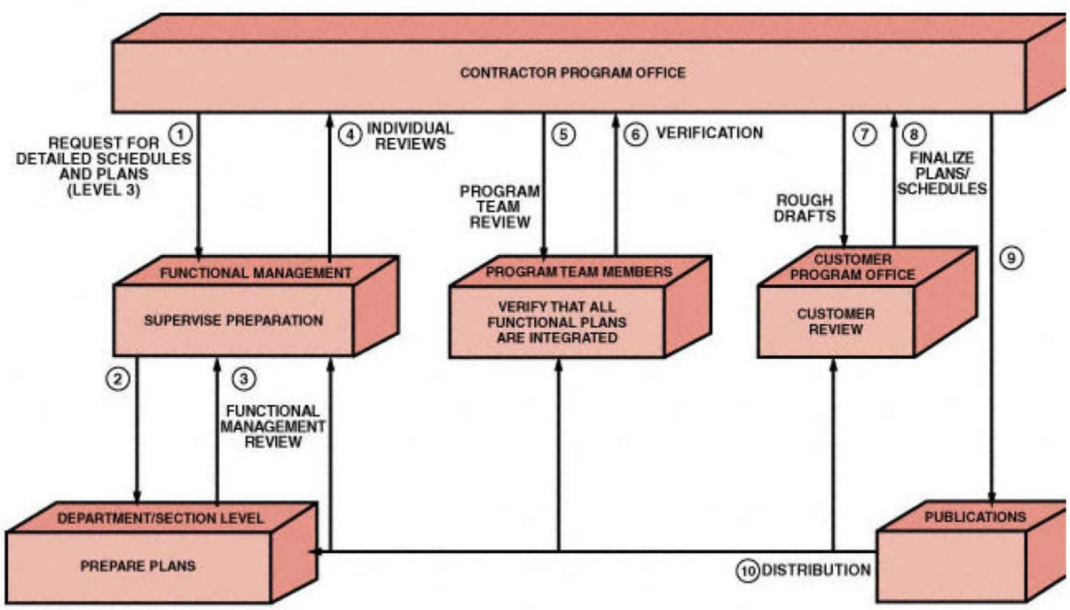


Figure 24.2: Preparation Sequence for Schedules and Program Plans

Thus, we say that the program plan is a standard from which performance can be measured, not only by the customer, but also by program and functional management as well. The plan serves as a cookbook for the duration of the program by answering the following questions for all personnel identified with the program:

- What will be accomplished?
- How will it be accomplished?
- Where will it be accomplished?
- When will it be accomplished?
- Why will it be accomplished?

The answers to these questions force both the contractor and the customer to take a hard look at:

- Program requirements
- Program management
- Program schedules
- Facility requirements
- Logistic support
- Financial support
- Manpower and organization

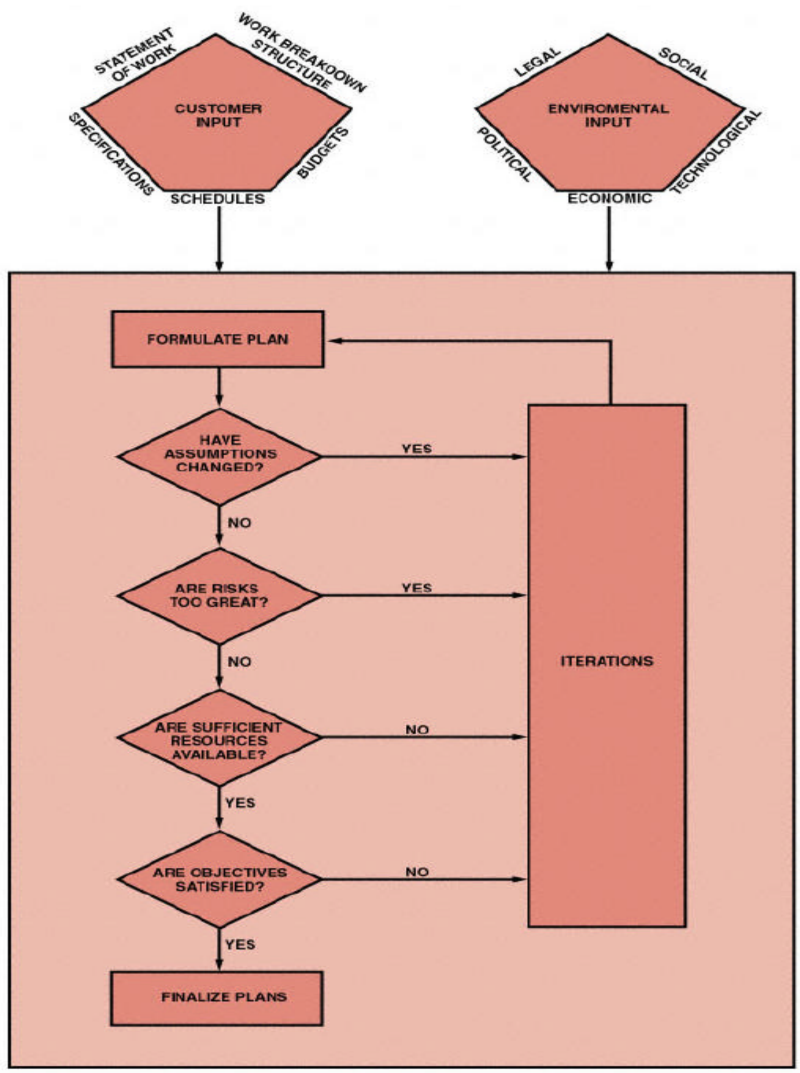


Figure 24.3: Iterations for the Planning Process

In addition to this, the program plan is more than just a set of instructions. It is an attempt to eliminate crisis by preventing anything from "falling through the cracks." The plan is documented and approved by both the customer and the contractor to determine what data, if any, are missing and the probable resulting effect. As the program matures, the program plan is revised to account for new or missing data. The most common reasons for revising a plan are:

- "Crashing" activities to meet end dates
- Trade-off decisions involving manpower, scheduling, and performance
- Adjusting and leveling manpower requests

Usually the maturity of a program implies that crisis will decrease. Unfortunately, this is not always the case.

The makeup of the program plan may vary from contractor to contractor. Most program plans can be subdivided into four main sections:

i) Introduction
ii) Summary and conclusions
iii) Management
iv) Technical

The complexity of the information is usually up to the discretion of the contractor, provided that customer requirements, as may be specified in the statement of work, are satisfied.

To begin with, the ***introductory*** section contains the definition of the program and the major parts involved. If the program follows another, or is an outgrowth of similar activities, this is indicated, together with a brief summary of the background and history behind the project.

The second section that is the ***summary and conclusion*** section identifies the targets and objectives of the program and includes the necessary "lip service" on how successful the program will be and how all problems can be overcome. This section must also include the program master schedule showing how all projects and activities are related. The total program master schedule should include the following:

- An appropriate scheduling system (bar charts, milestone charts, network, etc.)
- A listing of activities at the project level or lower
- The possible interrelationships between activities (can be accomplished by logic networks, critical path networks, or PERT networks)
- Activity time estimates (a natural result of the item above)

As already mentioned, the summary and conclusion chapter is usually the second section in the program plan so that upper-level customer management can have a complete overview of the program without having to search through the technical information.

The third section, that is the ***management*** section of the program plan contains procedures, charts, and schedules as follows:

- The assignment of key personnel to the program is indicated. This usually refers only to the program office personnel and team members, since under normal operations these will be the only individuals interfacing with customers.
- Manpower, planning, and training are discussed to assure customers that qualified people will be available from the functional units.
- A linear responsibility chart might also be included to identify to customers the authority relationships that will exist in the program.

There exist some situations in which the management section may be omitted from the proposal. For a follow-up program, the customer may not require this section if management's positions are unchanged.

In addition to this, the management sections are also not required if the management information was previously provided in the proposal or if the customer and contractor have continuous business dealings.

The fourth section that is the ***technical*** section may include as much as 75 to 90 percent of the program plan, especially if the effort includes research and development. The technical section may require constant updating as the program matures. The following items can be included as part of the technical section:

- Detailed breakdown of the charts and schedules used in the program master schedule, possibly including schedule/cost estimates.
- Listing of the testing to be accomplished for each activity. (It is best to include the exact testing matrices.)
- Procedures for accomplishment of testing. This might also include a description of the key elements in the operations or manufacturing plans as well as a listing of the facility and logistic requirements.
- Identification of materials and material specifications. (This might also include system specifications.)
- An attempt to identify the risks associated with specific technical requirements (not commonly included). This assessment tends to scare management personnel who are unfamiliar with the technical procedures, so it should be omitted if at all possible.

Therefore, the program plan contains a description of all phases of the program. For many programs, especially large ones, detailed planning is required for all major events and activities.

The following Table 24.1 identifies the type of individual plans that may be required in place of a (total) program plan. However, the amount of detail must be controlled, for too much paperwork can easily inhibit successful management of a program.

TABLE . TYPES OF PLANS

Type of Plan	Description
Budget	How much money is allocated to each event?
Configuration management	How are technical changes made?
Facilities	What facilities resources are available?
Logistics support	How will replacements be handled?
Management	How is the program office organized?
Manufacturing	What are the time-phase manufacturing events?
Procurement	What are my sources? Should I make or buy? If vendors are not qualified, how shall I qualify them?
Quality assurance	How will I guarantee specifications will be met?
Research/development	What are the technical activities?
Scheduling	Are all critical dates accounted for?
Tooling	What are my time-phased tooling requirements?
Training	How will I maintain qualified personnel?
Transportation	How will goods and services be shipped?

Table 24.1: Types of Plans

Once agreed on by the contractor and customer, the program plan is then used to provide program direction. This is shown in the figure 24.4 below. If the program plan is written clearly, then any functional manager or supervisor should be able to identify what is expected of him.

Note that the program plan should be distributed to each member of the program team, all functional managers and supervisors interfacing with the program, and all key functional personnel. The program plan does not contain all of the answers, for if it did, there would be no need for a program office. The plan serves merely as a guide.

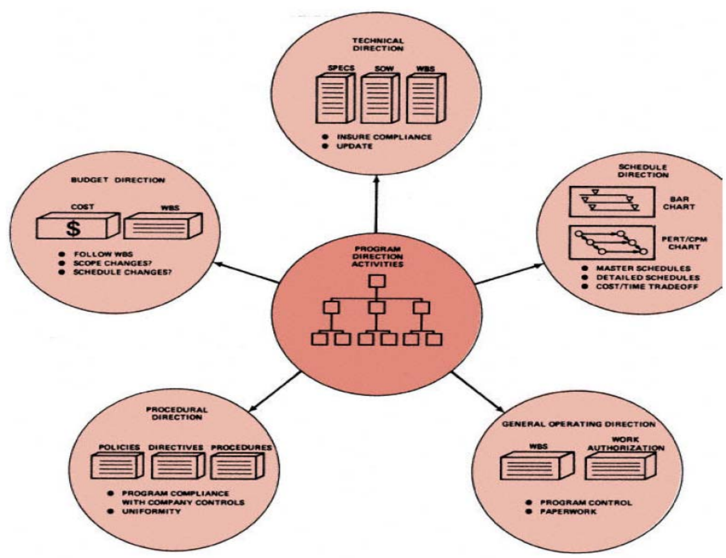


Figure 24.4: Program Direction Activities

Here we conclude with a final note that the program plan may be specified contractually to satisfy certain requirements as identified in the customer's statement of work. The contractor retains the right to decide how to accomplish this, unless, of course, this is also identified in the Statement of Work (SOW). If the Statement of Work (SOW) specifies that quality assurance testing will be accomplished on fifteen end-items from the production line, then fifteen is the minimum number that must be tested. The program plan may show that twenty-five items are to be tested. If the contractor develops cost overrun problems, he may wish to revert to the Statement of Work (SOW) and test only fifteen items. Contractually, he may do this without informing the customer. In most cases, however, the customer is notified, and the program is revised.

TOTAL PROJECT PLANNING

BROAD CONTENTS

Total Project Planning
Project Charter
Management Control
Project Manager–Line Manager Interface
Project Fast Tracking
Configuration Management

25.1 Total Project Planning:

Planning is one of the most significant functions of management. The difference between good project manager and poor project manager is often described in one word: planning. Unfortunately, people have a poor definition of what project planning actually involves. Project planning involves planning for:

- Schedule development
- Budget development
- Project administration
- Leadership styles (interpersonal influences)
- Conflict management

With reference to this, the first two items involve the quantitative aspects of planning. Planning for project administration includes the development of the Linear Responsibility Chart (LRC).

We know that although each project manager has the authority and responsibility to establish project policies and procedures, they must fall within the general guidelines established by top management. Guidelines can also be established for planning, scheduling, controlling, and communications.

Note that the Linear Responsibility Chart (LRC) can result from customer-imposed requirements above and beyond normal operations. For example, the customer may require as part of his quality control requirements that a specific engineer supervise and approve all testing of a certain item, or that another individual approve all data released to the customer over and above program office approval. Customer requirements similar to those identified above require Linear Responsibility Charts (LRCs) and can cause disruptions and conflicts within an organization.

There are several key factors that affect the delegation of authority and responsibility both from upper-level management to project management, and from project management to functional management. These key factors include:

- Maturity of the project management function
- Size, nature, and business base of the company
- Size and nature of the project
- Life cycle of the project
- Capabilities of management at all levels

Once agreement has been reached on the project manager's authority and responsibility, the results may be documented to delineate that role regarding:

- Focal position
- Conflict between the project manager and functional managers
- Influence to cut across functional and organizational lines
- Participation in major management and technical decisions
- Collaboration in staffing the project
- Control over allocation and expenditure of funds
- Selection of subcontractors
- Rights in resolving conflicts
- Input in maintaining the integrity of the project team
- Establishment of project plans
- Provisions for a cost-effective information system for control
- Provisions for leadership in preparing operational requirements
- Maintenance of prime customer liaison and contact
- Promotion of technological and managerial improvements
- Establishment of project organization for the duration
- Elimination of red tape

In addition to this, documenting the project manager's authority is necessary in some situations because:

- All interfacing must be kept as simple as possible.
- Project manager must have the authority to "force" functional managers to depart from existing standards and possibly incur risk.
- Gaining authority over those elements of a program that are not under the project manager's control is essential. This is normally achieved by earning the respect of the individuals concerned.
- The project manager should not attempt to fully describe the exact authority and responsibilities of the project office personnel or team members. Problem solving rather than role definition should be encouraged.

In most cases, although documenting project authority is undesirable, it may be a necessary prerequisite, especially if project initiation and planning require a formal project chart. Power and authority are often discussed as though they go hand in hand. Authority comes from people above you, perhaps by delegation, whereas power comes from people below you. You can have authority without power or power without authority.

Most individuals maintain position power in a traditional organizational structure. The higher up you sit, the more power you have. But in project management, the reporting level of the project might be irrelevant, especially if a project sponsor exists. In project management, the project manager's power base emanates from his:

- Expertise (technical or managerial)
- Credibility with employees
- Sound decision-making ability

Keeping in view its significance, the last item is usually preferred. If the project manager is regarded as a sound decision maker, then the employees normally give the project manager a great deal or power over them.

Here it is important to discuss leadership. Leadership styles refer to the interpersonal influence modes that a project manager can use. Project managers may have to use several different leadership styles, depending on the makeup of the project personnel. Conflict management is important because if the project manager can predict what conflicts will occur and when they are most likely to occur, he may be able to plan for the resolution of the conflicts through project administration. The object, of course, is to develop a project plan that shows complete distribution of resources and the corresponding costs. The project manager begins with a coarse (arrow diagram) network and then decides on the Work Breakdown Structure (WBS). The Work Breakdown Structure (WBS) is essential to the arrow diagram and should be constructed so that reporting elements and levels are easily identifiable.

For each element in the Work Breakdown Structure (WBS), eventually there will be an arrow diagram and detailed chart. If there exists too much detail, the project manager can refine the diagram by combining all logic into one plan and can then decide on the work assignments. There is a risk here that, by condensing the diagrams as much as possible, there may be a loss of clarity. All the charts and schedules can be integrated into one summary-level figure. This can be accomplished at each Work Breakdown Structure (WBS) level until the desired plan is achieved.

Moving ahead, finally, project, line, and executive management must analyze other internal and external variables before finalizing these schedules. A partial listing of these variables includes:

- Introduction or acceptance of the product in the marketplace
- Present or planned manpower availability
- Economic constraints of the project
- Degree of technical difficulty
- Manpower availability
- Availability of personnel training
- Priority of the project

In small companies and projects, certain items in the figure 25.1 below may be omitted, such as the Linear Responsibility Chart (LRC).

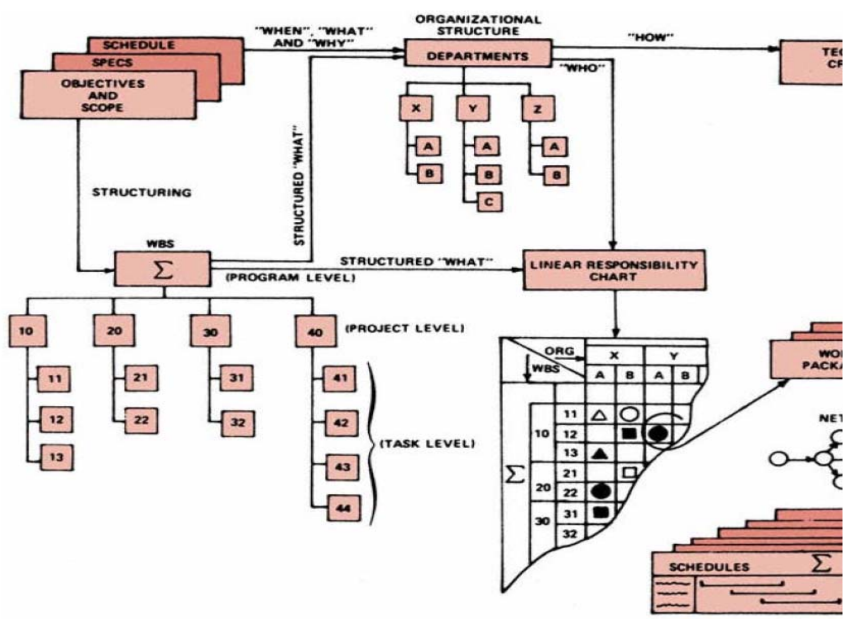


Figure 25.1: Project Planning

25.2 The Project Charter:

Initially, the original concept behind the project charter was to document the project manager's authority and responsibility, especially for projects implemented away from the home office. Today, the project charter has been expanded to become more of an internal legal document identifying to the line managers and his personnel not only the project manager's authority and responsibility, but also the management- and/or customer-approved scope of the project.

In theoretical terms, the sponsor prepares the charter and affixes his/her signature, but in reality, the project manager may prepare it for the sponsor's signature. At a minimum, the charter should include:

- Identification of the project manager and his/her authority to apply resources to the project
- The business purpose that the project was undertaken to address, including all assumptions and constraints
- Summary of the conditions defining the project

What is a “charter”? It is a "legal" agreement between the project manager and the company. Some companies supplement the charter with a "contract" that functions as an agreement between the project and the line organizations.

Recently, within the last two years or so, some companies have converted the charter into a highly detailed document containing:

- The scope baseline/scope statement
- Scope and objectives of the project (Statement of Work (SOW)
- Specifications
- Work Breakdown Structure (template levels)
- Timing
- Spending plan (S-curve)
- Management plan
- Resource requirements and man loading (if known)
- Résumés of key personnel
- Organizational relationships and structure
- Responsibility assignment matrix
- Support required from other organizations
- Project policies and procedures
- Change management plan
- Management approval of above

The project charter may function as the project plan when it contains a scope baseline and management plan. This is not really an effective use of the charter, but it may be acceptable on certain types of projects for internal customers.

25.3 Management Control:

It is essential that careful management control must be established because the planning phase provides the fundamental guidelines for the remainder of the project. In addition, since planning is an ongoing activity for a variety of different programs, management guidelines must be established on a company-wide basis in order to achieve unity and coherence.

Note that all functional organizations and individuals working directly or indirectly on a program are responsible for identifying, to the project manager, scheduling and planning problems that require corrective action during both the planning cycle and the operating cycle. The program manager bears the ultimate and final responsibility for identifying requirements for corrective actions.

For this purpose, management policies and directives are written specifically to assist the program manager in defining the requirements. Without clear definitions during the planning phase, many projects run off in a variety of directions.

In this regard, many companies establish planning and scheduling management policies for the project and functional managers, as well as a brief description of how they should interface.

25.4 The Project Manager–Line Manager Interface:

Good project planning, as well as other project functions, requires a good working relationship between the project and line managers. The utilization of management controls does not necessarily guarantee successful project planning. At this interface:

- The project manager answers the following questions:
    - What is to be done? (Using the Statement of Work, Work Breakdown Structure)
    - When will the task be done? (Using the summary schedule)
    - Why will the task be done? (Using the Statement of Work)
    - How much money is available? (Using the Statement of Work)
- The line manager answers the following questions:
    - How will the task be done? (i.e., technical criteria)
    - Where will the task be done? (i.e., technical criteria)
    - Who will do the task? (i.e., staffing)

Furthermore, project managers may be able to tell line managers "how" and "where," provided that the information appears in the Statement of Work (SOW) as a requirement for the project. Even then, the line manager can take exception based on his technical expertise.

The following figures 25.2 and 25.3, that is, “The Brick Wall” and “Modified Brick Wall” respectively, show what can happen when project managers overstep their bounds. In Figure 25.2 below, the manufacturing manager built a brick wall to keep the project managers away from his personnel because the project managers were telling his line people how to do their job. In Figure 25.3 “Modified Brick Wall”, the subproject managers (for simplicity's sake, equivalent to project engineers) would have, as their career path, promotions to Assistant Project Managers (A.P.Ms). Unfortunately, the Assistant Project Managers still felt that they were technically competent enough to give technical direction, and this created havoc for the engineering managers.

In view of this, the simplest solution to all of these problems is for the project manager to provide the technical direction *through* the line managers. After all, the line managers are supposedly the true technical experts.

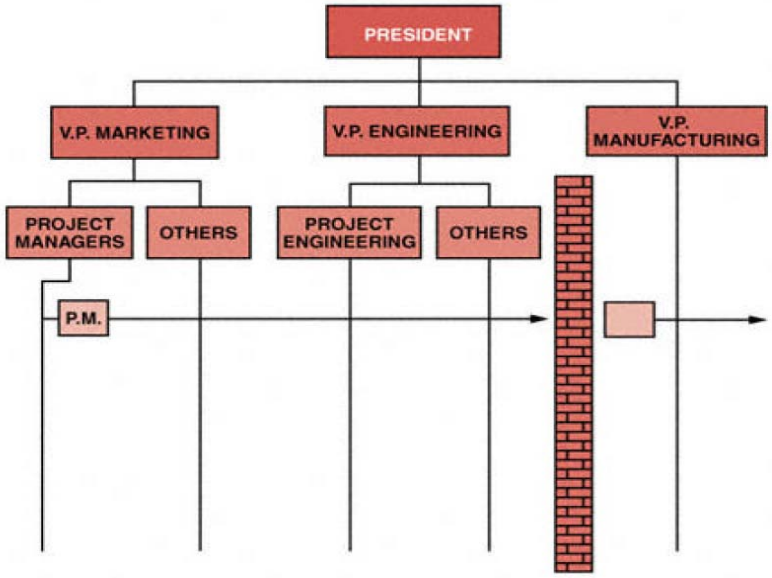


Figure 25.2: The Brick Wall

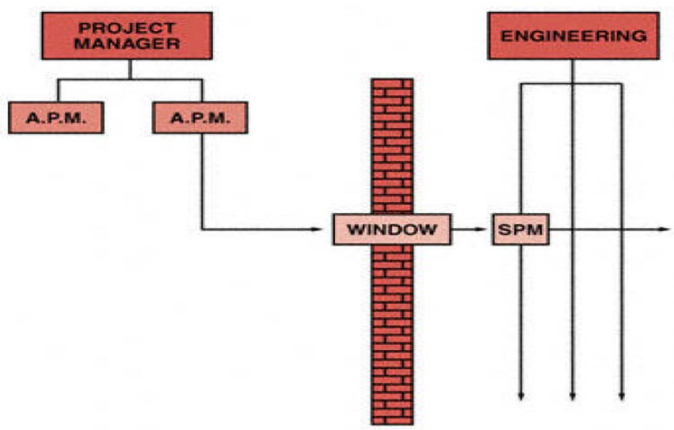


Figure 25.3: Modified Brick Wall

25.5 Project Fast-Tracking:

No matter how well we plan, sometimes something happens that causes havoc on the project. Such is the case when either the customer or management changes the project's constraints. Consider Figure 25.4 "The information explosion" and let us assume that the execution time for the construction of the project is one year. To prepare the working drawings and specifications down through level 5 of the Work Breakdown Structure (WBS) would require an additional 35 percent of the expected execution time, and if a feasibility study is required, then an additional 40 percent will be added on. In other words, if the execution phase of the project is one year, then the entire project is almost two years.

Let us now assume that management wishes to keep the end date fixed but the start date is delayed because of lack of adequate funding. How can this be accomplished *without* sacrificing the quality?

What should be the answer to it? The answer is to fast-track the project. Fast-tracking a project means that activities that are normally done in series are done in parallel. An example of this is when construction begins before detail design is completed.

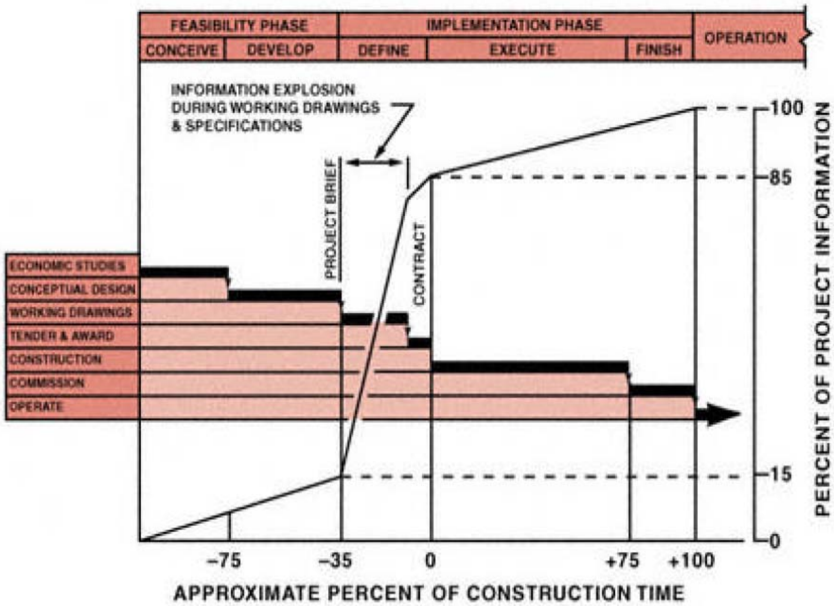


Figure 25.4: The Information Explosion

Now the question arises as to how would this help. Fast-tracking a job can accelerate the schedule but requires that additional risks be taken. If the risks materialize, then either the end date will slip or expensive rework will be needed. Almost all project driven companies fast-track projects. The danger, however, is when fast-tracking becomes a way of life on all projects.

25.6 Configuration Management:

Configuration management or configuration change control is one of the most critical tools employed by a project manager. As projects progress downstream through the various life-cycle phases, the cost of engineering changes can grow boundlessly. It is not uncommon for companies to bid on proposals at 40 percent below their own cost hoping to make up the difference downstream with engineering changes. It is also quite common for executives to "encourage" project managers to seek out engineering changes because of their profitability.

What is configuration management? It is a control technique, through an orderly process, for formal review and approval of configuration changes. If properly implemented, configuration management provides:

- Appropriate levels of review and approval for changes
- Focal points for those seeking to make changes
- A single point of input to contracting representatives in the customer's and contractor's office for approved changes

At a minimum, the configuration control committee should include representation from the customer, contractor, and line group initiating the change. Discussions should answer the following questions:

- What is the cost of the change?
- Do the changes improve quality?
- Is the additional cost for this quality justifiable?
- Is the change necessary?
- Is there an impact on the delivery date?

As we know that changes cost money. Therefore, it is imperative that configuration management be implemented correctly. The following steps can enhance the implementation process:

- Define the starting point or "baseline" configuration
- Define the "classes" of changes
- Define the necessary controls or limitations on both the customer and contractor
- Identify policies and procedures, such as:
  - Board chairman
  - Voters/alternatives
  - Meeting time
  - Agenda
  - Approval forums
  - Step-by-step processes
  - Expedition processes in case of emergencies

It is essential to know that effective configuration control pleases both customer and contractor. Overall benefits include:

- Better communication among staff
- Better communication with the customer
- Better technical intelligence
- Reduced confusion for changes
- Screening of frivolous changes
- Providing a paper trail

Lastly, but importantly, it must be understood that configuration control, as used here, is not a replacement for design review meetings or customer interface meetings. These meetings are still an integral part of all projects.

PROJECT SCOPE MANAGEMENT

BROAD CONTENTS

Scope
Difference between Scope, Objectives and Goals
Difference between Business Case, Project Charter and Scope Document
Scope Creep
Project Scope Management

26.1 Scope:

Scope is what the project contains or delivers. When starting to plan the scope of the project, think about the big picture first. At this level it is best to concentrate on major deliverables and not get bogged down with detail.

26.1.1: Why is Scope Important?

Scope of a project is the sum total of all of a project's products and their requirements or features.

Sometimes the term scope is used to mean the totality of work needed to complete a project.

In traditional project management, the tools to describe a project's scope (product) are the product breakdown structure and product descriptions. The primary tool to describe a project's scope is the Work Breakdown Structure (WBS).

Extreme project management advocates the use of user stories, feature lists and feature cards to describe a project's scope (product-deliverable).

If requirements are not completely defined and described and if there is no effective change control in a project, scope or requirements creep may ensue.

26.2 Difference Between Scope (In/Deferred/Out), Objectives and Goals:

Goals and objectives are what the business wants to achieve through this project. Goals and objectives define WHY the client wants to undertake the project.

Scope defines the size of the project. Scope can include such areas as:

a) Departments
b) Geographic locations
c) Deliverables
d) Features and functions

Often scope is limited by schedule and budget constraints.

Something *in scope* will be included in the current release or stage. Something *deferred* will be delivered in a later release. Something *out of scope* will not be included in the project. It is important to explicitly identify items out of scope to reduce misunderstandings which can generate conflict and hard feelings.

26.3 Difference Between Business Case, Project Charter and Scope Document?

A *business case* is usually prepared before project approval. If you are a contractor, your proposal would be similar a business case.

A *project charter* providing the project manager with formal authorization to proceed with the project is issued to a team by the project sponsor before the project starts.

Project scope document defines the project scope. It should be attached to the business case and to the project charter. The project scope will be refined as you proceed through the project.

Scope is bound to change, and this is to be expected. As the detail becomes clearer, more complications creep in. These are not foreseeable at the start and hopefully we build in a contingency for what we cannot see.

26.4 Scope Creep:

Scope creep (also called *requirement creep, feature creep,* and sometimes *kitchen sink syndrome*) in project management refers to uncontrolled changes in a project's scope. This phenomenon can occur when the scope of a project is not properly defined, documented, or controlled. It is generally considered a negative occurrence to be avoided.

Typically, the scope increase consists of either new products or new features of already approved product designs, without corresponding increases in resources, schedule, or budget. As a result, the project team risks drifting away from its original purpose and scope on unplanned additions, and also because of one's tendency to focus on only one dimension of project.

Therefore, scope creep can also result in a project team overrunning its original budget and schedule. As the scope of a project grows, more tasks must be completed at the same time and cost frame as original series of project tasks.

Scope creep can be a result of:

- Poor change control
- Lack of proper initial identification of what is required to bring about the project objectives.
- Weak project manager or executive sponsor
- Poor communication between parties.

Scope creep is a risk in most projects. Most mega projects fall victim to scope creep. Scope creep often results in cost overrun.

26.4.1 Features (Technology) Scope Creep Management:

Features (Technology) Scope Creep Management occurs when the scope creep is introduced by technologists adding features not originally contemplated. It is developed by technologists, for *customer pleasing* or *technical gold-plating* purposes where features are added to project (IT) by technologists causing scope creep.

Customer-pleasing scope creep occurs when the desire to please the customer through additional product features adds more work to the current project rather than to a new project proposal. It results from an organization and/or individual whose ultimate goal is to please customer while acting reluctant to reject proposed changes in requirement of project.

Gold-plating scope creep occurs when technologists augment the original requirements because of a bias toward "technical perfectionism" or because the initial requirements were insufficiently clear or detailed. It is different, and is a result of technologists adding substance or additions to original requirements, because of lack of details in initial business' requirements.

26.4.2 Scope Management Plan:

It is one of the major scope communication documents. The Project Scope Management Plan documents how the project scope will be defined, managed, controlled, verified and communicated to the project team and stakeholders/customers. It also includes all work required to complete the project.

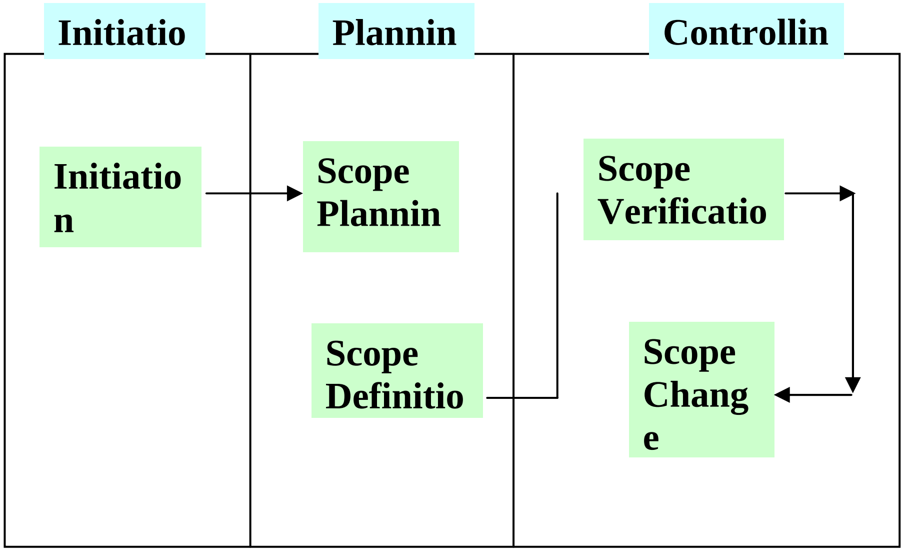
The documents are used to control what is in and out of the scope of the project by the use of a Change Management system. Items deemed out of scope go directly through the change control process and are not automatically added to the project work items.

The Project Scope Management plan is included in as one of the sections in the overall project management plan. It can be very detailed and formal or loosely framed and informal depending on the communication needs of the project.

26.5 Project scope management:

Processes used to identify all the work required to successfully complete the project.

- **Initiation**
- **Scope Planning**
- **Scope Definition**
- **Scope Verification**
- **Scope Change Control**



- ***Product Scope:***
  This refers to the features and functions that are to be included in a product or service. Successful completion of product scope is measured against the requirements.

- ***Project Scope:***
  This refers to the work that must be done to deliver the product with specified features and functions. Successful completion of project scope is measures against the plan.

26.5.1 Scope Initiation:

Formal authority that a project exists and recognizing that it should continue its next phase.

- Appointment of project team
- Introduction
- Needs identification
- Market research
- Opportunity studies
- Political input
- Tendering
- Project objectives and constraints
- Characteristics of objectives
- Strategic plan and objectives
- Constraints
- Project cost limit
- Performance measures
- Additional input to project selection and initiation

26.5.1.1Project Charter:

The project charter is the document that formally recognizes existence of a project. It refers to the business need the project is addressing. It describes the products to be delivered. It gives project manager the authority to apply organizational resources to project activities.

26.5.2 Scope Planning:

It is a written statement that includes:

- Project justification
- Major deliverables
- Project objectives

It refers to the criteria used to determine if the project or phase has been completed successfully.

Scope planning is defining and managing the project scope influences the project's overall success. Each project requires a careful balance of tools, data sources, methodologies, processes and procedures, and other factors to ensure that the effort expended on scoping activities is commensurate with the project's size, complexity, and importance.

26.5.2.1Scope Management Plan:

The project scope management plan provides guidelines on how project scope will be defined, documented, verified, managed, and controlled by the project management team.

Scope management plan describes:

- How scope changes will be identified and classified.
- How scope changes will be integrated into the project.
- Expected stability of the project.

26.5.3 Scope Definition:

This is where we get down to detail. It provides the detailed information for the Scope Plan, often called the *Scope Definition Document*. It provides the basis for estimating cost, time and resources, performance measurement and responsibilities.

Generally the scope definition document is presented in list format but development of the document requires some brainstorming activities that are best done with the key stakeholders and the project team involved.

26.5.3.1 Developing Preliminary and Detailed Project Scope Statement:

The project scope statement is the definition of the project – what needs to be accomplished.

The *preliminary project scope statement* is developed from the information provided by the initiator or sponsor. The project management team in the scope definition process further refines the *preliminary project scope statement into the project scope statement*. The project scope statement content will vary depending upon the application area and complexity of the project. During subsequent phases of multi-phase projects the Preliminary Project Scope Statement process validates and refines, if required, the project scope defined for that phase.

The preparation of a *detailed project scope statement* is critical to project success and builds upon the major deliverables, assumptions, and constraints that are documented during project initiation in the preliminary project scope statement. During planning, the project scope is defined and described with greater specificity because more information about the project is known.
Stakeholder needs, wants, and expectations are analyzed and converted into requirements. The assumptions and constraints are analyzed for completeness, with additional assumptions and constraints added as necessary. The project team and other stakeholders, who have additional insight into the preliminary project scope statement, can perform and prepare the analyses.

Defining what project scope means is critical. We have all been in the meetings where two or three people leave with different impressions of the discussion. Creating a project scope statement is a key way to ensure everyone is on the same page. The Project Scope Statement defines the project scope and what needs to be accomplished to meet the project's objectives.

- **Value of Sound Scope Statement:**

  With a sound scope statement, one can clearly understand the project details, deliverables and its boundaries. Product description helps to explain and understand the details for accomplishing objectives. It is essential to be sensitive to customer's constraints, assumptions, budgetary restrictions as well as definite limitations. Thus, it is necessary to follow project scope to have concrete decision making ability during the project. As a result of this, the team involved begins to identify risks and issues that could cause any delay in the project. Also, any scope deviations must be communicated immediately to all stakeholders including customers.

26.5.3.2Inputs to Defining Project Scope:

The five inputs to defining project scope are:

1. **Organizational Process Assets:**
   Organizational process assets provide information about standards that the company has already set in place—standards that are likely to be applied to every project. This information is re-used when creating the Project Scope Statement.

2. **Project Charter:**
   The project charter authorizes the existence of the project. It outlines the project objectives, which project managers need to detail further in the Project Scope Statement.

3. **Preliminary Project Scope Statement:**
   The Preliminary Project Scope Statement provides a description of the major project deliverables, project objectives, project assumptions, project constraints, and a statement of work.

4. **Project Scope Management Plan:**
The Project Scope Management Plan provides a description of how the stated project objectives will be developed within the detailed Project Scope Statement.

5. **Approved Change Requests:**
Change request which are agreed-upon and documented amendments to project scope. Approved change requests will ultimately be added to the Project Scope Statement.

26.5.3.3Outputs to Defining Project Scope:

The project scope statement describes, in detail, the project's deliverables and the work required to create those deliverables. The project scope statement also provides a common understanding of the project scope among all project stakeholders and describes the project's major objectives. It also enables the project team to perform more detailed planning, guides the project team's work during execution, and provides the baseline for evaluating whether requests for changes or additional work are contained within or outside the project's boundaries.

1. **Scope Statement:**

The degree and level of detail to which the project scope statement defines what work will be performed and what work is excluded can determine how well the project management team can control the overall project scope. Managing the project scope, in turn, can determine how well the project management team can plan, manage, and control the execution of the project.

The detailed project scope statement includes, either directly or by reference to other documents:

- **Project Objectives:** Project objectives include the measurable success criteria of the project. Projects may have a wide variety of business, cost, schedule, technical, and quality objectives. Project objectives can also include cost, schedule, and quality targets.

- **Product Scope Description:**
It describes the characteristics of the product, service, or result that the project was undertaken to create. These characteristics will generally have less detail in early phases and more detail in later phases as the product characteristics are progressively elaborated. While the form and substance of the characteristics will vary, the scope description should always provide sufficient detail to support later project scope planning.

- **Project Requirements:**
It describes the conditions or capabilities that must be met or possessed by the deliverables of the project to satisfy a contract, standard, specification, or other formally imposed documents. Stakeholder analyses of all stakeholder needs,

wants, and expectations are translated into prioritized requirements.

- **Project Boundaries:**
  Identifies generally what is included within the project. It states explicitly what is excluded from the project, if a stakeholder might assume that a particular product, service, or result could be a component of the project.

- **Project Deliverables:**
  Deliverables include both the outputs that comprise the product or service of the project, as well as ancillary results, such as project management reports and documentation. Depending on the project scope statement, the deliverables may be described at a summary level or in great detail.

- **Product Acceptance Criteria:**
  It defines the process and criteria for accepting completed products.

- **Project Constraints:**
  Lists and describes the specific project constraints associated with the project scope that limits the team's options. For example, a predefined budget or any imposed dates (schedule milestones) that are issued by the customer or performing organization are included. When a project is performed under contract, contractual provisions will generally be constraints. The constraints listed in the detailed project scope statement are typically more numerous and more detailed than the constraints listed in the project charter.

- **Project Assumptions:**
  Lists and describes the specific project assumptions associated with the project scope and the potential impact of those assumptions if they prove to be false. Project teams frequently identify, document, and validate assumptions as part of their planning process. The assumptions listed in the detailed project scope statement are typically more numerous and more detailed than the assumptions listed in the project charter.

- **Initial Project Organization:**
  The members of the project team, as well as stakeholders, are identified. The organization of the project is also documented.

- **Initial Defined Risks:**
  Identifies the known risks.

- **Schedule Milestones:**
  The customer or performing organization can identify milestones and can place imposed dates on those schedule milestones. These dates can be addressed as schedule constraints.

- **Fund Limitation:**

Describes any limitation placed upon funding for the project, whether in total value or over specified time frames.

- **Cost Estimate:**
  The project's cost estimate factors into the project's expected overall cost, and is usually preceded by a modifier that provides some indication of accuracy, such as conceptual or definitive.

- **Project Configuration Management Requirements:**
  It describes the level of configuration management and change control to be implemented on the project.

- **Project Specifications:**
  Identifies those specification documents with which the project should comply.

- **Approval Requirements:**
  It identifies approval requirements that can be applied to items such as project objectives, deliverables, documents, and work.

2. **Requested Changes:**

   Requested changes to the project management plan and its subsidiary plans may be developed during the Scope Definition process. Requested changes are processed for review and disposition through the Integrated Change Control process.

3. **Project Scope Management Plan (Updates):**

   The project scope management plan component of the project management plan may need to be updated to include approved change requests resulting from the project's Scope Definition process.

26.5.4 Scope Verification:

This process is carried out whenever one or more deliverables are ready to be handed over. It consists of obtaining the stakeholders' formal acceptance of the work completed.

Verifying the project scope includes reviewing deliverables to ensure that each is completed satisfactorily. If the project is terminated early, the project scope verification process should establish and document the level and extent of completion. Scope verification differs from quality control in that scope verification is primarily concerned with acceptance of the deliverables, while quality control is primarily concerned with meeting the quality requirements specified for the deliverables. Quality control is generally performed before scope verification, but these two processes can be performed in parallel.

26.5.5 Scope Change Control:

The scope changes that usually cause problems are those where the perception of what was in and out of scope was different between various parties. The Project Manager assumed there would only be four or five reports, and the business assumed ten to twenty. Nobody felt it was worth talking about because they assumed the other person thought the same way they did.

The scope management section of the project plan is a formalized document that captures the processes for handling Scope Changes. The last output of scope management is that of *"Scope Control"*. The project manager should implement a process to ensure the project's goals and objectives will be monitored throughout the project.

The project manager must be made aware of any discrepancies of project activities or potential risks promptly that deviate from the baseline or work breakdown schedule, in order to minimize any delays to the schedule which can ultimately cause project failure.

It is the project manager's responsibility to provide guidance for any corrective action and means of communications to all team members involved at any level of the project.

With adequate scope control mechanisms executed, the team's progress and performance can be measured. This will resolve any potential issues to the schedule and decrease resource conflicts.

Project scope control is concerned with influencing the factors that create project scope changes and controlling the impact of those changes. Scope control assures all requested changes and recommended corrective actions are processed through the project Integrated Change Control process.

Project scope control is also used to manage the actual changes when they occur and is integrated with the other control processes. Uncontrolled changes are often referred to as project scope creep. Change is inevitable, thereby mandating some type of change control process.

Scope creep (as already discussed) is a term which refers to the creeping forward of the scope of a project. It sometimes causes cost overrun. It is a term which refers to the incremental expansion of the scope of a project, which may include and introduce more requirements that may not have been a part of the initial planning of the project.

There are two distinct ways to separate scope creep management, the first is business scope creep, and the second is called features (also technology) scope creep. The type of scope creep management is nearly always dependent upon on the people who create the changes.

Business scope creep management occurs when decisions that are made with reference to a project are designed to solve or meet the requirements and needs of the business. Business scope creep changes may be a result of poor requirements definition early in development, or the failure to include the users of the project until the later stage of the systems development life cycle.

The type of scope creep management is always dependent upon on the people who create the changes.

Scope creep management is significant in many organizations all around the world, as many projects that an organization will set out on have a project scope. Since projects are expected to have strict deadlines with time, budget and quality restraints, the effect of a change in the scope can ultimately affect the success of the project.

If the approved change requests have an effect upon the project scope, then the project scope statement is revised and reissued to reflect the approved changes. The updated project scope statement becomes the new project scope baseline for future changes.

Scope Approval:

The *scope management plan* is a formal document that explains how the project scope will be managed and how scope changes will be factored into the project plan.

Once the scope is developed, the elements are thoroughly discussed and agreed on by the project team, stakeholders, sponsors and customers. Then scope definition is signed-off formally and the changes are discussed thoroughly by the project manager. With "acceptance/signed scope approval" project manager responds to ensure complete and monitored processing. Also, the customers are being noticed for every change to avoid project creep and risks.

PROJECT SCOPE MANAGEMENT

BROAD CONTENTS

Scope
Project Scope Management

27.1 SCOPE:

The term "scope" refers to:

- **Product Scope:**
  This includes work to deliver a project's product/service with specific features and functions. The result can be a single product or you can have several components. The features, functions, and characteristics to be included in a product are measured against set product requirements and are managed throughout the lifecycle.

- **Project Scope:**
  Project scope refers to the work that must be done in order to deliver a product, service, result with specified features and functions. Project scope has a start and end date, possesses unique characteristics or attributes, and produces specific results during the lifecycle.

27.2 PROJECT SCOPE MANAGEMENT:

Scope management is concerned with defining and controlling the scope of a project. It includes product description, any known constraints and assumptions. Project scope is defined in project charter. It serves as a basis for development of Work Breakdown Structure (WBS). It must be verified and controlled throughout the life of the project.

Project scope management includes the processes required to ensure that the project includes all the work required to complete the project successfully. It is primarily concerned with defining and controlling what is or is not included in project.

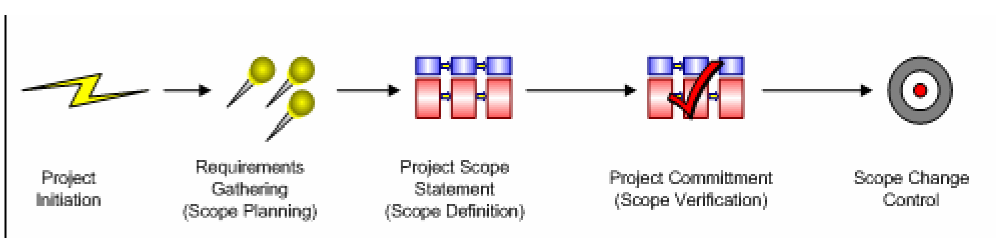
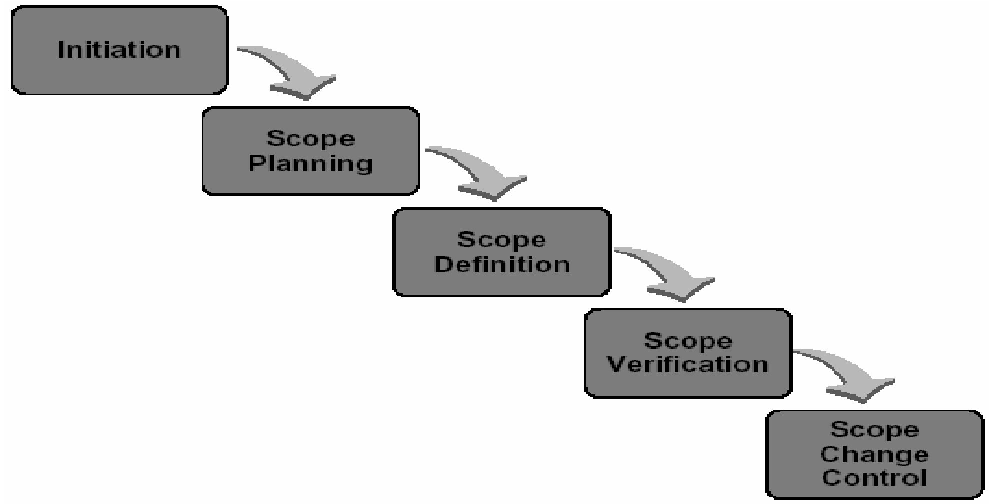


Figure 27.1: Scope Management Process

The scope management process comprises of the following:
- Project initiation: Approve Business case, feasibility, budget
- Scope planning: Gather requirements
- Scope definition: Create scope components, scope divide work
- Scope verification: Get approval from all stakeholders
- Scope change control: Manage scope change requests



27.2.1 Initiation Phase:

As described in the previous lecture, it is the process of formally recognizing that a new project exists or that an existing project should continue into its next phase

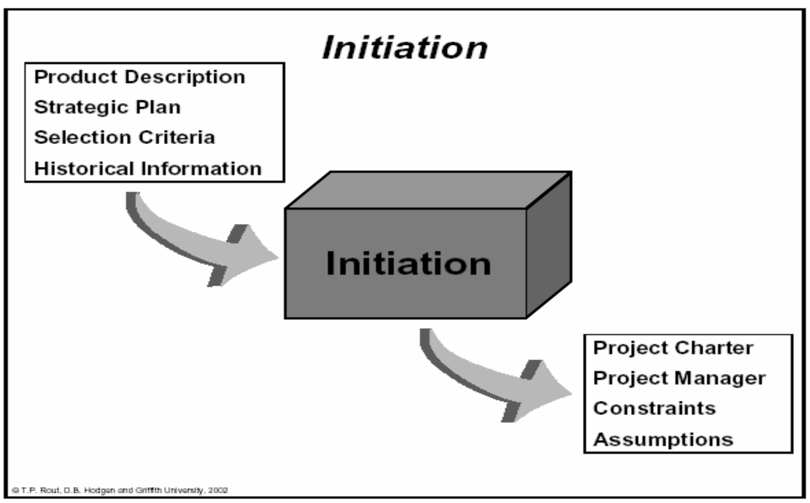


Figure 27.3: Initiation Phase

27.2.2 Project Scope Planning:

It refers to creating a project scope management plan that documents how project scope will be defined, verified, controlled and how the Work Breakdown Structure (WBS) will be created and defined.

Process of developing a written scope statement as the basis for future project decisions including, in particular, the criteria used to determine, if the project phase completed successfully.

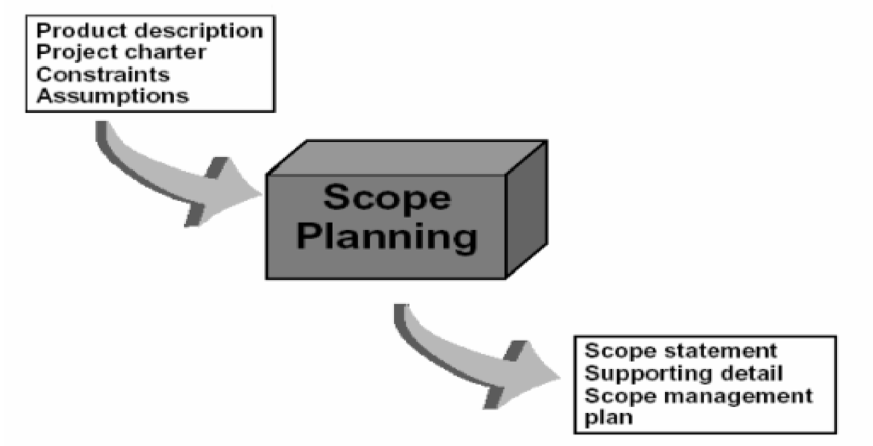


Figure 27.4: Scope Planning

27.2.2.1Applying the Process Model:

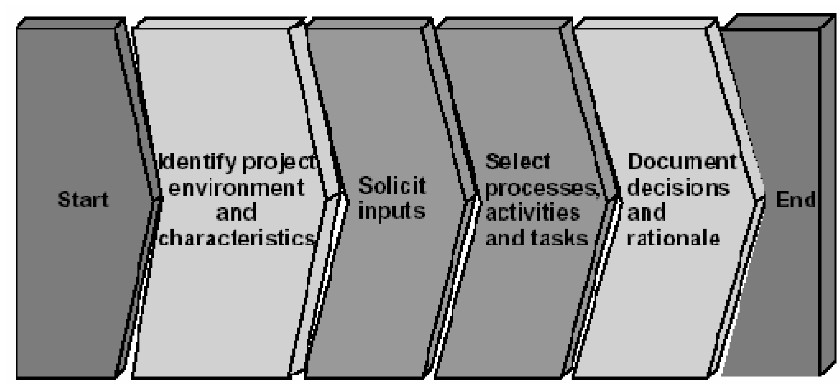


Figure 27.5: Process Model

1. ***Define Scope:*** I

   It is always essential to know what the goals of the project are. This needs to be defined in exact and quantitative terms:

   - What the project is supposed to achieve
   - What the project is not supposed to achieve

   This is achieved through the definition and management of the project scope.

2. ***Identify Project Environment and Characteristics:***

   Identify what processes are already in place. If process is fundamental to achieving organization's goals? Is there high risk involved in business? What the problem areas are? Also what type of an organizational culture exists (is it easily adaptable or adverse to change)? Lastly, identify what the requirements are?

3. ***Solicit Inputs:***

   The requirements for project are a major driver. The affected parties should be involved in the process. These people ensure resulting processes are:

a) Feasible /useful
b) Possible, including feedback of previous projects

4. Select Processes, Activities and Tasks:

Identify and prioritize processes or parts of process within the standards that will be implemented. It is useful to include "mapping current processes" practices and/or methods to processes activities and tasks. Mapping must be used to verify and to identify gaps between the *current situation* and *target situation.*

5. Document Decisions and Rationale:

Document refers to the mapping of defined processes, activities and tasks to determine relationships and reasons for adopting this approach. This document should be included into the Project Management Plan".

27.2.3 Project Scope Definition:

This involves subdividing major project deliverables (as identified in scope statement) into smaller, more manageable components.

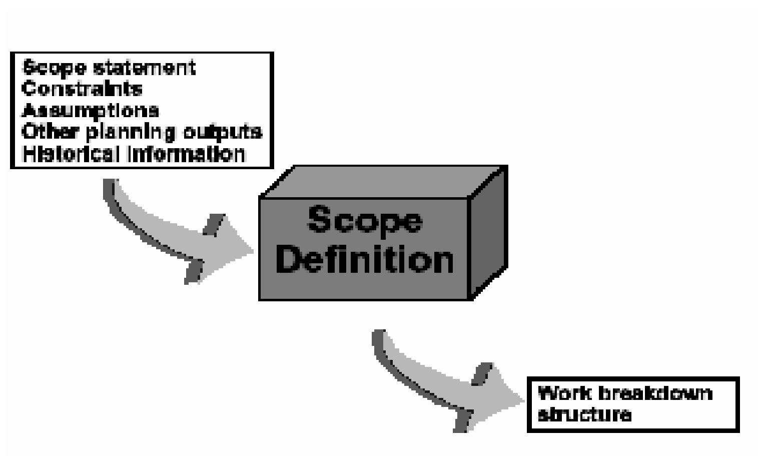


Figure 27.6: Scope Definition

The benefit of scope definition is to improve accuracy of estimated cost, time, and resources. The baseline for performance, measurement and control is defined. It facilitates clear responsibility and assignments.

27.2.3.1Work Breakdown Structure (WBS):

Deliverable oriented grouping of project elements that organizes and defines the scope of the project that work not in Work Breakdown Structure (WBS) is outside the scope of project.

As with the scope statement, Work Breakdown Structure (WBS) is often used to develop or confirm a common understanding of project scope.

Each descending level represents an increasingly detailed description of project elements.

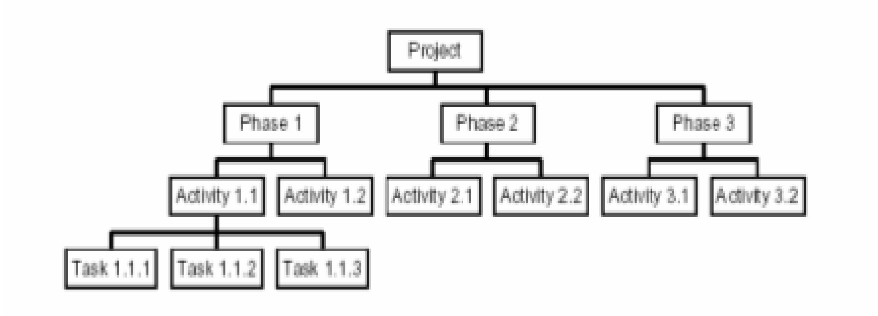


Figure 27.7: Model Work Breakdown Structure (WBS)

A Work Breakdown Structure (WBS) is normally presented in chart form. Each item in it is generally assigned a *unique identifier* often known collectively as "*code of accounts*". Items at lowest level of Work Breakdown Structure (WBS) are known as *work packages*.

27.2.4 Scope Verification:

It is the process of formalizing acceptance of the project scope by stakeholders (sponsor, client, customer, etc.).

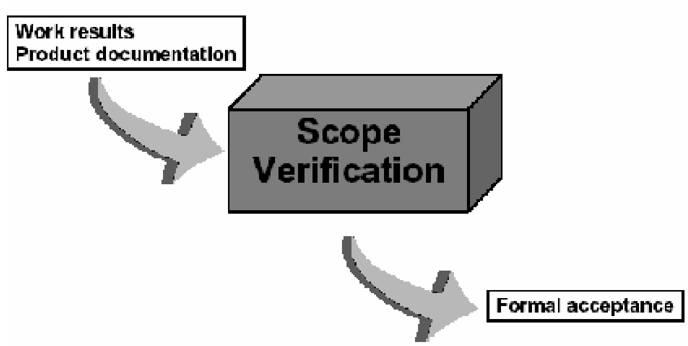


Figure 27.8: Scope Verification

27.2.4.1Formal Acceptance:

It is the documentation of the product, project or phase acceptance by the client and/or sponsor. It must be prepared and distributed. Such acceptance must be conditional, especially at the end of every phase.

27.2.5 Scope Change Control:

It defines procedures by which project scope must be changed. It includes paperwork, tracking systems, and approval levels necessary for authorizing changes. Scope change control system should be integrated with overall change control system. In particular, with any system in place to control product scope.

Scope change control is concerned with:

a) Influencing factors which create scope changes to ensure that changes are beneficial.
b) Determining that a scope change has occurred.
c) Managing the actual changes when and if they occur.

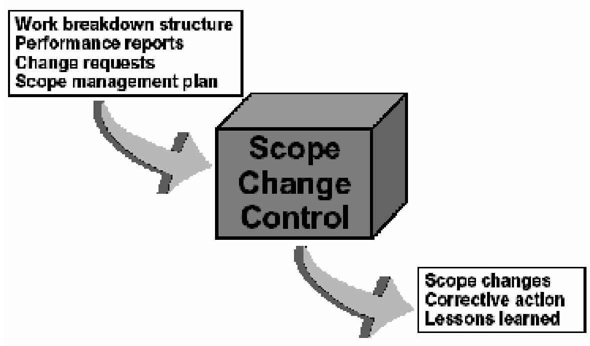


Figure 27.9: Scope Change Control

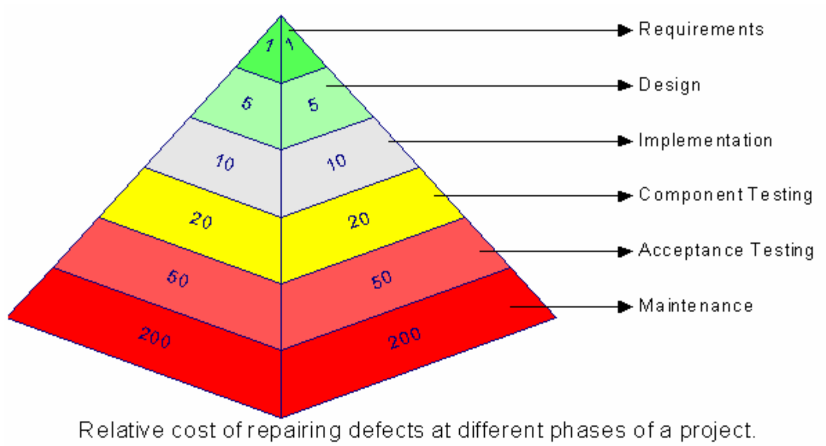


Figure 27.10: The Cost of Scope Change

NETWORK SCHEDULING TECHNIQUES

BROAD CONTENTS

Introduction
Benefits and Advantages of Scheduling
Historical Evolution of Network Scheduling
Network Fundamentals and Terminology
Pert/CPM and their Difference
Graphical Evaluation and Review Techniques (GERT)
Dependencies or Interrelationship
Slack Time

28.1 Introduction:

In today's highly competitive environment, management is continually seeking new and better control techniques to cope with the complexities, masses of data, and tight deadlines that are characteristic of many industries.
In addition, management is seeking better methods for presenting technical and cost data to customers.

Since World War II, scheduling techniques have taken on paramount importance. The most common of these techniques are shown below:

- Gantt or bar charts
- Milestone charts
- Line of balance
- Networks
  - Program Evaluation and Review Technique (PERT)
  - Arrow Diagram Method (ADM) [Sometimes called the Critical Path Method (CPM)]
  - Precedence Diagram Method (PDM)
  - Graphical Evaluation and Review Technique (GERT)

28.2 Benefits and Advantages of Scheduling:

The ***Program Evaluation and Review Technique (PERT)*** perhaps is the best known of all the relatively new techniques. PERT has several distinguishing characteristics:

- It forms the basis for all planning and predicting and provides management with the ability to plan.
- It enables management for best possible use of resources to achieve a given goal within time and cost limitations.
- It provides visibility and enables management to control "one-of-a-kind" programs as opposed to repetitive situations.
- It helps management to handle uncertainties involved by answering the following questions that provides management with a means for evaluating alternatives:

  a) How time delays in certain elements influence program completion?
  b) Where slack exists between elements?
  c) What elements are crucial to meet the completion date?

- It provides a basis for obtaining the necessary facts for decision making.
- It utilizes a time network analysis as the basic method to determine manpower, material, and capital requirements as well as providing a means for checking progress.
- It provides the basic structure for reporting information.
- It reveals interdependencies of activities.
- It facilitates "what if" exercises.
- It identifies the longest path or critical paths.
- It allows us to perform scheduling risk analysis.

The above-mentioned benefits apply to all network scheduling techniques, not just PERT.

28.3 Historical Evolution of Networks:

Before going further with the details, let us have an insight into the historical evolution of networks. PERT was originally developed in 1958 and 1959 to meet the needs of the "age of massive engineering" where the techniques of Taylor and Gantt were inapplicable. The Special Projects Office of the U.S. Navy, concerned with performance trends on large military development programs, introduced PERT on its Polaris Weapon System in 1958, after the technique had been developed with the aid of the management consulting firm of Booz, Allen, and Hamilton. Since that time, PERT has spread rapidly throughout almost all industries. At about the same time the Navy was developing PERT, the DuPont Company initiated a similar technique known as the ***Critical Path Method (CPM)***, which also has spread widely, and is particularly concentrated in the construction and process industries.

The basic requirements of PERT/time as established by the Navy, in the early 1960s, were as follows:

- All of the individual tasks to complete a given program must be visualized in a manner clear enough to be put down in a network, which comprises events and activities; that is, follow the work breakdown structure.
- Events and activities must be sequenced on the network under a highly logical set of ground rules that allow the determination of important critical and sub-critical paths. Networks can have up to one hundred or more events, but not less than ten or twenty.
- Time estimates must be made for each activity of the network on a three-way basis. Optimistic, most likely, and pessimistic elapsed-time figures are estimated by the person(s) most familiar with the activity involved.
- Critical path and slack times are computed. The critical path is that sequence of activities and events whose accomplishment will require the greatest expected time.

28.3.1 Advantages of PERT:

1. Firstly, a major advantage of PERT is the kind of planning required to a major network. Network development and critical path analysis reveal interdependencies and problem areas that are neither obvious nor well defined by other planning methods. The technique therefore determines where the greatest effort should be made for a project to stay on schedule.
2. By using PERT one can determine the probability of meeting specified deadlines by development of alternative plans. If the decision maker is statistically sophisticated, he can examine the standard deviations and the probability of accomplishment data. If there exists a minimum of uncertainty, one may use the single-time approach, of course, while retaining the advantage of network analysis.
3. A third advantage is the ability to evaluate the effect of changes in the program. For example, PERT can evaluate the effect of a contemplated shift of resources

from the less critical activities to the activities identified as probable bottlenecks. Other resources and performance trade-offs may also be evaluated.

4. PERT can also evaluate the effect of a deviation in the actual time required for an activity from what had been predicted.
5. Lastly, PERT allows a large amount of sophisticated data to be presented in a well-organized diagram from which both contractor and customer can make joint decisions.

Unfortunately, PERT is not without its disadvantages. The complexity of PERT adds to the implementation problems. There exist more data requirements for a PERT - organized MCCS reporting system than for most others. PERT, therefore, becomes an item that is expensive to maintain and is utilized most often on large, complex programs.

Many companies have taken a hard look at the usefulness of PERT on small projects in recent years. The literature contains many diversified approaches toward applying PERT to other than large and complex programs. The result has been the PERT/LOB procedures, which, when applied properly, can do the following job:

- Cut project costs and reduce time scale
- Coordinate and expedite planning
- Eliminate idle time
- Provide better scheduling and control of subcontractor activities
- Develop better troubleshooting procedures
- Cut the time required for routine decisions, but allow more time for decision making

Note that even with these advantages, many companies should ask themselves whether they actually need PERT. Incorporation of PERT may not be easy, even if canned software packages are available. One of the biggest problems with incorporating PERT occurred in the 1960s when the Department of Defense requested that its customers adopt PERT/cost for relating cost and schedules. This resulted in the expenditure of considerable cost and effort on behalf of the contractor to overcome the numerous cost-accounting problems. Many contractors eventually went to two sets of books; one set was for program control (which was in compliance with standard company cost control procedures), and a second set was created for customer reporting. Therefore, before accepting a PERT system, management must perform a trade-off study to determine if the results are worth the cost.

28.3.2 Criticism of PERT:

The criticism that most people discover when using PERT includes:

- Time and labor intensive effort is required.
- Upper-level management decision-making ability is reduced.
- There exists a lack of functional ownership in estimates.
- There exists a lack of historical data for time–cost estimates.
- The assumption of unlimited resources may be inappropriate.
- There may exist the need for too much detail.

28.4 Network Fundamentals and Terminology:

It is important to know that the major discrepancy with Gantt, milestone, or bubble charts is the inability to show the interdependencies between events and activities. These interdependencies must be identified so that a master plan can be developed that provides an up-to-date picture of operations at all times and is easily understood by all.

The interdependencies are shown through the construction of networks. Network analysis can provide valuable information for planning, integration of plans, time studies, scheduling, and resource management. The primary purpose of network planning is to eliminate the need for crisis management by providing a pictorial representation of the total program.

The following management information can be obtained from such a representation:

- Interdependencies of activities
- Project completion time
- Impact of late starts
- Impact of early starts
- Trade-offs between resources and time
- "What if" exercises
- Cost of a crash program
- Slippages in planning/performance
- Evaluation of performance

As we know that networks are composed of events and activities. An event is defined as the starting or ending point for a group of activities, and an activity is the work required to proceed from one event or point in time to another. Figure 28.1 below shows the standard nomenclature for PERT networks. The circles represent events, and arrows represent activities. The numbers in the circles signify the specific events or accomplishments. The number over the arrow specifies the time needed (hours, days, months), to go from event 6 to event 3. The events need not be numbered in any specific order. However, event 6 must take place before event 3 can be completed (or begin).

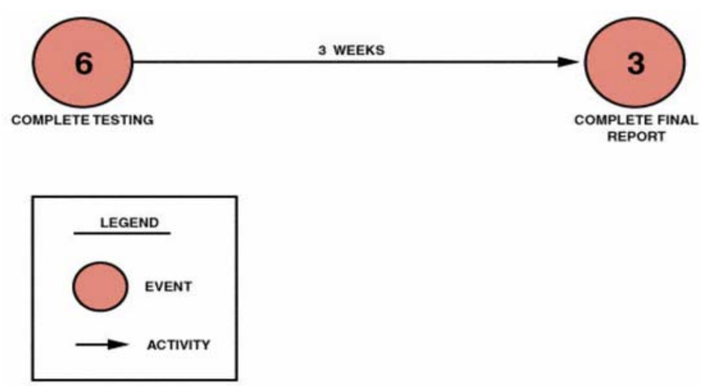


Figure 28.1: Standard PERT Nomenclature

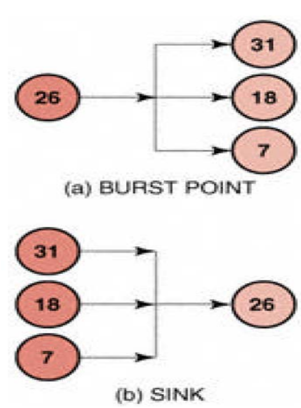


Figure 28.2: PERT Sources (Burst Points) and Sinks

As depicted in Figure 28.2 (a) above, event 26 must take place prior to events 7, 18, and 31. In Figure 28.2 (b), the opposite holds true, and events 7, 18, and 31 must take place prior to event 26. Thus, it is similar to "and gates" used in logic diagrams.

However, these charts can be used to develop the PERT network, as shown in Figure 28.3 below. The bar chart in Figure (A) below can be converted to the milestone chart in Figure (B) below. By then defining the relationship between the events on different bars in the milestone chart, we can construct the PERT chart in Figure (C) below.

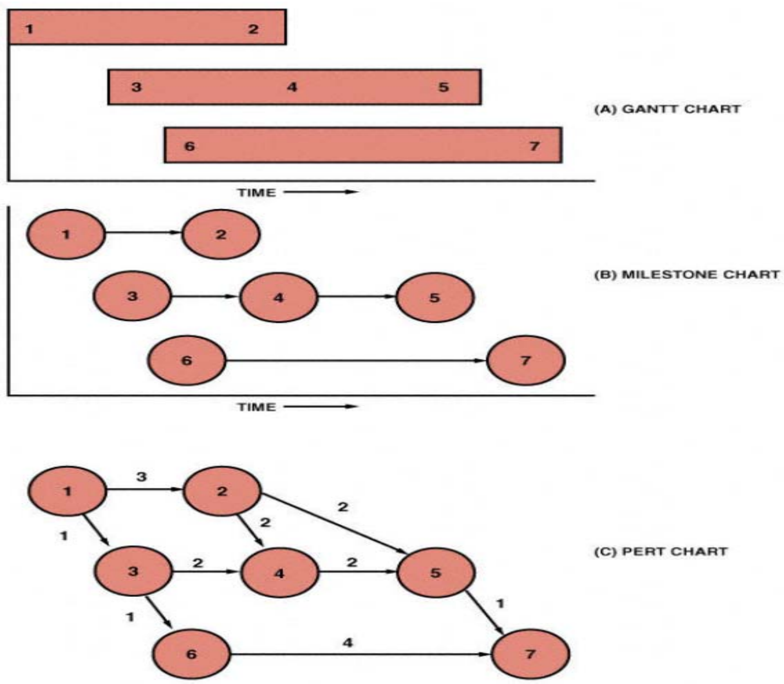


Figure 28.3: Conversion from Bar Chart to PERT Chart

Basically PERT is a management planning and control tool. It can be considered as a road map for a particular program or project in which all of the major elements (events) have been completely identified together with their corresponding interrelations. PERT charts are often constructed from back to front because, for many projects, the end date is fixed and the contractor has front-end flexibility.

It is important to note here that one of the purposes of constructing the PERT chart is to determine how much time is needed to complete the project. PERT, therefore, uses time as a common denominator to analyze those elements that directly influence the success of the project, namely, time, cost, and performance. The construction of the network requires two inputs. First, a selection must be made as to whether the events represent the start or the completion of an activity. Event completions are generally preferred.

Activity	Title	Immediate Predecessors	Activity Time, Weeks
1–2	A	—	1
2–3	B	A	5
2–4	C	A	2
3–5	D	B	2
3–7	E	B	2
4–5	F	C	2
4–8	G	C	3
5–6	H	D,F	2
6–7	I	H	3
7–8	J	E,I	3
8–9	K	G,J	2

Table 28.1: Sequence of Events

The next step is to define the sequence of events, as shown in Table 28.1 above, which relates each event to its immediate predecessor. Large projects can easily be converted into PERT networks once the following questions are answered:

- What job immediately precedes this job?
- What job immediately follows this job?
- What jobs can be run concurrently?

A typical PERT network is shown in the following figure 28.4.

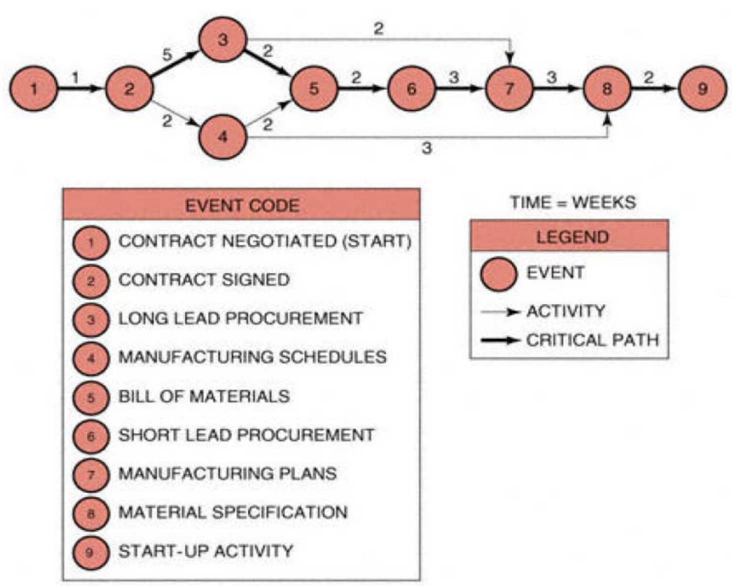


Figure 28.4: Simplified PERT Network

The bold line represents the critical path, which is established by the longest time span through the total system of events. The critical path is composed of events 1–2–3–5–6–7–8–9. The critical path is vital for successful control of the project because it tells management two things:

1. Because there is no slack time in any of the events on this path, any slippage will cause a corresponding slippage in the end date of the program unless this slippage can be recovered during any of the downstream events (on the critical path).

2. Because the events on this path are the most critical for the success of the project, management must take a hard look at these events in order to improve the total program.

Therefore, by using PERT we can now identify the earliest possible dates on which we can expect an event to occur, or an activity to start or end. There is nothing overly mysterious about this type of calculation, but without a network analysis the information might be hard to obtain.

PERT charts can be managed from either the events or the activities. For levels 1–3 of the Work Breakdown Structure (WBS), the project manager's prime concerns are the milestones, and therefore, the events are of prime importance. For levels 4–6 of the Work Breakdown Structure (WBS), the project manager's concerns are the activities.

28.5 Differences Between PERT and CPM:

Note that the principles that we have discussed so far apply not only to PERT, but to CPM as well. The nomenclature is the same for both, and both techniques are often referred to as arrow diagramming methods, or activity-on-arrow networks. The differences between PERT and CPM are as follows:

- PERT uses three time estimates (optimistic, most likely, and pessimistic). From these estimates, an expected time can be derived. CPM uses one time estimate that represents the normal time (that is, better estimate accuracy with CPM).
- PERT is probabilistic in nature, based on a beta distribution for each activity time and a normal distribution for expected time duration. This allows us to calculate the "risk" in completing a project. CPM is based on a single time estimate and is deterministic in nature.
- Both PERT and CPM permit the use of dummy activities in order to develop the logic.
- PERT is used for Research and Development projects where the risks in calculating time durations have a high variability. CPM is used for construction projects that are resource dependent and based on accurate time estimates.
- PERT is used on those projects, such as Research and Development, where percent complete is almost impossible to determine except at completed milestones. CPM is used for those projects, such as construction, where percent complete can be determined with reasonable accuracy and customer billing can be accomplished based on percent complete.

28.6 Graphical Evaluation And Review Technique (GERT):

Graphical Evaluation and Review Techniques (GERT) are similar to PERT but have the distinct advantages of allowing for looping, branching, and multiple project end results. With PERT one cannot easily show that if a test fails, we may have to repeat the test several more times. With PERT, we cannot show that, based upon the results of a test, we can select one of several different branches to continue the project. These problems are easily overcome using GERT.

28.7 Dependencies or Interrelationships:

There are three basic types of interrelationships or dependencies:

1. ***Mandatory Dependencies (i.e., Hard Logic):***
These are dependencies that cannot change, such as erecting the walls of a house before putting up the roof.

2. ***Discretionary Dependencies (i.e., Soft Logic):***
These are dependencies that may be at the discretion of the project manager or may simply change from project to project. As an example, one does not need to complete the entire bill of materials prior to beginning procurement.

3. ***External Dependencies:***
These are dependencies that may be beyond the control of the project manager such as having contractors sit on your critical path.

28.7.1 Dummy Activities:

It is sometimes impossible to draw network dependencies without including dummy activities. Dummy activities are artificial activities, represented by a dotted line, and do not consume resources or require time. They are added into the network simply to complete the logic.

In the Figure 28.5 below, the dummy activity is required to show that D is preceded by A and B.

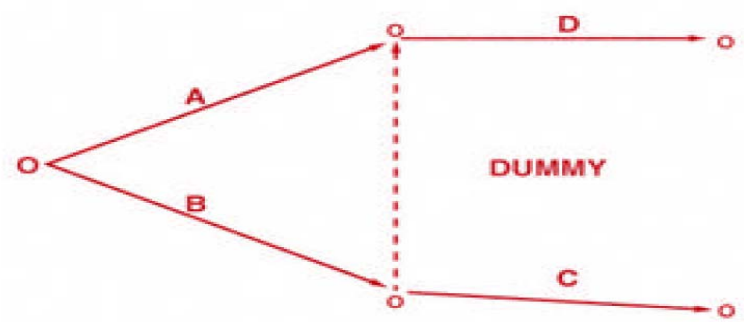


Figure 28.5: Dummy Activity

28.8 Slack Time:

It is essential to know that since there exists only one path through the network that is the longest, the other paths must be either equal in length to or shorter than that path. Therefore, there must exist events and activities that can be completed before the time when they are actually needed. The time differential between the scheduled completion date and the required date to meet critical path is referred to as the slack time. In Figure 28.4, event 4 is not on the crucial path. To go from event 2 to event 5 on the critical path requires seven weeks taking the route 2–3–5. If route 2–4–5 is taken, only four weeks are required. Therefore, event 4, which requires two weeks for completion, should begin anywhere from zero to three weeks after event 2 is complete. During these three weeks, management might find another use for the resources of people, money, equipment, and facilities required to complete event 4.

Therefore, the critical path is vital for resource scheduling and allocation because the project manager, with coordination from the functional manager, can reschedule those events not on the critical path for accomplishment during other time periods when maximum utilization of resources can be achieved, provided that the critical path time is not extended. This type of rescheduling through the use of slack times provides for a better balance of resources throughout the company, and may possibly reduce project costs by eliminating idle or waiting time.

NETWORK SCHEDULING TECHNIQUES

BROAD CONTENTS

Slack Terminology
Slack Time Calculation
Slack Identification
Network Re-planning

29.1 Slack Terminology:

Slack can be defined as the difference between the latest allowable date and the earliest expected data based on the nomenclature below:

TE = the earliest time (date) on which an event can be expected to take place
TL = the latest date on which an event can take place without extending the completion date of the project
Slack time = *TL* – *TE*

29.2 Slack Time Calculation:

As shown in Figure 29.1 below, the calculation for slack time is performed for each event in the network, by identifying the earliest expected date and the latest starting date. For event 1, *TL* – *TE* = 0. Event 1 serves as the reference point for the network and could just as easily have been defined as a calendar date. As before, the critical path is represented as a bold line. The events on the critical path have no slack (i.e., *TL* = *TE*) and provide the boundaries for the non-critical path events. Since event 2 is critical, *TL* = *TE* × 3 + 7 = 10 for event 5. Event 6 terminates the critical path with a completion time of fifteen weeks.

The earliest time for event 3, which is not on the critical path, would be two weeks (*TE* = 0 + 2 = 2), assuming that it started as early as possible. The latest allowable date is obtained by subtracting the time required to complete the activity from events 3 to 5 from the latest starting date of event 5.

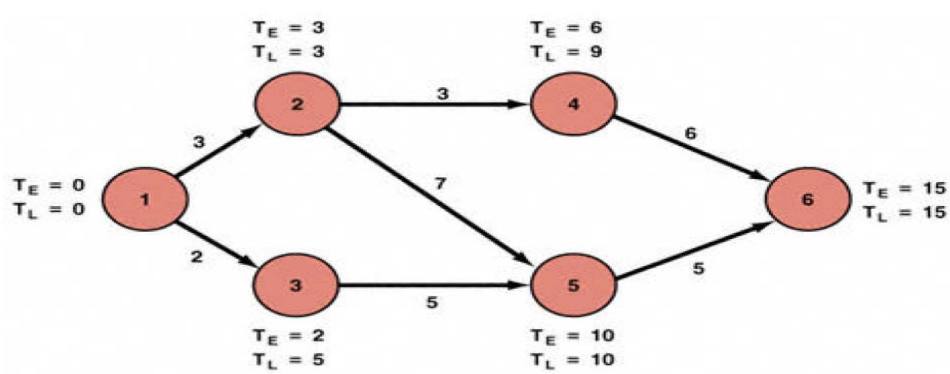


Figure 29.1: PERT Network with Slack Time

Therefore, *TL* (for event 3) = 10 – 5 = 5 weeks. Event 3 can now occur anywhere between weeks 2 and 5 without interfering with the scheduled completion date of the project. This same procedure can be applied to event 4, in which case *TE* = 6 and *TL* = 9.

The same figure 29.1 contains a simple PERT network, and therefore the calculation of slack time is not too difficult. For complex networks containing multiple paths, the earliest starting dates must be found by proceeding from start to finish through the network, while the latest allowable starting date must be calculated by working backward from finish to start.

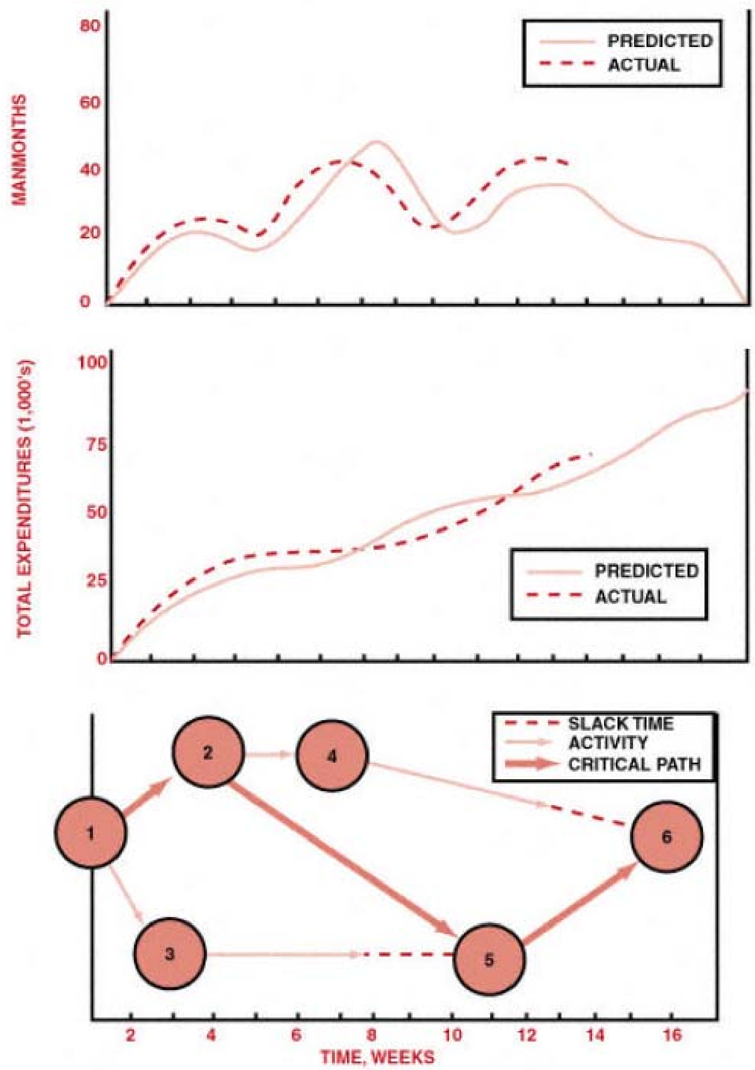


Figure 29.2: Comparison Models for a Time- Phase PERT Chart

We must understand that the importance of knowing exactly where the slack exists cannot be overstated. Proper use of slack time permits better technical performance. Donald Marquis has observed that those companies making proper use of slack time were 30 percent more successful than the average in completing technical requirements.

PERT networks are often not plotted with a time scale, because of these slack times. Planning requirements, however, can require that PERT charts be reconstructed with time scales, in which case a decision must be made as to whether we wish early or late time requirements for slack variables. This is shown in Figure 29.2 above for comparison with total program costs and manpower planning. Early time requirements for slack variables are utilized in this figure.

Note that the earliest times and late times can be combined to determine the probability of successfully meeting the schedule. A sample of the required information is shown in Table 29.1 below. The earliest and latest times are considered as random variables. The original schedule refers to the schedule for event occurrences that were established at the beginning of the project.

The last column in this table gives the probability that the earliest time will not be greater than the original schedule time for this event.

	Earliest Time		Latest Time			
Event Number	Expected	Variance	Expected	Variance	Slack	Orig Sche

Table 29.1: PERT Control Output Information

In the example shown in Figure 29.1, the earliest and latest times were calculated for each event. Some people prefer to calculate the earliest and latest times for each activity instead. Also, the earliest and latest times were identified simply as the time or date when an event can be expected to take place. To make full use of the capabilities of PERT/CPM, we could identify the following four values:

- The earliest time when an activity can start (ES)
- The earliest time when an activity can finish (EF)
- The latest time when an activity can start (LS)
- The latest time when an activity can finish (LF)

The following Figure 29.3 below shows the earliest and latest times identified on the activity.

In order to calculate the earliest starting times, we must make a forward pass through the network (that is, left to right). The earliest starting time of a successor activity is the latest of the earliest finish dates of the predecessors. The latest starting time is the total of the earliest starting time and the activity duration.

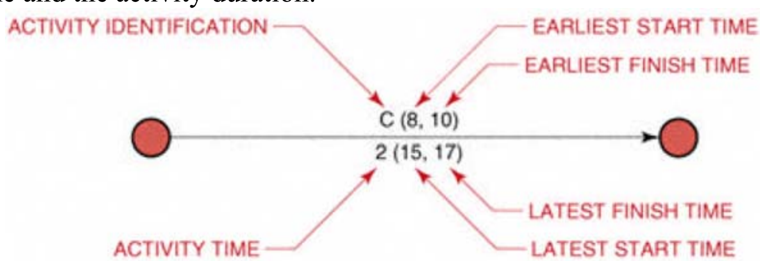


Figure 29.3: Slack Identification

It is important to note that to calculate the finishing times we must make a *backward* pass through the network by calculating the latest finish time. Since the activity time is known, the latest starting time can be calculated by subtracting the activity time from the latest finishing time. The latest finishing time for an activity entering a node is the earliest finishing time of the activities exiting the node.

Figure 29.4 below shows the earliest and latest starting and finishing times for a typical network.

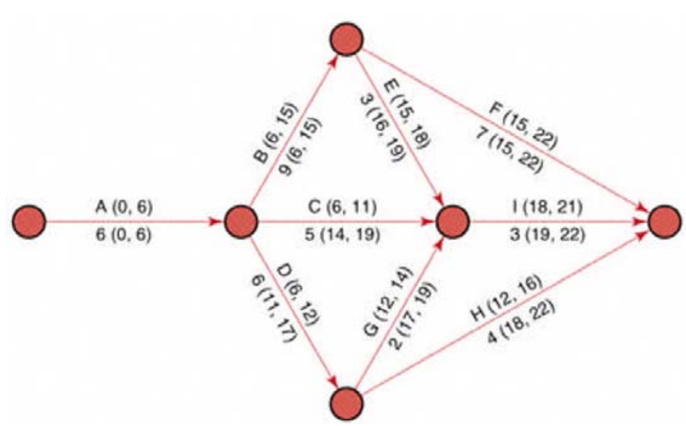


Figure 29.4: A Typical PERT Chart with Slack Times

29.3 Slack Identification:

Its significance is that the identification of slack time can function as an early warning system for the project manager. As an example, if the total slack time available begins to decrease from one reporting period to the next, that could indicate that work is taking longer than anticipated or that more highly skilled labor is needed. A new critical path could be forming.

By looking at the earliest and latest start and finish times, we can identify slack. As an example, look at the two situations below:

Situation a	Situation b
[20, 26]	[30, 36]
[24, 30]	[25, 31]

According to these, in *Situation a*, the slack is easily identified as four work units, where the work units can be expressed in hours, days, weeks, or even months. In *Situation b*, the slack is *negative* five units of work. This is referred to as negative slack or negative float.

Here the question arises, what can cause the slack to be negative? Look at Figure 29.5 below. When performing a forward pass through a network, we work from left to right beginning at the customer's starting milestone (position 1). The backward pass, however, begins at the customer's end date milestone (position 2), *not* (as is often taught in the classroom) where the forward pass ends. If the forward pass ends at position 3, which is before the customer's end date, it is possible to have slack on the critical path.

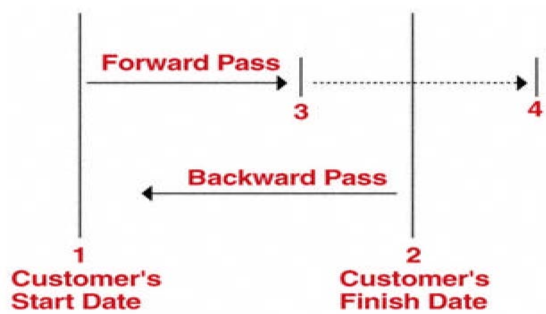


Figure 29.5: Slack Time

This slack is often called *reserve time* and may be added to other activities or filled with activities such as report writing so that the forward pass will extend to the customer's completion date.

Note that negative slack usually occurs when the forward pass extends beyond the customer's end date, as shown by position 4 in the figure. However, the backward pass is still measured from the customer's completion date, thus creating negative slack. This is most likely to result when:

- The original plan was highly optimistic, but unrealistic
- The customer's end date was unrealistic
- One or more activities slipped during project execution
- The assigned resources did not possess the correct skill levels
- The required resources would not be available until a later date

In any event, negative slack is an early warning indicator that corrective action is needed to maintain the customer's end date.

29.4 Network Re-planning:

We know that once constructed, the PERT/CPM charts provide the framework from which detailed planning can be initiated and costs can be controlled and tracked. Much iteration, however, are normally made during the planning phase before the PERT/CPM chart is finished.

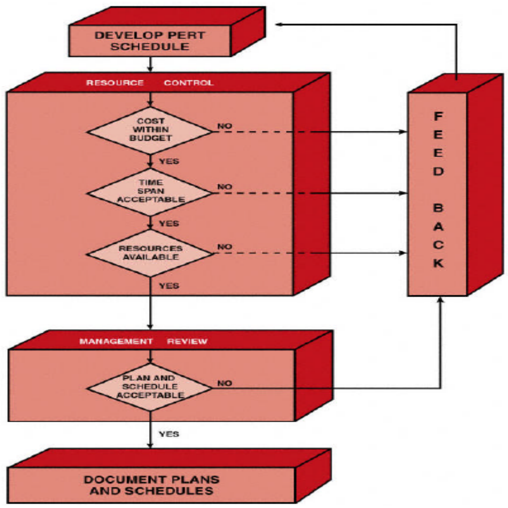


Figure 29.6: Iteration Process for PERT Schedule Development

This iteration process is shown in the Figure 29.6 above. The slack times form the basis from which additional iterations, or network replanning, can be performed. Network replanning is performed either at the conception of the program in order to reduce the length of the critical path, or during the program, should the unexpected occur. If all were to go according to schedule, then the original PERT/CPM chart would be unchanged for the duration of the project. But, how many programs or projects follow an exact schedule from start to finish?

Let us again consider Figure 29.1. Suppose that activities 1–2 and 1–3 in it require manpower from the same functional unit. Upon inquiry by the project manager, the functional manager asserts that he can reduce activity 1–2 by one week if he shifts resources from activity 1–3 to activity 1–2. Should this happen, however, activity 1–3 will increase in length by one week.

Reconstructing the PERT/CPM network as shown in Figure 29.7 below, the length of the critical path is reduced by one week, and the corresponding slack events are likewise changed.

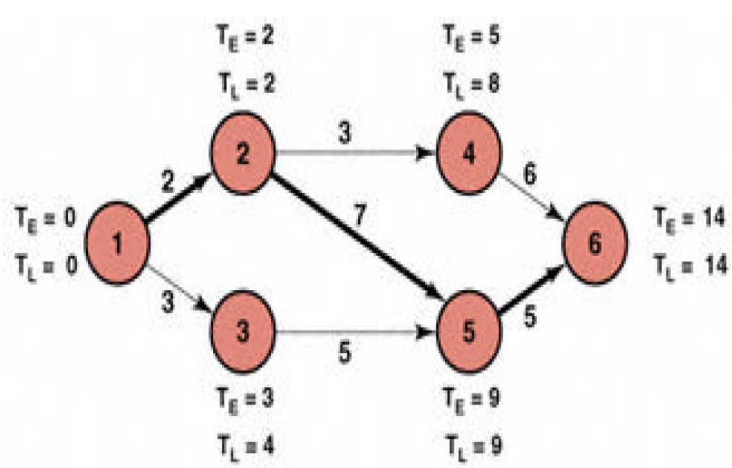


Figure 29.7: Network Replanning of Figure 29.1

29.4.1 Network Replanning Techniques:

There are two network replanning techniques based almost entirely upon resources: *resource leveling and resource allocation*.

- Resource leveling is an attempt to eliminate the manpower peaks and valleys by smoothing out the period-to-period resource requirements. The ideal situation is to do this without changing the end date. However, in reality, the end date moves out and additional costs are incurred.
- Resource allocation is an attempt to find the shortest possible critical path based upon the available or fixed resources. The problem with this approach is that the employees may not be qualified technically to perform on more than one activity in a network.

Not all PERT/CPM networks permit such easy rescheduling of resources. Project managers should make every attempt to reallocate resources so as to reduce the critical path, provided that the slack was not intentionally planned as a safety valve.

It is important to note here that transferring resources from slack paths to more critical paths is only one method for reducing expected project time. Several other methods are available. These are as follows:

- Elimination of some parts of the project
- Addition of more resources
- Substitution of less time-consuming components or activities
- Parallelization of activities
- Shortening critical path activities
- Shortening early activities
- Shortening longest activities
- Shortening easiest activities
- Shortening activities that are least costly to speed up
- Shortening activities for which you have more resources
- Increasing the number of work hours per day

In this regard, under the ideal situation, the project start and end dates are fixed, and performance within this time scale must be completed within the guidelines described by the statement of work. Should the scope of effort have to be reduced in order to meet other requirements, the contractor incurs a serious risk in that the project may be canceled, or performance expectations may no longer be possible.

However, adding resources is not always possible. If the activities requiring these added resources also call for certain expertise, then the contractor may not have qualified or experienced employees, and may avoid the risk. The contractor might still reject this idea, even if time and money were available for training new employees, because on project termination he might not have any other projects to which to assign these additional people. However, if the project is the construction of a new facility, then the labor-union pool may be large enough that additional experienced manpower can be hired.

Another aspect is parallelization of activities. It can be regarded as accepting a risk by assuming that a certain event can begin in parallel with a second event that would normally be in sequence with it. This is shown in Figure 29.8 below. One of the biggest headaches at the beginning of any project is the purchasing of tooling and raw materials. As shown in Figure below, four weeks can be saved by sending out purchase orders after contract negotiations are completed, but before the one-month waiting period necessary to sign the contract. Here the contractor incurs a risk. Should the effort be canceled or the statement of work change prior to the signing of the contract, the customer incurs the cost of the termination liability expenses from the vendors. This risk is normally overcome by the issuance of a long-lead procurement letter immediately following contract negotiations.

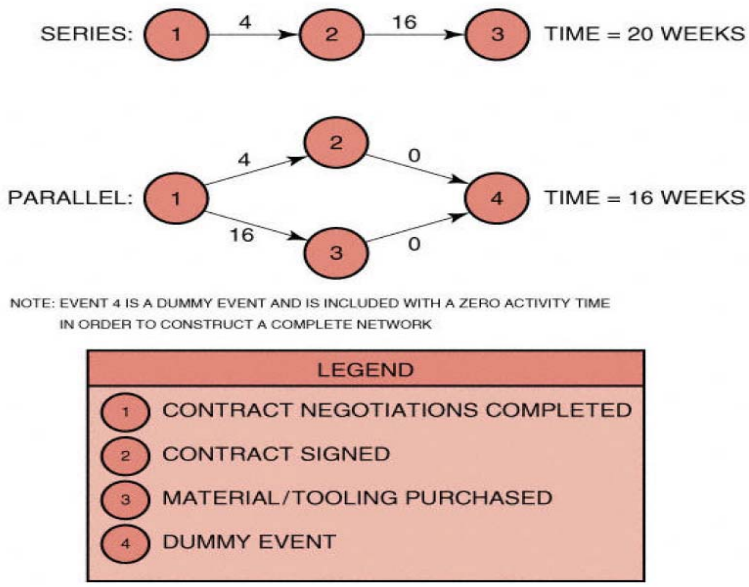


Figure 29.8: Parallelization of PERT Activities

In addition to this, there are two other types of risk that are common. In the first situation, engineering has not yet finished the prototype, and manufacturing must order the tooling in order to keep the end date fixed. In this case, engineering may finally design the prototype to fit the tooling.

In the second situation, the subcontractor finds it difficult to perform according to the original blueprints. In order to save time, the customer may allow the contractor to work without blueprints, and the blueprints are then changed to represent the as-built end-item.

As a result of the complexities of large programs, network re-planning becomes an almost impossible task when analyzed on total program activities. It is often better to have each department or division that develops its own PERT/CPM networks, on approval by the project office, and based on the work breakdown structure. The individual PERT charts are then integrated into one master chart to identify total program critical paths, as shown in Figure 29.9 below. It should not be inferred from this figure that department D does not interact with other departments or that department D is the only participant for this element of the project.

In addition, segmented PERT charts can also be used when a number of contractors work on the same program.

Each contractor (or subcontractor) develops his own PERT chart. It then becomes the responsibility of the prime contractor to integrate all of the subcontractors' PERT charts to ensure that total program requirements can be met.

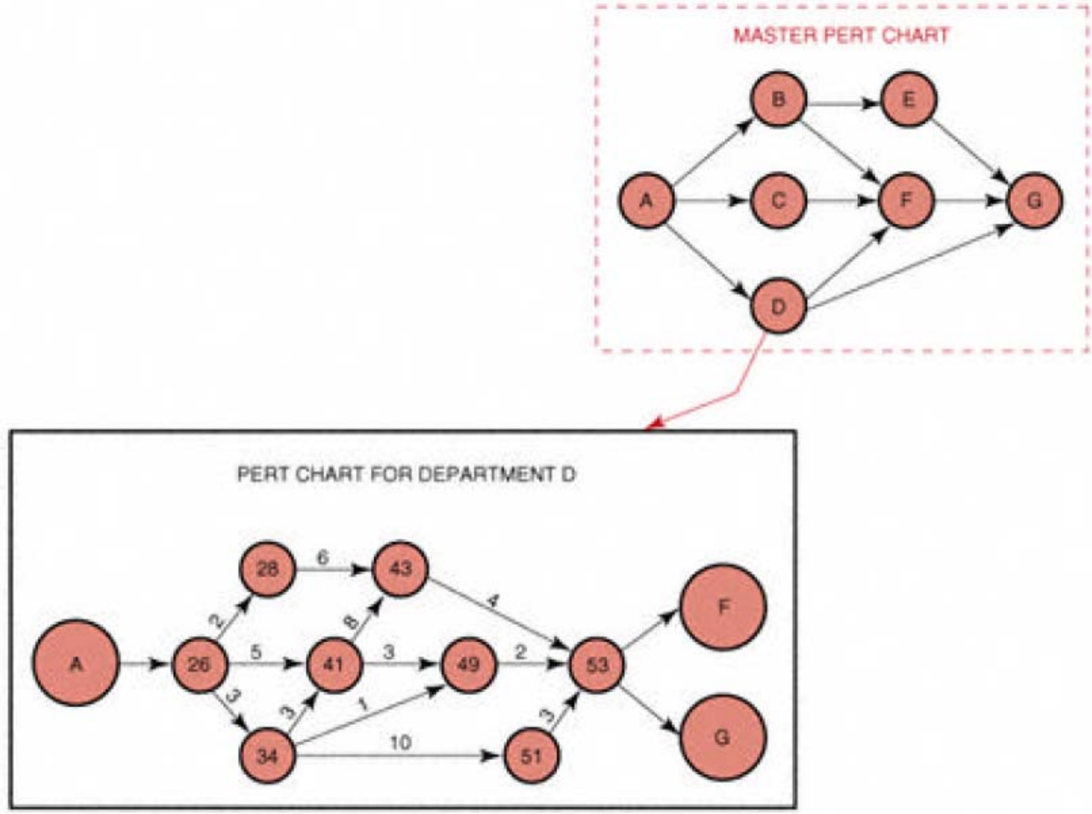


Figure 29.9: Master PERT chart breakdown by department

NETWORK SCHEDULING TECHNIQUES

BROAD CONTENTS

Estimating Activity Time
Estimating Total Program Time
Total PERT/CPM Planning
Crash Times
PERT/CPM Problem Areas
Alternative PERT/CPM Model

30.1 Estimating Activity Time:

In order to determine the elapsed time between events requires that responsible functional managers evaluate the situation and submit their best estimates. The calculations for critical paths and slack times in the previous sections were based on these best estimates.

Thus, in this ideal situation, the functional manager would have at his disposal a large volume of historical data from which to make his estimates. Obviously, the more historical data available, the more reliable the estimate would be. Many programs, however, include events and activities that are non-repetitive.

In this case, the functional managers must submit their estimates using three possible completion assumptions:

- *Most optimistic completion time*:
  This time assumes that everything will go according to plan and with a minimal amount of difficulties. This should occur approximately 1 percent of the time.

- *Most pessimistic completion time*:
  This time assumes that everything will not go according to plan and that the maximum potential difficulties will develop. This should also occur approximately 1 percent of the time.
- *Most likely completion time*:
  This is the time that, in the mind of the functional manager, would most often occur should this effort be reported over and over again.

Two assumptions must be made before these three times can be combined into a single expression for expected time. The first assumption is that the standard deviation, □, is one-sixth of the time requirement range. This assumption stems from probability theory, where the end points of a curve are three standard deviations from the mean. The second assumption requires that the probability distribution of time required for an activity be expressible as a beta distribution.

The expected time between events can be found from the expression:

$$t_e = \frac{a + 4m + b}{6}$$

In this, *te* = expected time, *a* = most optimistic time, *b* = most pessimistic time, and *m* = most likely time.

Here we take an example. If a = 3, b = 7, and m = 5 weeks, then the expected time, *te*, would be 5 weeks. This value for *te* would then be used as the activity time between two events in the construction of a PERT chart. This method for obtaining best estimates contains a large degree of uncertainty. If we change the variable times to a = 2, b = 12, and m = 4 weeks, then *te* will still be 5 weeks. The latter case, however, has a much higher degree of uncertainty because of the wider spread between the optimistic and pessimistic times. Care must be taken in the evaluation of risks in the expected times.

30.2 Estimating Total Program Time:

It is important to know that in order to calculate the probability of completing the project on time, the standard deviations of each activity must be known. This can be found from the expression:

$$\sigma_{t_e} = \frac{b - a}{6}$$

Where σ_{t_e} is the standard deviation of the expected time, *te*. Another useful expression is the variance, □, which is the square of the standard deviation. The variance is primarily useful for comparison to the expected values.

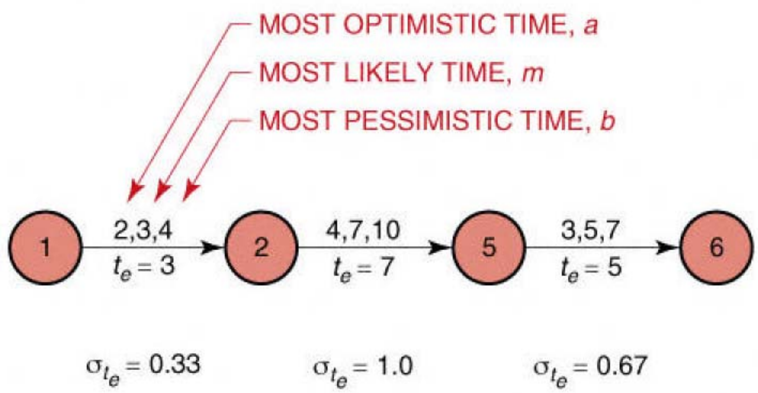


Figure 30.1: Expected Time Analysis for Critical Path Events in Figure 29.1 (Lecture 29)

However, the standard deviation can be used just as easily, except that we must identify whether it is a one, two, or three sigma limit deviation. Figure 30.1 above shows the critical path of Figure 29.1 (lecture 29), together with the corresponding values from which the expected times were calculated, as well as the standard deviations. The total path standard deviation is calculated by the square root of the sum of the squares of the activity standard deviations using the following expression:

$$\begin{aligned}\sigma_{\text{total}} &= \sqrt{\sigma_{1-2}^2 + \sigma_{2-5}^2 + \sigma_{5-6}^2} \\ &= \sqrt{(0.33)^2 + (1.0)^2 + (0.67)^2} \\ &= 1.25\end{aligned}$$

30.3 Total PERT/CPM Planning:

It is necessary to discuss the methodology for preparing PERT schedules, before we continue further. PERT scheduling is a six-step process.

Steps one and two begin with the project manager laying out a list of activities to be performed and then placing these activities in order of precedence, thus identifying the interrelationships. These charts drawn by the project manager are called logic charts, arrow diagrams, work flow, or simply networks. The arrow diagrams will look like Figure 29.1 (lecture 29) with two exceptions: The activity time is not identified, and neither is the critical path.

The next step that is step three is reviewing the arrow diagrams with the line managers (that is, the true experts) in order to obtain their assurance that neither too many nor too few activities are identified, and that the interrelationships are correct.

In step four, the functional manager converts the arrow diagram to a PERT chart by identifying the time duration for each activity. It should be noted here that the time estimates that the line managers provide are based on the *assumption of unlimited resources* because the calendar dates have not yet been defined.

Fifth step is the first iteration on the critical path. It is here that the project manager looks at the critical calendar dates in the definition of the project's requirements. If the critical path does not satisfy the calendar requirements, then the project manager must try to shorten the critical path using methods explained earlier or by asking the line managers to take the "fat" out of their estimates.

Step six is often the most overlooked step. Here the project manager places calendar dates on each event in the PERT chart, thus, converting from planning under unlimited resources to planning with *limited resources*. Even though the line manager has given you a time estimate, there is no guarantee that the correct resources will be available when needed. That is why this step is crucial. If the line manager cannot commit to the calendar dates, then replanning will be necessary. Most companies that survive on competitive bidding lay out proposal schedules based on unlimited resources. After contract award, the schedules are analyzed again because the company now has limited resources.

The question arises that after all, how can a company bid on three contracts simultaneously and put a detailed schedule into each proposal if it is not sure how many contracts, if any, it will win? For this reason customers require that formal project plans and schedules be provided thirty to ninety days after contract award.

Finally, PERT re-planning should be an ongoing function during project execution. The best project managers are those individuals who continually try to assess what can go wrong and perform perturbation analysis on the schedule. (This should be obvious because the constraints and objectives of the project can change during execution.) Primary objectives on a schedule are:

- Best time
- Least cost
- Least risk

In addition to this, the secondary objectives include:

- Studying alternatives
- Optimum schedules
- Effective use of resources
- Communications
- Refinement of the estimating process
- Ease of project control
- Ease of time or cost revisions

It is quite obvious that these objectives are limited by such constraints as:

- Calendar completion

- Cash or cash flow restrictions
- Limited resources
- Management approvals

30.4 Crash Times:

So far no distinction was made between PERT and CPM. The basic difference between PERT and CPM lies in the ability to calculate percent complete. PERT is used in Research and Development or just development activities, where a percent-complete determination is almost impossible.

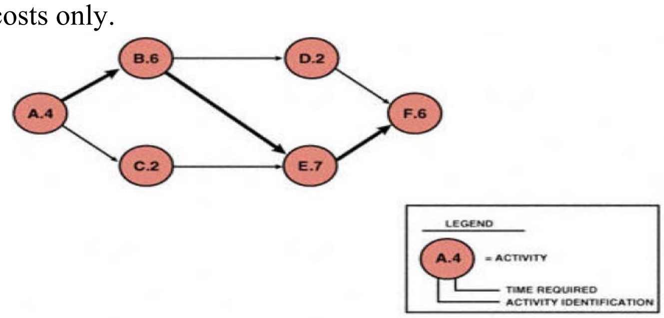
Therefore, PERT is event oriented rather than activity oriented. In PERT, funding is normally provided for each milestone (i.e., event) achieved because incremental funding along the activity line has to be based on percent complete. CPM, on the other hand, is activity oriented because, in activities such as construction, percent complete along the activity line can be determined. CPM can be used as an arrow diagram network without PERT. The difference between the two methods lies in the environments in which each one evolved and how each one is applied.

In addition, the CPM (activity-type network) has been widely used in the process industries, in construction, and in single-project industrial activities. Common problems include no place to store early arrivals of raw materials and project delays for late arrivals.

Project managers can consider the cost of speeding up, or crashing, certain phases of a project using strictly the CPM approach. In order to accomplish this, it is necessary to calculate a crashing cost per unit time as well as the normal expected time for each activity. CPM charts, which are closely related to PERT charts, allow visual representation of the effects of crashing. There are these following requirements:

- For a CPM chart, the emphasis is on activities, not events. Therefore, the PERT chart should be redrawn with each circle representing an activity rather than an event.
- In CPM, both time and cost of each activity are considered.
- Only those activities on the critical path are considered, starting with the activities for which the crashing cost per unit time is the lowest.

The following Figure 30.2 below shows a CPM network with the corresponding crash time for all activities both on and off the critical path. The activities are represented by circles and include an activity identification number and the estimated time. The costs expressed in it are usually direct costs only.



ACTIVITY	TIME REQUIRED, WEEKS NORMAL	TIME REQUIRED, WEEKS CRASH	COST $ NORMAL	COST $ CRASH	CRASHING COST PER WEEK, $
A	4	2	10,000	14,000	2,000
B	6	5	30,000	42,500	12,500
C	2	1	8,000	9,500	1,500
D	2	1	12,000	18,000	6,000
E	7	5	40,000	52,000	6,000
F	6	3	20,000	29,000	3,000

Figure 30.2: CPM Network

As shown in the figure 30.2, in order to determine crashing costs we begin with the lowest weekly crashing cost, activity A, at $2,000 per week. Although activity C has a lower crashing cost, it is not on the critical path. Only critical path activities are considered for crashing. Activity A will be the first to be crashed for a maximum of two weeks at $2,000 per week. The next activity to be considered would be F at $3,000 per week for a maximum of three weeks. These crashing costs are additional expenses above the normal estimates.

It is important to remember a word of caution concerning the selection and order of the activities that are to crash: There is a good possibility that as each activity is crashed, a new critical path will be developed. This new path may or may not include those elements that were bypassed because they were not on the original critical path.

In the same Figure 30.2 (and assuming that no new critical paths are developed), activities A, F, E, and B would be crashed in that order. The crashing cost would then be an increase of $37,500 from the base of $120,000 to $157,500. The corresponding time would then be reduced from twenty-three weeks to fifteen weeks. This is shown in Figure 30.3 below to illustrate how a trade-off between time and cost can be obtained. Also shown in it is the increased cost of crashing elements not on the critical path.

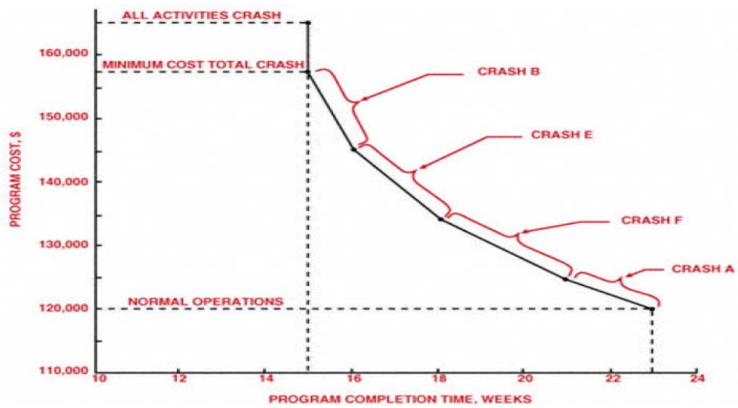


Figure 30.3: CPM Crashing Costs

Crashing these elements would result in a cost increase of $7,500 without reducing the total project time. There is also the possibility that this figure will represent unrealistic conditions because sufficient resources are not or cannot be made available for the crashing period.

Importantly, the purpose behind balancing time and cost is to avoid the useless waste of resources. If the direct and indirect costs can be accurately obtained, then a region of feasible budgets can be found, bounded by the early-start (crash) and late-start (or normal) activities. This is shown in Figure 30.4 below.

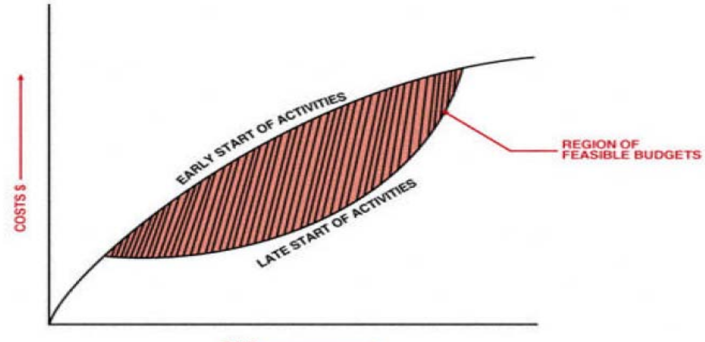


Figure 30.4: Region of Feasible Budgets

Since the direct and indirect costs are not necessarily expressible as linear functions, time–cost trade-off relationships are made by searching for the lowest possible total cost (that is, direct and indirect) that likewise satisfies the region of feasible budgets. This method is shown in Figure 30.5 below.

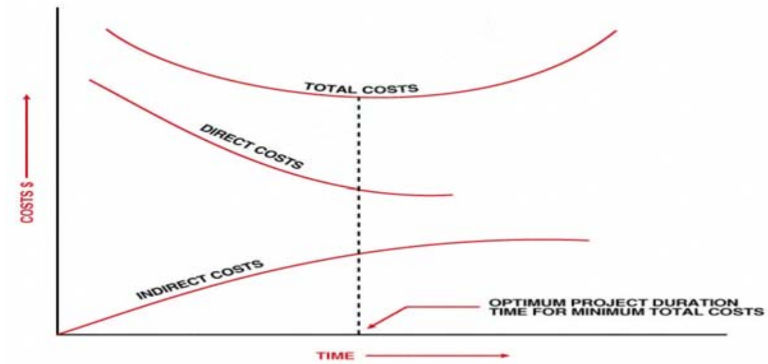


Figure 30.5: Determining Project Duration

Note that like PERT, CPM also contains the concept of slack time, the maximum amount of time that a job may be delayed beyond its early start without delaying the project completion time. Figure 30.6 below shows a typical representation of slack time using a CPM chart.

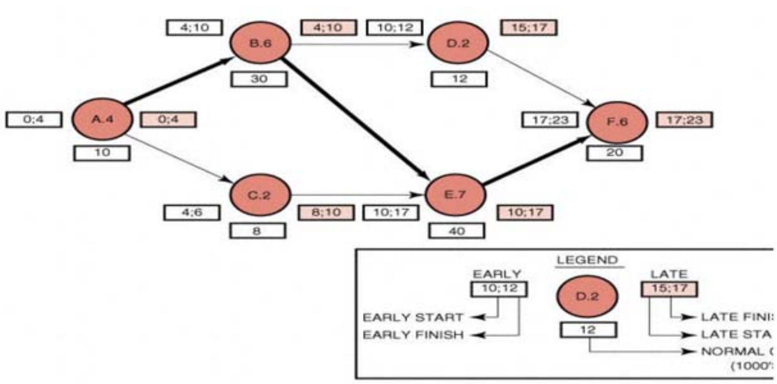


Figure 30.6: CPM Network with Slack

This figure also shows how target activity costs can be identified. It can be modified to include normal and crash times as well as normal and crash costs. In this case, the cost box in the figure would contain two numbers: The first number would be the normal cost, and the second would be the crash cost. These numbers might also appear as running totals.

30.5 PERT/CPM Problem Areas:

Even the largest organizations with years of experience in using PERT and CPM have the same ongoing problems as newer or smaller companies. Thus, PERT/CPM models are not without their disadvantages and problems.

Due to its characteristics, many companies have a difficult time incorporating PERT systems because PERT is end-item oriented. Many upper-level managers feel that the adoption of PERT/CPM remove a good part of their power and ability to make decisions. This is particularly evident in companies that have been forced to accept PERT/CPM as part of contractual requirements.

In addition to this, there exists a distinct contrast in PERT systems between the planners and the doers. This human element must be accounted for in order to determine where the obligation actually lies. In most organizations PERT planning is performed by the program office and functional management. Yet once the network is constructed, the planners and managers become observers and rely on the doers to accomplish the job within time and cost limitations.

Management must convince the doers that they have an obligation toward the successful completion of the established PERT/CPM plans.

It is important to note that unless the project is repetitive, there usually exists a lack of historical information on which to base the cost estimates of most optimistic, most pessimistic, and most likely times. Problems can also involve poor predictions for overhead costs, other indirect costs, material and labor escalation factors, and crash costs. It is also possible that each major functional division of the organization has its own method for estimating costs. Engineering, for example, may use historical data, whereas manufacturing operations may prefer learning curves. PERT works best if all organizations have the same method for predicting costs and performance.

PERT networks are based on the assumption that all activities start as soon as possible. This assumes that qualified personnel and equipment are available. Regardless of how well we plan, there almost always exist differences in performance times from what would normally be acceptable for the model selected. For the selected model, time and cost should be well-considered estimates, not a spur-of-the-moment decision.

Another problem is that of cost control. It presents a problem in that the project cost and control system may not be compatible with company fiscal planning policies. Project-oriented costs may be meshed with non-PERT-controlled jobs in order to develop the annual budget. This becomes a difficult chore for cost reporting, especially when each project may have its own method for analyzing and controlling costs.

Furthermore, many people have come to expect too much of PERT -type networks. Figure 30.7 below illustrates a PERT/CPM network broken down by work packages with identification of the charge numbers for each activity. Large projects may contain hundreds of charge numbers. Subdividing work packages (which are supposedly the lowest element) even further by identifying all sub activities has the advantage that direct charge numbers can be easily identified, but the time and cost for this form of detail may be prohibitive. PERT/CPM networks are tools for program control, and managers must be careful that the original game plan of using networks to identify prime and supporting objectives is still met. Additional detail may mask this all-important purpose. Remember, networks are constructed as a means for understanding program reports. Management should not be required to read reports in order to understand PERT/CPM networks.

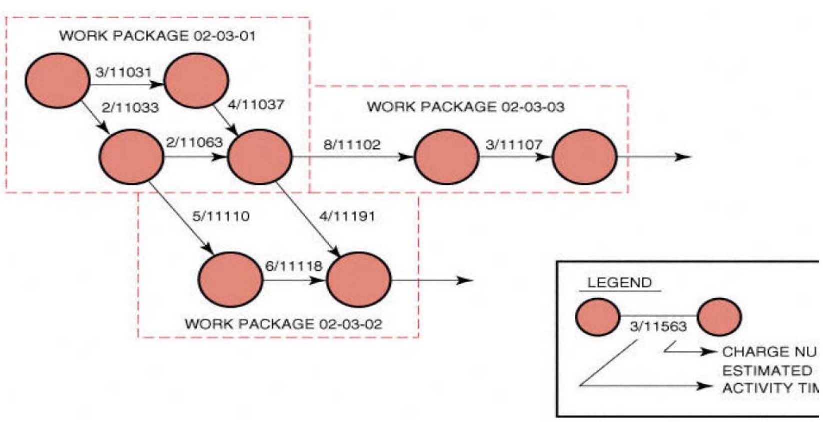


Figure 30.7: Using PERT for Work Package Control

30.6 Alternative PERT/CPM Models:

Numerous industries have found applications for this form of network, because of the many advantages of PERT/time. A partial list of these advantages includes capabilities for:

- Trade-off studies for resource control
- Providing contingency planning in the early stages of the project
- Visually tracking up-to-date performance
- Demonstrating integrated planning
- Providing visibility down through the lowest levels of the work breakdown structure
- Providing a regimented structure for control purposes to ensure compliance with the work breakdown structure and the statement of work
- Increasing functional members' ability to relate to the total program, thus, providing participants with a sense of belonging

Remember that even with these advantages, in many situations PERT/time has proved ineffective in controlling resources. Earlier we have defined three parameters necessary for the control of resources: time, cost, and performance. With these factors in mind, companies began reconstructing PERT/time into PERT/cost and PERT/performance models.
In addition, PERT/cost is an extension of PERT/time and attempts to overcome the problems associated with the use of the most optimistic and most pessimistic time for estimating completion. PERT/cost can be regarded as a cost accounting network model based on the work breakdown structure and capable of being subdivided down to the lowest elements, or work packages. The advantages of PERT/cost are that it:

- Contains all the features of PERT/time
- Permits cost control at any Work Breakdown Structure (WBS) level

Note that the primary reason for the development of PERT/cost was so that project managers could identify critical schedule slippages and cost overruns in time for corrective action to be taken.

In this regard, many attempts have been made to develop effective PERT/schedule models. In almost all cases, the charts are constructed from left to right. An example of such current attempts is the *Accomplishment/Cost Procedure (ACP)*.

Summing up our discussion, unfortunately, the development of PERT/schedule techniques is still in its infancy. Although their applications have been identified, many companies feel locked in with their present method of control, whether it is PERT, CPM, or some other technique.

PRICING AND ESTIMATION

BROAD CONTENTS

Computerized Software Packages
Pricing and Estimating
Global Pricing Strategies
Types of Estimates
Pricing Process

31.1 COMPUTERIZED SOFTWARE PACKAGES:

It has been seen that over the past ten years there has been an explosion in project management software packages. Small packages may sell for a few thousand dollars, whereas the price for larger packages may be $70,000.

Computerized project management can provide answers to such questions as:

- How will the project be affected by limited resources?
- How will the project be affected by a change in the requirements?
- What is the cash flow for the project (and for each WBS element)?
- What is the impact of overtime?
- What additional resources are needed to meet the constraints of the project?
- How will a change in the priority of a certain WBS element affect the total project?

The more sophisticated packages can provide answers to schedule and cost based on:

- Adverse weather conditions
- Weekend activities
- Unleveled manpower requirements
- Variable crew size
- Splitting of activities
- Assignment of unused resources

Regardless of the sophistication of computer systems, printers and plotters prefer to draw straight lines rather than circles. Most software systems today use precedence networks, as shown in Figure 31.1 below, which attempt to show interrelationships on bar charts. As shown in the figure, task 1 and task 2 are related because of the solid line between them. Task 3 and task 4 can begin when task 2 is half finished. (This cannot be shown easily on PERT without splitting activities.) The dotted lines indicate slack. The critical path can be identified either by putting an asterisk (*) beside the critical elements, by making the critical connections in a different-colored ink, or by making the critical path a boldface type.

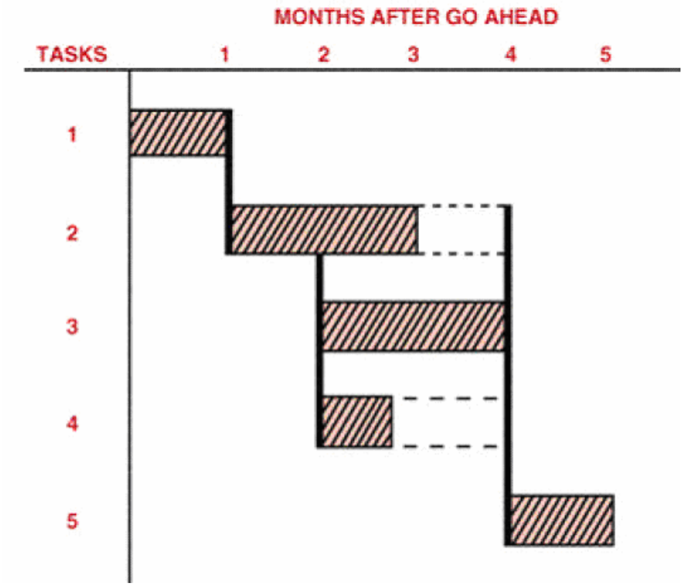


Figure 31.1: Precedence Network

The more sophisticated software packages display precedence networks in the format shown in Figure 31.2 below. In each of these figures, work is accomplished during the activity. This is sometimes referred to as the activity-on-node method. The arrow represents the relationship or constraint between activities.

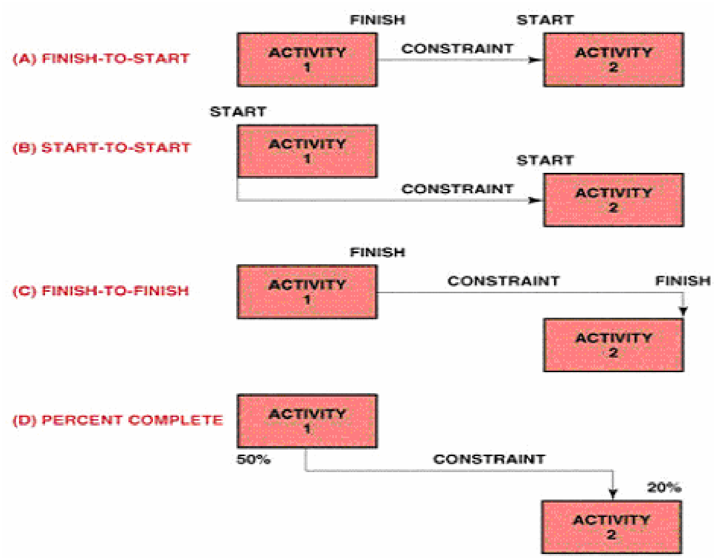


Figure 31.2: Typical Precedence Relationships

Figure above 31.2 (A) illustrates a finish-to-start constraint. In this figure, activity 2 can start no earlier than the completion of activity 1. Figure 31.2 (B) illustrates a start-to-start constraint. Activity 2 cannot start prior to the start of activity 1. Figure 31.2 (C) illustrates a finish-to-finish constraint. In this figure, activity 2 cannot finish until activity 1 finishes. Lastly, Figure 31.2 (D) illustrates a percent-complete constraint. In this figure, the last 20 percent of activity 2 cannot be started until 50 percent of activity 1 has been completed.

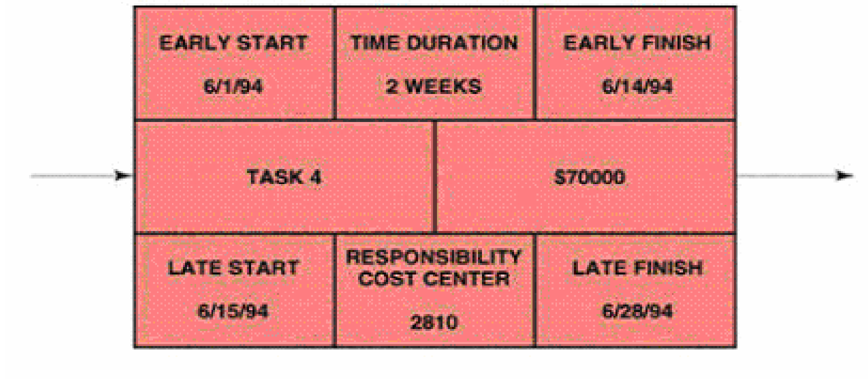


Figure 31.3: Computerized Information Flow

Figure 31.3 above shows the typical information that appears in each of the activity boxes shown in the previous figure. The box identified as "responsibility cost center" could also have been identified as the name, initials, or badge number of the person responsible for this activity.

Figure 31.4 below shows the comparison of three of the different network techniques.

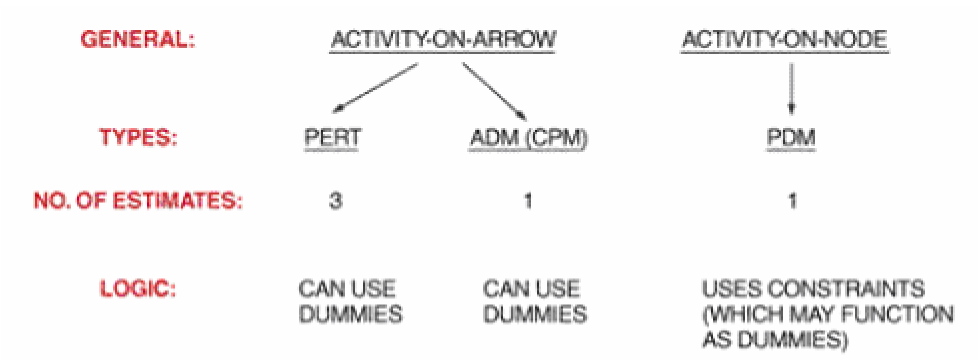


Figure 31.4: Comparison of Networks

31.2 PRICING AND ESTIMATION:

As we know that with the complexities involved, it is not surprising that many business managers consider pricing an art. Having the right intelligence information on customer cost budgets and competitive pricing would certainly help. However, the reality is that whatever information is available to one bidder is generally available to the others. Even more important, intelligence sources are often unreliable. The only thing worse than missing information, is wrong or misleading information.

When it comes to competitive pricing, the old saying still applies: "Those who talk don't know; and those who know don't talk!" It is true, partially, that pricing remains an art. However, a disciplined approach certainly helps one to develop all the input for a rational pricing recommendation. A side benefit of using a disciplined management process is that it leads to the documentation of the many factors and assumptions involved at a later point in time. These can be compared and analyzed, contributing to the learning experiences that make up the managerial skills needed for effective business decisions.

Estimates are *not* blind luck. They are well-thought-out decisions based on the best available information, some type of cost estimating relationship, or some type of cost model. Cost estimating relationships (CERs) are generally the output of cost models. Typical CERs might be:

- Mathematical equations based on regression analysis
- Cost–quantity relationships such as learning curves

- Cost–cost relationships
- Cost–noncost relationships based on physical characteristics, technical parameters, or performance characteristics

31.3 GLOBAL PRICING STRATEGIES:

Specific pricing strategies must be developed for each individual situation. Frequently, however, one of two situations prevails when one is pursuing project acquisitions competitively. First, the new business opportunity may be a one-of-a-kind program with little or no follow-on potential; a situation classified as type I acquisition.

Second, the new business opportunity may be an entry point to a larger follow-on or repeat business, or may represent a planned penetration into a new market. This acquisition is classified as type II.

Clearly, in each case, we have specific but different business objectives. The objective for type I acquisition is to win the program and execute it profitably and satisfactorily according to contractual agreements. The type II objective is often to win the program and perform well, thereby gaining a foothold in a new market segment or a new customer community in place of making a profit.

Accordingly, each acquisition type has its own, unique pricing strategy, as summarized in Table 31.1 below.

Comparing the two pricing strategies for the two global situations (as shown in Table below) reveals a great deal of similarity for the first five points. The fundamental difference is that for a profitable new business acquisition the bid price is determined according to actual cost, whereas in a "must win" situation the price is determined by the market forces. It should be emphasized that one of the most crucial inputs in the pricing decision is the cost estimate of the proposed baseline. The design of this baseline to the minimum requirements should be started early, in accordance with well defined ground rules, cost models, and established cost targets. Too often the baseline design is performed in parallel with the proposal development. At the proposal stage it is too late to review and fine-tune the baseline for minimum cost. Also, such a late start does not allow much of an option for a final bid decision. Even if the price appears outside the competitive range, it makes little sense to terminate the proposal development. As all the resources have been sent anyway, one might just as well submit a bid in spite of the remote chance of winning.

Clearly, effective pricing begins a long time before proposal development. It starts with preliminary customer requirements, well-understood subtasks, and a top-down estimate with should-cost targets.

This allows the functional organization to design a baseline to meet the customer requirements and cost targets, and gives management the time to review and redirect the design before the proposal is submitted. Furthermore, it gives management an early opportunity to assess the chances of winning during the acquisition cycle, at a point in time when additional resources can be allocated or the acquisition effort can be terminated before too many resources are committed to a hopeless effort.

The final pricing review session should be an integration and review of information already well known in its basic context. The process and management tools outlined here should help to provide the framework and discipline for deriving pricing decisions in an orderly and effective way.

TABLE TWO GLOBAL PRICING STRATEGIES

Type I Acquisition: One-of-a-Kind Program with Little or No Follow-On Business	Type II Acquisition: New Program with Potential for Large Follow-On Business or Representing a Desired Penetration into New Markets
1. Develop cost model and estimating guidelines; design proposed project/program baseline for minimum cost, to minimum customer requirements.	1. Design proposed project/program baseline compliant with customer requirements, with innovative features but minimum risks.
2. Estimate cost realistically for minimum requirements.	2. Estimate cost realistically.
3. Scrub the baseline. Squeeze out unnecessary costs.	3. Scrub baseline. Squeeze out unnecessary costs.
4. Determine realistic minimum cost. Obtain commitment from performing organizations.	4. Determine realistic minimum cost. Obtain commitment from performing organizations.
5. Adjust cost estimate for risks.	5. Determine "should-cost" including risk adjustments.
6. Add desired margins. Determine the price.	6. Compare your final cost estimate to customer budget and the "most likely" winning price.
7. Compare price to customer budget and competitive cost information.	7. Determine the gross profit margin necessary for your winning proposal. This margin could be negative!
8. Bid only if price is within competitive range.	8. Decide whether the gross margin is acceptable according to the must-win desire.
	9. Depending on the strength of your desire to win, bid the "most likely" winning price or lower.
	10. If the bid price is below cost, it is often necessary to provide a detailed explanation to the customer of where the additional funding is coming from. The source could be company profits or sharing of related activities. In any case, a clear resource picture should be given to the customer to ensure cost credibility.

Table 31.1: Two Global Pricing Strategies

31.4 TYPES OF ESTIMATES:

Note that projects can range from a feasibility study, through modification of existing facilities, to complete design, procurement, and construction of a large complex. Whatever the project may be, whether large or small, the estimate and type of information desired may differ radically.

The first type of estimate is an *order-of-magnitude* analysis, which is made without any detailed engineering data. The order-of-magnitude analysis may have an accuracy of ±35 percent within the scope of the project. This type of estimate may use past experience (not necessarily similar), scale factors, parametric curves or capacity estimates (that is, $/# of product or $/KW electricity).

Next, there is the *approximate estimate* (or top-down estimate), which is also made without detailed engineering data, and may be accurate to ±15 percent. This type of estimate is prorated from previous projects that are similar in scope and capacity, and may be titled as estimating by analogy, parametric curves, rule of thumb, and indexed cost of similar activities adjusted for capacity and technology. In such a case, the estimator may say that this activity is 50 percent more difficult than a previous (i.e., reference) activity and requires 50 percent more time, man-hours, dollars, materials, and so on.

The *definitive estimate,* or grassroots buildup estimate, is prepared from well-defined engineering data including (as a minimum) vendor quotes, fairly complete plans, specifications, unit prices, and estimate to complete. The definitive estimate, also referred to as detailed estimating, has an accuracy of ±5 percent.

Another method for estimating is the use of *learning curves.* Learning curves are graphical representations of repetitive functions in which continuous operations will lead to a reduction in time, resources, and money. The theory behind learning curves is usually applied to manufacturing operations.

Each company may have a unique approach to estimating. However, for normal project management practices, Table 31.2 below would suffice as a starting point.

TABLE STANDARD PROJECT ESTIMATING

Estimating Method	**Generic Type**	**WBS Relationship**	**Accuracy**	**Time to**
Parametric	ROM*	Top down	–25% to +75%	Days
Analogy	Budget	Top down	–10% to +25%	Weeks
Engineering (grass roots)	Definitive	Bottom up	–5% to +10%	Months

*ROM = Rough order of magnitude.

Table 31.2: Standard Project Estimating

Many companies try to standardize their estimating procedures by developing an *estimating manual*. The estimating manual is then used to price out the effort, perhaps as much as 90 percent. Estimating manuals usually give better estimates than industrial engineering standards because they include groups of tasks and take into consideration such items as downtime, cleanup time, lunch, and breaks. Table 31.3 below shows the table of contents for a construction estimating manual.

Estimating manuals, as the name implies, provide estimates. The question, of course, is "How good are the estimates?" Most estimating manuals provide accuracy limitations by defining the type of estimates (shown in Table 31.4 below). Using Table below, we can create the next three tables which illustrate the use of the estimating manual.

Not all companies can use estimating manuals. Estimating manuals work best for repetitive tasks or similar tasks that can use a previous estimate adjusted by a degree-of-difficulty factor. Activities such as Research and Development do not lend themselves to the use of estimating manuals other than for benchmark, repetitive laboratory tests.

Proposal managers must carefully consider whether the estimating manual is a viable approach. The literature abounds with examples of companies that have spent millions trying to develop estimating manuals for situations that just do not lend themselves to the approach.

TABLE ESTIMATING MANUAL TABLE OF CONTENTS

Introduction
Purpose and types of estimates
Major Estimating Tools
Cataloged equipment costs
Automated investment data system
Automated estimate system
Computerized methods and procedures
Classes of Estimates
Definitive estimate
Capital cost estimate
Appropriation estimate
Feasibility estimate
Order of magnitude
Charts—estimate specifications quantity and pricing guidelines
Data Required
Chart—comparing data required for preparation of classes of estimates
Presentation Specifications
Estimate procedure—general
Estimate procedure for definitive estimate
Estimate procedure for capital cost estimate
Estimate procedure for appropriation estimate
Estimate procedure for feasibility estimate

Table 31.3: Estimating Manual Table of Contents

During competitive bidding, it is important that the type of estimate be consistent with the customer's requirements. For in-house projects, the type of estimate can vary over the life cycle of a project:

- *Conceptual Stage:*
  Venture guidance or feasibility studies for the evaluation of future work. This estimating is often based on minimum-scope information.

- *Planning Stage:*
  Estimating for authorization of partial or full funds. These estimates are based on preliminary design and scope.

- *Main Stage:*
  Estimating for detailed work.

- *Termination Stage:*
  Re-estimation for major scope changes or variances beyond the authorization range.

TABLE CLASSES OF ESTIMATES

Class	Types	Accuracy
I	Definitive	±5%
II	Capital cost	±10–15%
III	Appropriation (with some capital cost)	±15–20%
IV	Appropriation	±20–25%
V	Feasibility	±25–35%
VI	Order of magnitude	> ± 35%

Table 31.4: Classes of Estimates

TABLE CHECKLIST FOR WORK NORMALLY REQUIRED FOR THE VARIOUS CLASSES (I–VI) OF ESTIMATES

Item	I	II	III	IV	V	VI
1. Inquiry	X	X	X	X	X	X
2. Legibility	X	X	X			
3. Copies	X	X				
4. Schedule	X	X	X	X		
5. Vendor inquiries	X	X	X			
6. Subcontract packages	X	X				
7. Listing	X	X	X	X	X	
8. Site visit	X	X	X	X		
9. Estimate bulks	X	X	X	X	X	
10. Labor rates	X	X	X	X	X	
11. Equipment and subcontract selection	X	X	X	X	X	
12. Taxes, insurance, and royalties	X	X	X	X	X	
13. Home office costs	X	X	X	X	X	
14. Construction indirects	X	X	X	X	X	
15. Basis of estimate	X	X	X	X	X	X
16. Equipment list	X					
17. Summary sheet	X	X	X	X	X	
18. Management review	X	X	X	X	X	X
19. Final cost	X	X	X	X	X	X
20. Management approval	X	X	X	X	X	X
21. Computer estimate	X	X	X	X		

Table 31.5: Checklist for Work Normally Required for the Various Classes of Estimates

31.5 PRICING PROCESS:

This activity schedules the development of the Work Breakdown Structure (WBS) and provides management with two of the three operational tools necessary for the control of a system or project. The development of these two tools is normally the responsibility of the program office with input from the functional units.

Note that the integration of the functional unit into the project environment or system occurs through the pricing-out of the work breakdown structure. The total program costs obtained by pricing out the activities over the scheduled period of performance provide management with the third tool necessary to successfully manage the project. During the pricing activities, the functional units have the option of consulting program management about possible changes in the activity schedules and work breakdown structure.

TABLE DATA REQUIRED FOR PREPARATION OF ESTIMATES

	Classes of Estimates					
	I	II	III	IV	V	VI
General						
Product	X	X	X	X	X	X
Process description	X	X	X	X	X	X
Capacity	X	X	X	X	X	X
Location—general					X	X
Location—specific	X	X	X	X		
Basic design criteria	X	X	X	X		
General design specifications	X	X	X	X		
Process						
Process block flow diagram						X
Process flow diagram (with equipment size and material)				X	X	
Mechanical P&I's	X	X	X			
Equipment list	X	X	X	X	X	
Catalyst/chemical specifications	X	X	X	X	X	
Site						
Soil conditions	X	X	X	X		
Site clearance	X	X	X			
Geological and meteorological data	X	X	X			
Roads, paving, and landscaping	X	X	X			
Property protection	X	X	X			
Accessibility to site	X	X	X			
Shipping and delivery conditions	X	X	X			
Major cost is factored					X	X
Major Equipment						
Preliminary sizes and materials			X	X	X	
Finalized sizes, materials, and appurtenances	X	X				
Bulk Material Quantities						
Finalized design quantity take-off		X				
Preliminary design quantity take -off	X	X	X	X		
Engineering						
Plot plan and elevations	X	X	X	X		
Routing diagrams	X	X	X			

Piping line index	X	X			
Electrical single line	X	X	X	X	
Fire protection	X	X	X		
Sewer systems	X	X	X		
Pro -services—detailed estimate	X	X			
Pro -services—ratioed estimate			X	X	X
Catalyst/chemicals quantities	X	X	X	X	X
Construction					
Labor wage, F/B, travel rates	X	X	X	X	X
Labor productivity and area practices	X	X			
Detailed construction execution plan	X	X			
Field indirects—detailed estimate	X	X			
Field indirects—ratioed estimate			X	X	X
Schedule					
Overall timing of execution				X	X
Detailed schedule of execution	X	X	X		
Estimating preparation schedule	X	X	X		

Table 31.6: Data Required for Preparation of Estimates

The Work Breakdown Structure (WBS) and activity schedules are priced out through the lowest pricing units of the company. It is the responsibility of these pricing units, whether they are sections, departments, or divisions, to provide accurate and meaningful cost data (based on historical standards, if possible). All information is priced out at the lowest level of performance required, which, will be the task level. Costing information is rolled up to the project level and then one step further to the total program level.

Under ideal conditions, the work required (that is, man-hours) to complete a given task can be based on historical standards. Unfortunately, for many industries, projects and programs are so diversified that realistic comparison between previous activities may not be possible. The costing information obtained from each pricing unit, whether or not it is based on historical standards, should be regarded only as an estimate. How can a company predict the salary structure three years from now? What will be the cost of raw materials two years from now? Will the business base (and therefore overhead rates) change over the duration of the program? The final response to these questions shows that costing data are explicitly related to an environment that cannot be predicted with any high degree of certainty. The systems approach to management, however, provides for a more rapid response to the environment than less structured approaches permit.

Remember that once the cost data are assembled, they must be analyzed for their potential impact on the company resources of people, money, equipment, and facilities. It is only through a total program cost analysis that resource allocations can be analyzed. The resource allocation analysis is performed at all levels of management, ranging from the section supervisor to the vice president and general manager. For most programs, the chief executive must approve final cost data and the allocation of resources.

Proper analysis of the total program costs can provide management (both program and corporate) with a strategic planning model for integration of the current program with other programs in order to obtain a total corporate strategy. Meaningful planning and pricing models include analyses for monthly man-loading schedules per department, monthly costs per department, monthly and yearly total program costs, monthly material expenditures, and total program cash-flow and man-hour requirements per month.

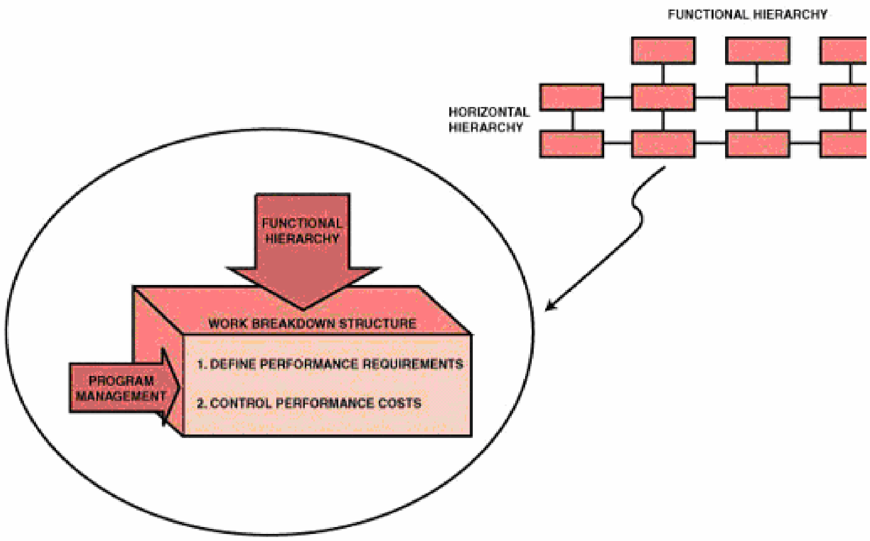


Figure 31.5: The Vertical Horizontal Interface

Previously we identified several of the problems that occur at the nodes where the horizontal hierarchy of program management interfaces with the vertical hierarchy of functional management.

The pricing-out of the work breakdown structure provides the basis for effective and open communication between functional and program management where both parties have one common goal. This is shown in Figure 31.5 above. After the pricing effort is completed, and the program is initiated, the work breakdown structure still forms the basis of a communications tool by documenting the performance agreed on in the pricing effort, as well as establishing the criteria against which performance costs will be measured.

LESSON 32

PRICING AND ESTIMATION (CONTD.)

BROAD CONTENTS

Organizational Input Requirements
Labor Distributions
Overhead Costs

32.1 ORGANIZATIONAL INPUT REQUIREMENTS:

Note that once the work breakdown structure and activity schedules are established, the program manager calls a meeting for all organizations that will be required to submit pricing information. It is imperative that all pricing or labor-costing representatives be present for the first meeting. During this "kickoff" meeting, the work breakdown structure is described in depth so that each pricing unit manager will know exactly what his responsibilities are during the program. The kickoff meeting also resolves the struggle-for-power positions of several functional managers whose responsibilities may be similar to overlap on certain activities. An example of this would be quality control activities. During the research and development phase of a program, research personnel may be permitted to perform their own quality control efforts, whereas during production activities the quality control department or division would have overall responsibility. Unfortunately, one meeting is not always sufficient to clarify all problems. Follow-up or status meetings are held, normally with only those parties concerned with the problems that have arisen. Some companies prefer to have all members attend the status meetings so that all personnel will be familiar with the total effort and the associated problems. The advantage of not having all program-related personnel attend is that time is of the essence when pricing out activities. Many functional divisions carry this policy one step further by having a divisional representative together with possibly key department managers or section supervisors as the only attendees at the kickoff meeting. The divisional representative then assumes all responsibility for assuring that all costing data are submitted on time. This arrangement may be beneficial in that the program office need contact only one individual in the division to learn of the activity status, but it may become a bottleneck if the representative fails to maintain proper communication between the functional units and the program office, or if the individual simply is unfamiliar with the pricing requirements of the work breakdown structure.

Time may be extremely important, during proposal activities. There are many situations in which a Request for Proposal (RFP) requires that all responders submit their bids no later than a specific date, say within thirty days. Under a proposal environment, the activities of the program office, as well as those of the functional units, are under a schedule set forth by the proposal manager. The proposal manager's schedule has very little, if any, flexibility and is normally under tight time constraints so that the proposal may be typed, edited, and published prior to the date of submittal. In this case, the Request for Proposal (RFP) will indirectly define how much time the pricing units have to identify and justify labor costs.

The justification of the labor costs may take longer than the original cost estimates, especially if historical standards are not available. Many proposals often require that comprehensive labor justification be submitted. Other proposals, especially those that request an almost immediate response, may permit vendors to submit labor justification at a later date.

Remember that in the final analysis, it is the responsibility of the lowest pricing unit supervisors to maintain adequate standards, if possible, so that an almost immediate response can be given to a pricing request from a program office.

32.2 LABOR DISTRIBUTIONS:

The functional units supply their input to the program office in the form of man-hours as shown in Figure 32.1 below.

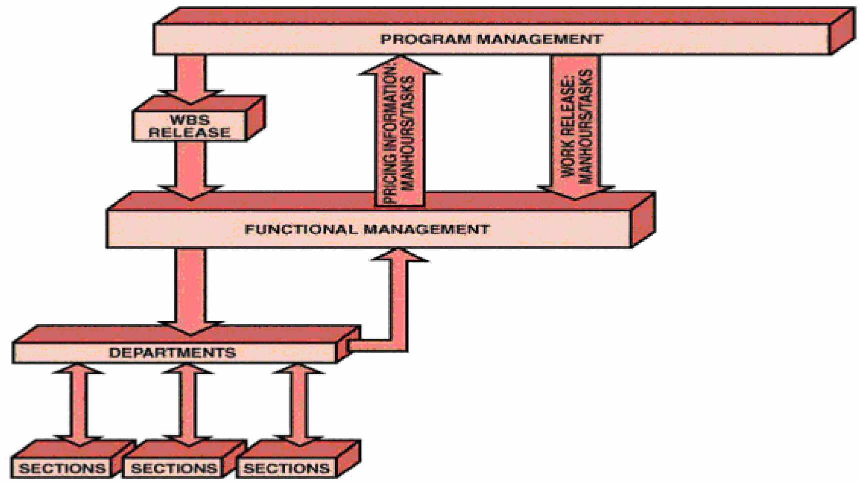


Figure 32.1: Functional Pricing Flow

The input may be accompanied by labor justification, if required. The man-hours are submitted for each task, assuming that the task is the lowest pricing element, and are time-phased per month. The man-hours per month per task are converted to dollars after multiplication by the appropriate labor rates. The labor rates are generally known with certainty over a twelve-month period, but from then on are only estimates. How can a company predict salary structures five years hence? If the company underestimates the salary structure, increased costs and decreased profits will occur. If the salary structure is overestimated, the company may not be competitive; if the project is government funded, then the salary structure becomes an item under contract negotiations.

In this regard, the development of the labor rates to be used in the projection is based on historical costs in business base hours and dollars for the most recent month or quarter. Average hourly rates are determined for each labor unit by direct effort within the operations at the department level. The rates are only averages, and include both the highest-paid employees and lowest-paid employees, together with the department manager and the clerical support. These base rates are then escalated as a percentage factor based on past experience, budget as approved by management, and the local outlook and similar industries. If the company has a predominant aerospace or defense industry business base, then these salaries are negotiated with local government agencies prior to submittal for proposals.

The labor hours submitted by the functional units are quite often overestimated for fear that management will "massage" and reduce the labor hours while attempting to maintain the same scope of effort. Many times management is forced to reduce man-hours either because of insufficient funding or just to remain competitive in the environment. The reduction of man-hours often causes heated discussions between the functional and program managers. Program managers tend to think in terms of the best interests of the program, whereas functional managers lean toward maintaining their present staff.

To cater to this, the most common solution to this conflict rests with the program manager. If the program manager selects members for the program team who are knowledgeable in man-hour standards for each of the departments, then an atmosphere of trust can develop between the program office and the functional department so that man-hours can be reduced in a manner that represents the best interests of the company. This is one of the reasons why program team members are often promoted from within the functional ranks.

The man-hours submitted by the functional units provide the basis for total program cost analysis and program cost control. To illustrate this process, consider the following Example 32.1:

Example 32.1:
On May 15, Apex Manufacturing decided to enter into competitive bidding for the modification and updating of an assembly line program. A work breakdown structure was developed as shown below:

PROGRAM (01-00-00): Assembly Line Modification
  PROJECT 1 (01-01-00): Initial Planning
    Task 1 (01-01-01): Engineering Control
    Task 2 (01-01-02): Engineering Development
  PROJECT 2 (01-02-00): Assembly
    Task 1 (01-02-01): Modification
    Task 2 (01-02-02): Testing

On June 1, each pricing unit was given the work breakdown structure together with the schedule as shown in Figure 32.2 below. According to the schedule developed by the proposal manager for this project, all labor data must be submitted to the program office for review no later than June 15. It should be noted here that, in many companies, labor hours are submitted directly to the pricing department for submittal into the base case computer run. In this case, the program office would “massage” the labor hours only after the base case figures are available. This procedure assumes that sufficient time exists for analysis and modification of the base case. If the program office has sufficient personnel capable of critiquing the labor input prior to submittal to the base case, then valuable time can be saved, especially if two or three days are required to obtain computer output for the base case.

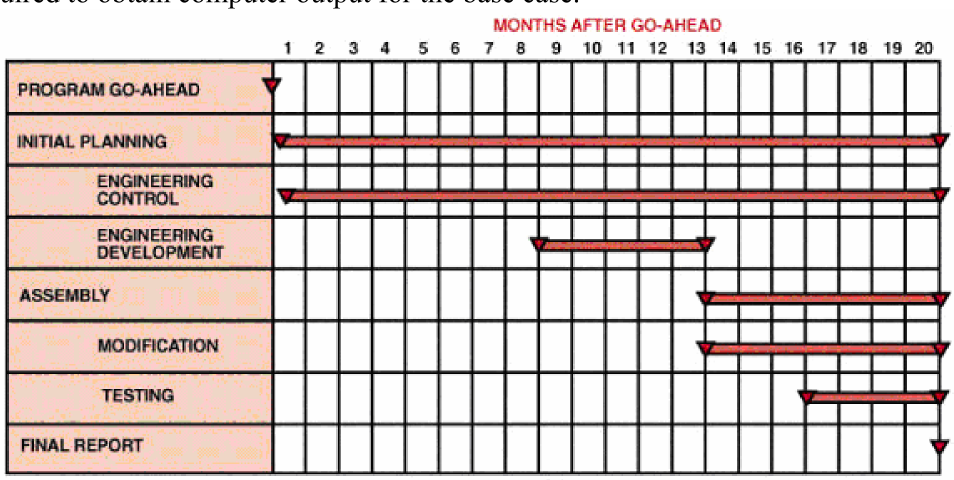


Figure 32.2: Activity Schedule for Assembly Line Updating

Note that during proposal activities, the proposal manager, pricing manager, and program manager must all work together, although the program manager has the final say. The primary responsibility of the proposal manager is to integrate the proposal activities into the operational system so that the proposal will be submitted to the requestor on time. A typical schedule developed by the proposal manager is shown in Figure 32.3 below. The schedule includes all activities necessary to "get the proposal out of the house," with the first major step being the submittal of man-hours by the pricing organizations. It also indicates the tracking of proposal costs. The proposal activity schedule is usually accompanied by a time schedule with a detailed estimates checklist if the complexity of the proposal warrants one.

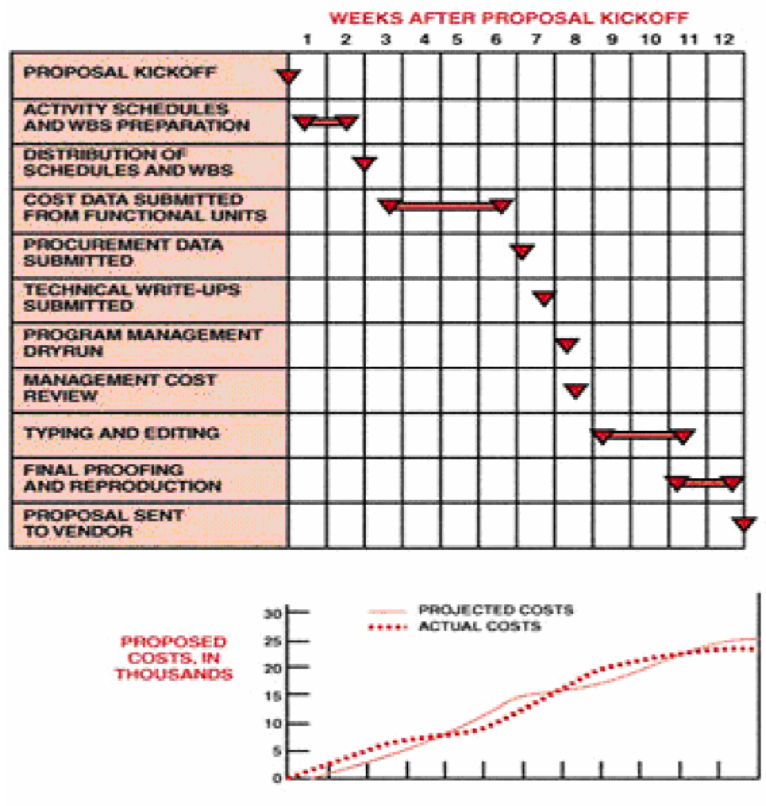


Figure 32.3: Proposal Activity Schedule

The checklist generally provides detailed explanations for the proposal activity schedule.

After the planning and pricing charts are approved by program team members and program managers, they are entered into an Electronic Data Processing (EDP) system as shown in Figure 32.4 below. The computer then prices the hours on the planning charts using the applicable department rates for preparation of the direct budget time plan and estimate-at-completion reports. The direct budget time plan reports, once established, remain the same for the life of the contract except for customer directed or approved changes or when contractor management determines that a reduction in budget is advisable. However, if a budget is reduced by management, it cannot be increased without customer approval.

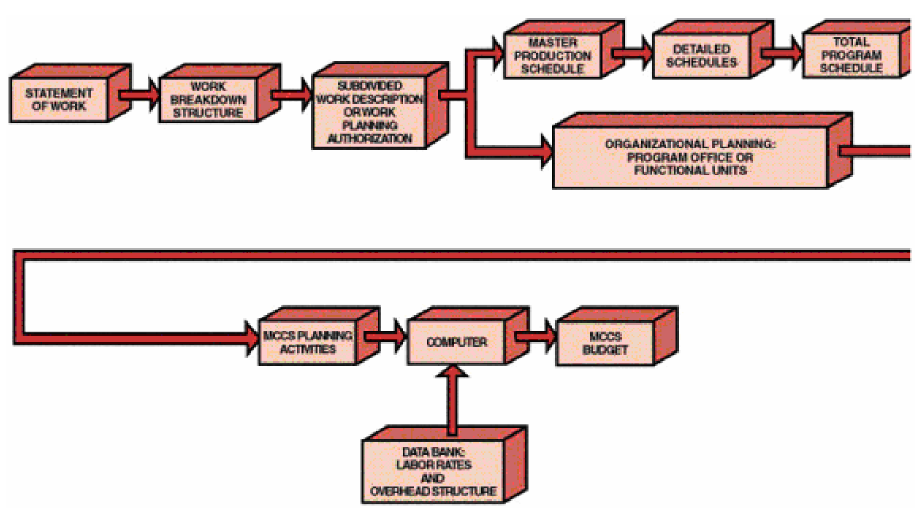


Figure 32.4: Labor Planning Flow Chart

In addition, the time plan is normally a monthly mechanical printout of all planned effort by work package and organizational element over the life of the contract, and serves as the data bank for preparing the status completion reports.

Initially, the estimate-at-completion report is identical to the budget report, but it changes throughout the life of a program to reflect degradation, or improvement in performance, or any other events that will change the program cost or schedule.

32.3 OVERHEAD RATES:

We should know that the ability to control program costs involves more than tracking labor dollars and labor hours. Overhead dollars can be one of the biggest headaches in controlling program costs and must be tracked along with labor hours and dollars. Although most programs have an assistant program manager for cost whose responsibilities include monthly overhead rate analysis, the program manager can drastically increase the success of his program by insisting that each program team member understand overhead rates. For example, if overhead rates apply only to the first forty hours of work, then, depending on the overhead rate, program dollars can be saved by performing work on overtime where the increased salary is at a lower burden. This can be seen in Example 32.2 below.

Example 32.2:
Assume that Apex Manufacturing must write an interim report for task 1 of project 1 during regular shift or on overtime. The project will require 500 man-hours at $15.00 per hour. The overhead burden is 75 percent on regular shift but only 5 percent on overtime. Overtime, however, is paid at a rate of time and a half.

Assuming that the report can be written on either time, which is cost-effective— regular time or overtime?

- On regular time the total cost is:
  (500 hours) × ($15.00/hour) × (100% + 75% burden) = $13,125

- On overtime, the total cost is:
  (500 hours) × ($15.00/hour × 1.5 overtime) × (100% + 5% burden) = $11,812.50

Therefore, the company can save $1,312.50 by performing the work on overtime. Scheduling overtime can produce increased profits if the overtime overhead rate burden is much less than the regular time burden. This difference can be very large in manufacturing divisions, where overhead rates between 300 and 450 percent are common.

Regardless of whether one analyzes a project or a system, all costs must have associated overhead rates. Unfortunately, many program managers and systems managers consider overhead rates as a magic number pulled out of the air. The preparation and assignment of overheads to each of the functional divisions is a science. Although the *total dollar pool* for overhead rates is relatively constant, management retains the option of deciding how to distribute the overhead among the functional divisions. A company that supports its Research and Development staff through competitive bidding projects may wish to keep the Research and Development overhead rate as low as possible. Care must be taken, however, that other divisions do not absorb additional costs so that the company no longer remains competitive on those manufactured products that may be its bread and butter.

Furthermore, the development of the overhead rates is a function of three separate elements: direct labor rates, direct business base projections, and projection of overhead expenses. Direct labor rates have already been discussed. The direct business base projection involves the determination of the anticipated direct labor hours and dollars along with the necessary direct materials and other direct costs required to perform and complete the program efforts included in the business base. Those items utilized in the business base projection include all contracted programs as well as the proposed or anticipated efforts. The foundation for determination of the business base required for each program can be one or more of the following:

- Actual costs to date and estimates to completion
- Proposal data
- Marketing intelligence
- Management goals
- Past performance and trends

Additionally, the projection of the overhead expenses is made by an analysis of each of the elements that constitute the overhead expense. A partial listing of those items that constitute overhead expenses is shown in Table 32.1 below. Projection of expenses within the individual elements is then made based on one or more of the following:

- Historical direct/indirect labor ratios
- Regression and correlation analysis
- Manpower requirements and turnover rates
- Changes in public laws
- Anticipated changes in company benefits
- Fixed costs in relation to capital asset requirements
- Changes in business base
- Bid and proposal (B&P) tri-service agreements
- IR&D tri-service agreements

In case of many industries, such as aerospace and defense, the federal government funds a large percentage of the Bid and proposal (B&P) and IR&D activities. This federal funding is a necessity since many companies could not otherwise be competitive within the industry. The federal government employs this technique to stimulate research and competition. Therefore, Bid and proposal (B&P) and IR&D are included in the above list.

The annual budget is the prime factor in the control of overhead costs. This budget, which is the result of goals and objectives established by the chief executive officer, is reviewed and approved at all levels of management. It is established at department level, and the department manager has direct responsibility for identifying and controlling costs against the approved plan.

The departmental budgets are summarized, in detail, for higher levels of management. This summarization permits management, at these higher organizational levels, to be aware of the authorized indirect budget in their area of responsibility.

Building maintenance	New business directors
Building rent	Office supplies
Cafeteria	Payroll taxes
Clerical	Personnel recruitment
Clubs/associations	Postage
Consulting services	Professional meetings
Corporate auditing expenses	Reproduction facilities
Corporate salaries	Retirement plans
Depreciation of equipment	Sick leave
Executive salaries	Supplies/hand tools
Fringe benefits	Supervision
General ledger expenses	Telephone/telegraph facilities
Group insurance	Transportation
Holiday	Utilities
Moving/storage expenses	Vacation

Table 32.1: Elements of Overhead Rates

Monthly reports are published indicating current month and year-to-date budget, actuals, and variances. These reports are published for each level of management, and an analysis is made by the budget department through coordination and review with management. Each directorate's total organization is then reviewed with the budget analyst who is assigned the overhead cost responsibility. A joint meeting is held with the directors and the vice president and general manager, at which time overhead performance is reviewed.

PRICING AND ESTIMATION (CONTD.)

BROAD CONTENTS

Materials/Support Costs
Pricing out the Work
System Pricing
Developing the Supporting/Backup Costs
The Low-Bidder Dilemma
Special Problems
Estimating Pitfalls

33.1 MATERIALS/SUPPORT COSTS:

Three of four major pricing input requirements are fulfilled by the salary structure, overhead structure, and labor hours. The fourth major input is the cost for materials and support. Six subtopics are included under materials/support: materials, purchased parts, subcontracts, freight, travel, and other. Freight and travel can be handled in one of two ways, both normally dependent on the size of the program. For small-dollar-volume programs, estimates are made for travel and freight. For large dollar-volume programs, travel is normally expressed as between 3 and 5 percent of the direct labor costs, and freight is likewise between 3 and 5 percent of all costs for material, purchased parts, and subcontracts. The category labeled "other support costs" may include such topics as computer hours or special consultants.

Determination of the material costs is very time-consuming, more so than cost determination for labor hours. Material costs are submitted via a bill of materials that includes all vendors from whom purchases will be made, projected costs throughout the program, scrap factors, and shelf lifetime for those products that may be perishable.

As depicted in the Figure 33.1 below, upon release of the work statement, work breakdown structure, and subdivided work description, the end-item bill of materials and manufacturing plans are prepared. End item materials are those items identified as an integral part of the production end-item. Support materials consist of those materials required by engineering and operations to support the manufacture of end-items, and are identified on the manufacturing plan.

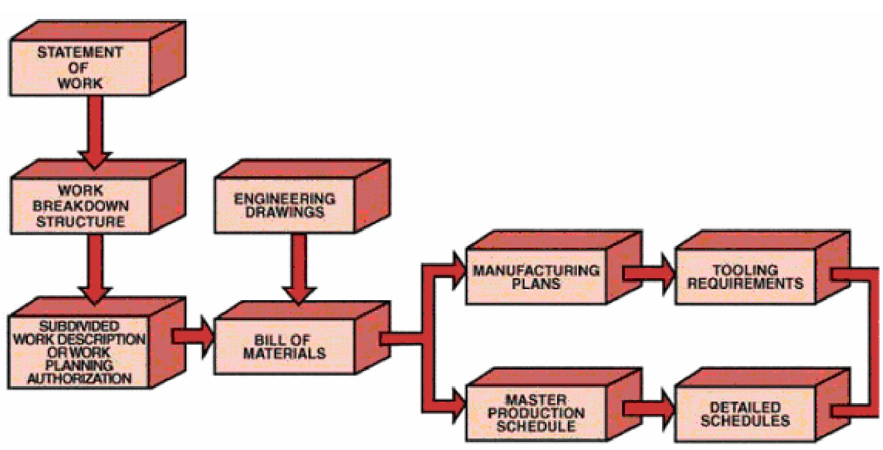


Figure 33.1: Material Planning Flow Chart

Furthermore, a procurement plan/purchase requisition is prepared as soon as possible after contract negotiations (using a methodology as shown in Figure 33.2 below). This plan is used to monitor material acquisitions, forecast inventory levels, and identify material price variances.

Manufacturing plans prepared upon release of the subdivided work descriptions are used to prepare tool lists for manufacturing, quality assurance, and engineering. From these plans a special tooling breakdown is prepared by tool engineering, which defines those tools to be procured and the material requirements of tools to be fabricated in-house. These items are priced by cost element for input on the planning charts.

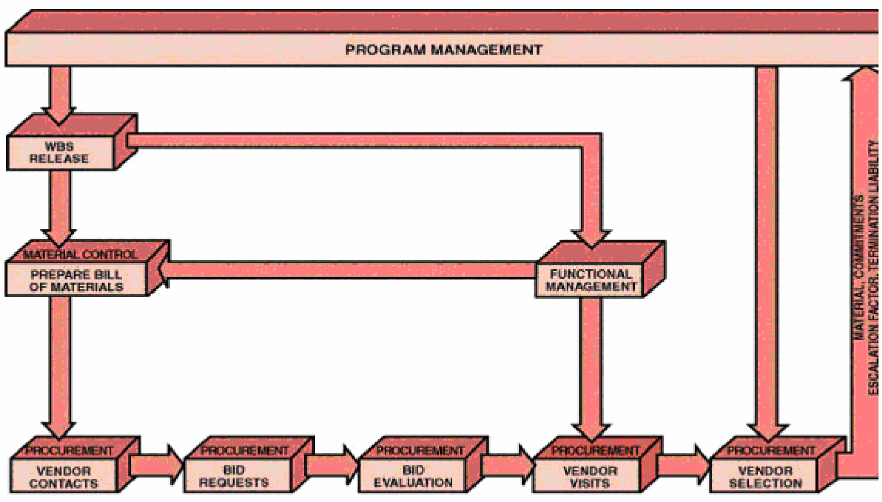


Figure 33.2: Procurement Activity

The materials/support costs are submitted by month for each month of the program. If long-lead funding of materials is anticipated, then they should be as items must be applied to all materials/support costs. Some vendors may provide fixed prices over time periods in excess of a twelve-month period. As an example, vendor Z may quote a firm-fixed price of $130.50 per unit for 650 units to be delivered over the next eighteen months if the order is placed within sixty days. There are additional factors that influence the cost of materials.

33.2 PRICING OUT THE WORK:

Note that the logical pricing techniques are available in order to obtain detailed estimates. The following thirteen steps provide a logical sequence in order to better control the company's limited resources. These steps may vary from company to company.

Step 1: Provide a complete definition of the work
Step 2: Establish a logic network with checkpoints.
Step 3: Develop the work breakdown structure.
Step 4: Price out the work breakdown structure.
Step 5: Review WBS costs with each functional manager.
Step 6: Decide on the basic course of action.
Step 7: Establish reasonable costs for each WBS element.
Step 8: Review the base case costs with upper-level management.
Step 9: Negotiate with functional managers for qualified personnel.
Step 10: Develop the linear responsibility chart.
Step 11: Develop the final detailed and PERT/CPM schedules.
Step 12: Establish pricing cost summary reports.
Step 13: Document the result in a program plan.

Although the pricing of a project is an iterative process, the project manager must still burden himself at each iteration point by developing cost summary reports so that key project decisions can be made during the planning. Detailed pricing summaries are needed at least twice: in preparation for the pricing review meeting with management and at pricing termination. At all other times it is possible that "simple cosmetic surgery" can be performed on previous cost summaries, such as perturbations in escalation factors and procurement cost of raw materials. The list identified below shows the typical pricing reports:

- *A detailed cost breakdown for each Work Breakdown Structure (WBS) element.* If the work is priced out at the task level, then there should be a cost summary sheet for each task, as well as rollup sheets for each project and the total program.

- *A total program manpower curve for each department.* These manpower curves show how each department has contracted with the project office to supply functional resources. If the departmental manpower curves contain several "peaks and valleys," then the project manager may have to alter some of his schedules to obtain some degree of manpower smoothing. Functional managers always prefer manpower-smoothed resource allocations.

- *A monthly equivalent manpower cost summary.* This table normally shows the fully burdened cost for the average departmental employee carried out over the entire period of project performance. If project costs have to be reduced, the project manager performs a parametric study between this table and the manpower curve tables.

- *A yearly cost distribution table.* This table is broken down by WBS element and shows the yearly (or quarterly) costs that will be required. This table, in essence, is a project cash-flow summary per activity.

- *A functional cost and hour summary.* This table provides top management with an overall description of how many hours and dollars will be spent by each major functional unit, such as a division. Top management would use this as part of the forward planning process to make sure that there are sufficient resources available for all projects. This also includes indirect hours and dollars.

- *Monthly labor hour and dollar expenditure forecast.* This table can be combined with the yearly cost distribution, except that it is broken down by month, not activity or department. In addition, this table normally includes manpower termination liability information for premature cancellation of the project by outside customers.

- *A raw material and expenditure forecast.* This shows the cash flow for raw materials based on vendor lead times, payment schedules, commitments, and termination liability.

- *Total program termination liability per month.* This table shows the customer the monthly costs for the entire program. This is the customer's cash flow, not the contractor's. The difference is that each monthly cost contains the termination liability for man-hours and dollars, on labor and raw materials. This table is actually the monthly costs attributed to premature project termination.

It is important to note that these tables are used by both project managers and upper-level executives. The project managers utilize these tables as the basis for project cost control. Top-level management utilizes them for selecting, approving, and prioritizing projects.

33.3 SYSTEMS PRICING:

The basis of successful program management is the establishment of an accurate cost package from which all members of the organization can both project and track costs. The cost data must be represented in such a manner that maximum allocation of the corporate resources of people, money, and facilities can be achieved.

In addition, the systems approach to pricing out the activity schedules and the work breakdown structure provides a means for obtaining unity within the company. The flow of information readily admits the participation of all members of the organization in the program, even if on a part-time basis.

Functional managers obtain a better understanding of how their labor fits into the total program and how their activities interface with those of other departments. For the first time, functional managers can accurately foresee how their activity can lead to corporate profits.

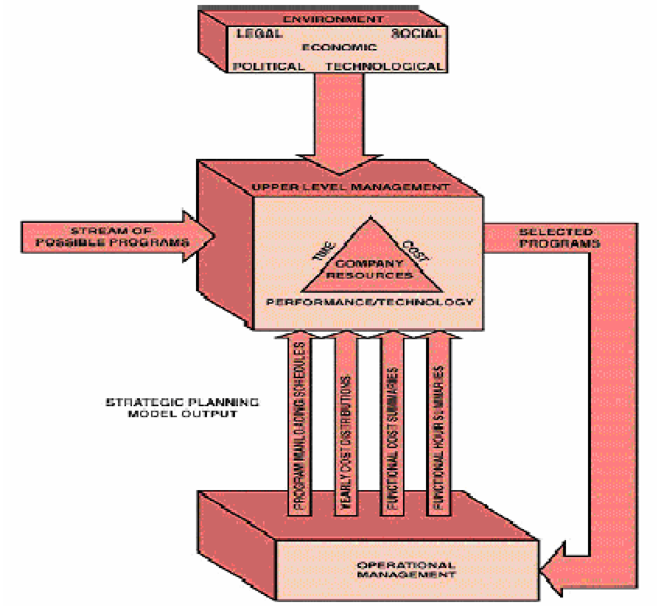


Figure 33.3: System Approach to Resource Control

As shown in Figure 33.3 above the project pricing model (sometimes called a strategic project planning model) acts as a management information system, forming the basis for the systems approach to resource control. The summary sheets from the computer output of the strategic pricing model provide management with the necessary data from which the selection of possible programs can be made so that maximum utilization of resources will follow.

The strategic pricing model also provides management with an invaluable tool for performing perturbation analysis on the base case costs. This perturbation analysis provides management with sufficient opportunity for design and evaluation of contingency plans, should a deviation from the original plan be required.

33.4 DEVELOPING THE SUPPORTING/BACKUP COSTS:

Remember that not all cost proposals require backup support, but for those that do, the backup support should be developed along with the pricing. Extreme caution must be exercised to make sure that the itemized prices are compatible with the supporting data. Government pricing requirements are a special case.
Most supporting data come from external (subcontractor or outside vendor) quotes. Internal data must be based on historical data, and these historical data must be updated continually as each new project is completed. The supporting data should be traceable by itemized charge numbers.

It must be kept in mind that customers may wish to audit the cost proposal. In this case, the starting point might be with the supporting data. It is not uncommon on sole-source proposals to have the supporting data audited before the final cost proposal is submitted to the customer.

Not all cost proposals require supporting data; the determining factor is usually the type of contract. On a fixed-price effort, the customer may not have the right to audit your books. However, for a cost-reimbursable package, your costs are an open book, and the customer usually compares your exact costs to those of the backup support.

Commonly, most companies usually have a choice of more than one estimate to be used for backup support. In deciding which estimate to use, consideration must be given to the possibility of follow-on work:

- If your actual costs grossly exceed your backup support estimates, you may lose credibility for follow-on work.

- If your actual costs are less than the backup costs, you must use the new actual costs on follow-on efforts.

We see that the moral here is that backup support costs provide future credibility. If you have well-documented, "livable" cost estimates, then you may wish to include them in the cost proposal even if they are not required.

Since both direct and indirect costs may be negotiated separately as part of a contract, supporting data such as those in the following four Tables (33.1, 33.2, 33.3 and 33.4 respectively) and Figure 33.4 following them may be necessary to justify any costs that may differ from company (or customer-approved) standards.

TABLE OPERATIONS SKILLS MATRIX

Functional areas of expertise \ Technical Staff	Able, J.	Baker, P.	Cook, D.	Dirk, L.	Easley, P.	Franklin, W.	Green, C.	Henry, L.	Imhoff, R.	Jules, C.	Klein, W.	Ledger, D.	Mayer, Q.	[illegible]
Administrative management		a				a		a			a	a		
Control and communications	b		b	b	b		b	b		b	b	b		b
Environmental impact assessment	c	c	c						c		c		c	
Facilities management		d					d				d		d	
Financial management	e					e			e	e	e			
Human resources mangement	f							f				f		
Industrial engineering	g				g					g				
Intelligence and security								h				h		h
Inventory control	i						i							
Logistics			j		j			j				j		
OSHA	k									k			k	
Project management	l			l		l					l			
Quality control		m	m			m	m	m	m					
R&D			n	n							n		n	
Wage and salary administration		o			o				o	o		o		o

TABLE CONTRACTOR'S MANPOWER AVAILABILITY

	Number of Personnel			
	Total Current Staff			
	Permanent Employees	Agency Personnel	Available for This Project and Other New Work 1/93 Permanent + Agency	Anticipated Growth by 1/93 Permanent + Agency
Process engineers	93	—	70	4
Project managers/engineers	79	—	51	4
Cost estimating	42	—	21	2
Cost control	73	—	20	2
Scheduling/scheduling control	14	—	8	1
Procurement/ purchasing	42	—	20	1
Inspection	40	—	20	2
Expediting	33	—	18	1
Home office construction management	9	—	6	0
Piping	90	13	67	6
Electrical	31	—	14	2
Instrumentation	19	—	3	1
Vessels/exchangers	24	—	19	1
Civil/structural	30	—	23	2
Other	13	—	8	0

Tables 33.1 and 33.2

TABLE STAFF TURNOVER DATA

	For Twelve-Month Period 1/1/92 to 1/1/93	
	Number Terminated	Number Hired
Process engineers	5	2
Project managers/engineers	1	1
Cost estimating	1	2
Cost control	12	16
Scheduling/scheduling control	2	5
Procurement/purchasing	13	7
Inspection	18	6
Expediting	4	5
Home office construction management	0	0
Design and drafting—total	37	29
Engineering specialists—total	26	45
Total	119	118

Table 33.3: Staff Turnover Data

TABLE	STAFF EXPERIENCE PROFILE				
	Number of Years' Employment with Contractor				
	0–1	1–2	2–3	3–5	5 or more
Process engineers	2	4	15	11	18
Project managers/engineers	1	2	5	11	8
Cost estimating	0	4	1	5	7
Cost control	5	9	4	7	12
Scheduling and scheduling control	2	2	1	3	6
Procurement/purchasing	4	12	13	2	8
Inspection	1	2	6	14	8
Expediting	6	9	4	2	3
Piping	9	6	46	31	22
Electrical	17	6	18	12	17
Instrumentation	8	8	12	13	12
Mechanical	2	5	13	27	19
Civil/structural	4	8	19	23	16
Environmental control	0	1	1	3	7
Engineering specialists	3	3	3	16	21
Total	64	81	161	180	184

Table 33.4: Staff Experience Profile

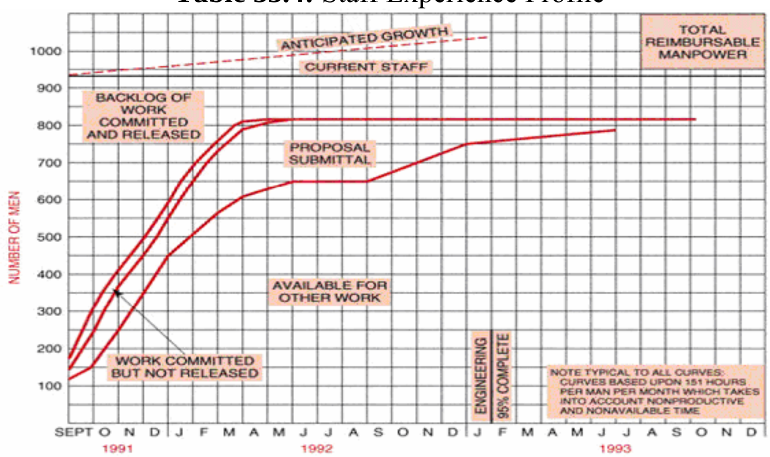


Figure 33.4: Total Reimbursable Manpower

33.5 THE LOW-BIDDER DILEMMA:

There is little argument about the importance of the price tag to the proposal. The question is what price will win the job? Everyone has an answer to this question. The decision process that leads to the final price of your proposal is highly complex with many uncertainties. Yet proposal managers, driven by the desire to win the job, may think that a very low-priced proposal will help. But, hopefully, winning is only the beginning. Companies have short- and long-range objectives on profit, market penetration, new product development, and so on. These objectives may be incompatible with or irrelevant to a low-price strategy per se; for example:

- A suspiciously low price, particularly on cost-plus type proposals, might be perceived by the customer as unrealistic, thus affecting the bidder's cost credibility or even the technical ability to perform.
- The bid price may be unnecessarily low, relative to the competition and customer budget, thus eroding profits.
- The price may be irrelevant to the bid objective, such as entering a new market. Therefore, the contractor has to sell the proposal in a credible way, e.g., using cost sharing.

- Low pricing without market information is meaningless. The price level is always relative to (1) the competitive prices, (2) the customer budget and (3) the bidder's cost estimate.

- The bid proposal and its price may cover only part of the total program. The ability to win phase II or follow-on business depends on phase I performance and phase II price.

- The financial objectives of the customer may be more complex than just finding the lowest bidder.

They may include cost objectives for total system *life-cycle cost (LCC)*, for *design to unit production cost (DTUPC)*, or for specific logistic support items. Presenting sound approaches for attaining these system cost–performance parameters and targets may be just as important as, if not more important than, a low bid for the system's development.

In addition to this, it is refreshing to note that in spite of customer pressures toward low cost and fixed price, the lowest bidder is certainly not an automatic winner. Both commercial and governmental customers are increasingly concerned about cost realism and the ability to perform under contract. A compliant, sound, technical and management proposal, based on past experience with realistic, well documented cost figures, is often chosen over the lowest bidder, who may project a risky image regarding technical performance, cost, or schedule.

33.6 SPECIAL PROBLEMS:

It is essential to note that there are always special problems that, although often overlooked, have a severe impact on the pricing effort. As an example, pricing must include an understanding of cost control— specifically, how costs are billed back to the project. There are three possible situations:

1. *Work is priced out at the department average, and all work performed is charged to the project at the department average salary, regardless of who accomplished the work.* This technique is obviously the easiest, but encourages project managers to fight for the highest salary resources, since only average wages are billed to the project.
2. *Work is priced out at the department average, but all work performed is billed back to the project at the actual salary of those employees who perform the work.* This method can create a severe headache for the project manager if he tries to use only the best employees on his project. If these employees are earning substantially more money than the department average, then a cost overrun will occur unless the employees can perform the work in less time. Some companies are forced to use this method by government agencies and have estimating problems when the project that has to be priced out is of a short duration where only the higher-salaried employees can be used. In such a situation it is common to "inflate" the direct labor hours to compensate for the added costs.
3. *The work is priced out at the actual salary of those employees who will perform the work, and the cost is billed back the same way.* This method is the ideal situation as long as the people can be identified during the pricing effort.

In this regard, some companies use a combination of all three methods. In this case, the project office is priced out using the third method (because these people are identified early), whereas the functional employees are priced out using the first or second method.

33.7 ESTIMATING PITFALLS:

There are several pitfalls that can impede the pricing function. Probably the most serious pitfall, and the one that is usually beyond the control of the project manager, is the "buy-in" decision, which is based on the assumption that there will be "bail-out" changes or follow-on contracts later. These changes and/or contracts may be for spares, spare parts, maintenance, maintenance manuals, equipment surveillance, optional equipment, optional services, and scrap factors. Other types of estimating pitfalls include:

- Misinterpretation of the statement of work
- Omissions or improperly defined scope
- Poorly defined or overly optimistic schedule
- Inaccurate work breakdown structure
- Applying improper skill levels to tasks
- Failure to account for risks
- Failure to understand or account for cost escalation and inflation
- Failure to use the correct estimating technique
- Failure to use forward pricing rates for overhead, general and administrative, and indirect costs.

Unfortunately, many of these pitfalls do not become evident until detected by the cost control system, well into the project.

QUALITY IN PROJECT MANAGEMENT

BROAD CONTENTS
What is Quality?
Quality from Different Perspective
Quality Dimensions
Competitive Advantage
Quality Evolution and Quality Stages in Japan
TQM (Total Quality Management) and Its Philosophy

34.1 WHAT IS QUALITY?

Quality is by no menus a new concept in modern business. In October 1887, William Cooper Procter, grandson of the founder of Procter and Gamble, told his employees, "The first job we have is to him out quality merchandise that consumers will buy and keep on buying. If we produce it efficiently and economically, we will earn a profit, in which you will share." Procter's statement addresses three issues that are critical to managers of manufacturing and service organizations: productivity, cost, and quality. Productivity (the measure of efficiency defined as the amount of output achieved per unit of input), the cost of operations, and the quality of the goods and services that create customer satisfaction all contribute to profitability. Of these three determinants of profitability, the most significant factor in determining the long-run success or failure of any organization is quality. High quality goods and services can provide an organization with a competitive edge. High quality reduces costs due to returns, rework, and scrap. It increases productivity, profits, and other measures of success. Most importantly, high quality generates satisfied customers, who reward the organization with continued patronage and word-of-mouth advertising.

Quality can be a confusing concept, partly because people view quality in relation to differing criteria based on their individual roles in the production-marketing value chain. In addition, the meaning of quality continues to evolve as the quality profession grows and matures. Neither consultants nor business professionals agree on a universal definition. A study that asked managers of 86 firms in the eastern United States to define quality produced several dozen different responses, including the following:

1. Perfection
2. Consistency
3. Eliminating waste
4. Speed of delivery
5. Compliance with policies and procedures
6. Providing a good, usable product
7. Doing it right the first time
8. Delighting or pleasing customers
9. Total customer service and satisfaction

Thus, it is important to understand the various perspectives from which quality is viewed in order to fully appreciate the role it plays in the many pails of a business organization.

The concept of quality is subjective and difficult to define. While certain aspects of quality can be identified, ultimately, the "judgement of quality" rests with the customer.

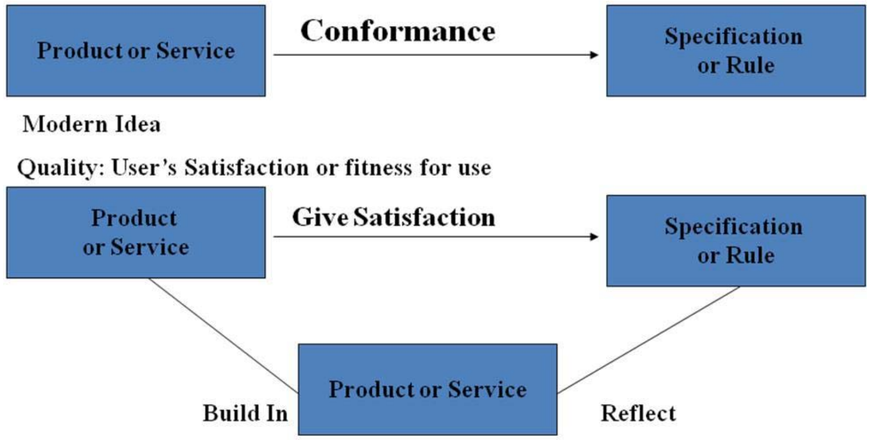


Figure 34.1

34.2 QUALITY FROM DIFFERENT PERSPECTIVES*:*

- **Judgmental Perspective:**

One common notion of quality, used by consumers, is that it is synonymous with superiority or excellence. In 1931 Walter Shewhart first defined quality as the goodness of a product. This view is referred to as the *transcended (*to rise above or extend notably beyond ordinary limits*)*, definition of quality. In this sense, quality is "both absolute and universally recognizable, a mark of uncompromising standards and high achievement." As such, it cannot he defined precisely—you just know it when you see it. It is often loosely related to a comparison of features and characteristics of products and promulgated by marketing efforts aimed at developing quality as an image variable in the minds of consumers. Common examples of products attributed with this image are Kolex watches and BMW and Lexus automobiles.

- **Product-Based Perspective:**

Another definition of quality is that it is a function of a specific, measurable variable and that differences in quality reflect differences in quantity of product attribute, such as in the number of stitches per inch on a shirt or in the number of cylinders in an engine. This assessment implies that higher levels or amounts of product characteristics are equivalent to higher quality, As a result, quality is often mistakenly assumed to be related to price: the higher the price, the higher the quality. Just consider the case of a Florida man who purchased a $262,000 Lamborghini only to find a leaky roof, a battery that quit without notice, a sunroof that detached when the car hit a bump, and doors that jammed " However, a product refer to either a manufactured good or a service—need not be expensive to be considered a quality product by consumers. Also, as with the notion of excellence, the assessment of product attributes may vary considerably among individuals.

- **User-Based Perspective:**

A third definition of quality is based on the presumption that quality is determined by what a customer wants. Individuals have different wants and needs and, hence, different quality standards, which leads to a user-based definition: quality is defined as fitness for *intended use,* or how well the product performs its intended function. Both a Cadillac sedan and a Jeep Cherokee arc fit for use, for example, but they serve different needs and different groups of customers. If you want a highway-touring vehicle with luxury amenities, then a Cadillac may better satisfy your needs. If you want a vehicle for camping, fishing, or skiing trips, a Jeep might be viewed as having better quality.

- **Value-Based Perspective:**

A fourth approach to defining quality is based on *value;* that is, the relationship of usefulness or satisfaction to price. From this perspective, a quality product is one that is as useful as competing products and is sold at a lower price, or one that offers greater usefulness or satisfaction at a comparable price. Thus, one might purchase a generic product, rather than a brand name one, if it performs as well as the brand-name product at a lower price. An example of this perspective in practice is evident in a comparison of the U.S. and Japanese automobile markets. A Chrysler marketing executive noted "one of the main reasons that the loading Japanese brands—Toyota and Honda—don't offer the huge incentives of the big Three (General Motors, Ford, and Chrysler) is that they have a much better reputation for long-term durability." In essence, incentives and rebates are payments to customers lo compensate for lower quality.

- **Manufacturing-Based Perspective:**

A fifth view of quality is manufacturing-based and defines quality as the desirable outcome of engineering and manufacturing practice, or *conformance to specifications.* Specifications are targets and tolerances determined by designers of products and services. Targets are the ideal values for which production is to strive; tolerances are specified because designer's recognize that it is impossible to meet targets all of the time in manufacturing. For example, a part dimension might be specified as "0.236 i 0.003 cm." These measurements would mean that the target, or ideal value, is 0.236 centimeters, and that the allowable variation is (MHB centimeters from the target (a tolerance of 0.006 cm.). Thus, any dimension in the range 0.233 to 0.239 centimeters is deemed acceptable and is said to conform lo specifications. Likewise, in services, "on-time arrival" for an airplane might be specified as within'15 minutes of the scheduled arrival time. The target is the scheduled time, and the tolerance is specified to be 15 minutes.

- **Integrating Perspectives on Quality:**

Although product quality should be important to all individuals throughout the value chain, how quality is viewed may depend on one's position in the value chain, that is, whether one is the designer, manufacturer or service provider, distributor, or customer. The customer is the driving force for the production of goods and services, and customers generally view quality from either the transcendent or the product-based perspective. The goods and services produced should meet customers' needs; indeed, business organizations' existences depend upon meeting customer needs. It is the rule of the marketing function to determine these needs. A product that meets customer needs can rightly be described as a quality product. Hence, the user-based definition of quality is meaningful to people who work in marketing.

The manufacturer must translate customer requirements into detailed product and process specifications. Making this translation is the role of research and development, product design, and engineering. Product specifications might address such attributes as size, form, finish, taste, dimensions, tolerances, materials, operational characteristics, and safety features. Process specifications indicate the types of equipment, tools, and facilities to be used in production. Product designers must balance performance and cost to meet marketing objectives; thus, the value-based definition of quality is most useful at this stage.

- **Customer-Driven Quality:** I

The American National Standards Institute (ANSI) and the American Society for Quality (ASQ) standardized official definitions of quality terminology in 1978. These groups defined quality as *the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs.* This definition draws heavily on the product- and user-based approaches and is driven by the need to contribute value to customers and thus to influence satisfaction and preference. By the end of the 1980s, many companies had begun using a simpler, yet powerful, customer-driven definition of quality that remains popular today:

"Quality is meeting or exceeding customer expectations"

34.3 QUALITY DIMENSIONS:

Following are the "principal quality dimensions":

- Performance **–** a product's primary operating characteristics. For example: A car's acceleration, braking distance, steering and handling.
- Features – the "bells and whistles" of a product. A car may have power options, a tape or CD (compact disk) player, antilock brakes, reclining seats.
- Reliability – the probability of a product's surviving over a specified period of time under stated "conditions of use". Examples of reliability factors could be a car's ability to start on cold days and frequency of failures.
- Conformance – the degree to which physical and performance characteristics of a product match with the pre-established standards. For example, car's fit/finish, freedom from noises can reflect this.
- Durability – the amount of use one gets from a product before it physically deteriorates or until replacement is preferable. If we take the example of a car its corrosion resistance and long wear of upholstery fabric reflects this.
- Serviceability – this refers to the speed, courtesy, competence of repair work. Auto owner access to spare parts also comes under serviceability.
- Aesthetics – refers to how a product looks, feels, sounds, tastes, or smells. Car's color, instrument panel design and "feel of road" make it aesthetically pleasing.
- Perceived quality – the "subjective assessment of quality" resulting from image. For example: Advertising, or brand names. car, shaped by magazine reviews-manufacturers' brochures.
- Affordability, Variety, simplicity etc. are also the principal quality dimensions.

34.4 COMPETITIVE ADVANTAGE:

When a firm sustains profits that exceed the average for its industry, the firm is said to possess a **competitive advantage** over its rivals. The goal of much of business strategy is to achieve a sustainable competitive advantage.

Michael Porter identified two basic types of competitive advantage:

- Cost advantage
- Differentiation advantage

A competitive advantage exists when the firm is able to deliver the same benefits as competitors but at a lower cost (cost advantage), or deliver benefits that exceed those of competing products (differentiation advantage). Thus, a competitive advantage enables the firm to create superior value for its customers and superior profits for itself.

Cost and differentiation advantages are known as *positional advantages* since they describe the firm's position in the industry as a leader in either cost or differentiation.

A *resource-based view* emphasizes that a firm utilizes its resources and capabilities to create a competitive advantage that ultimately results in superior value creation.

34.5 QUALITY EVOLUTION AND QUALITY STAGES IN JAPAN:

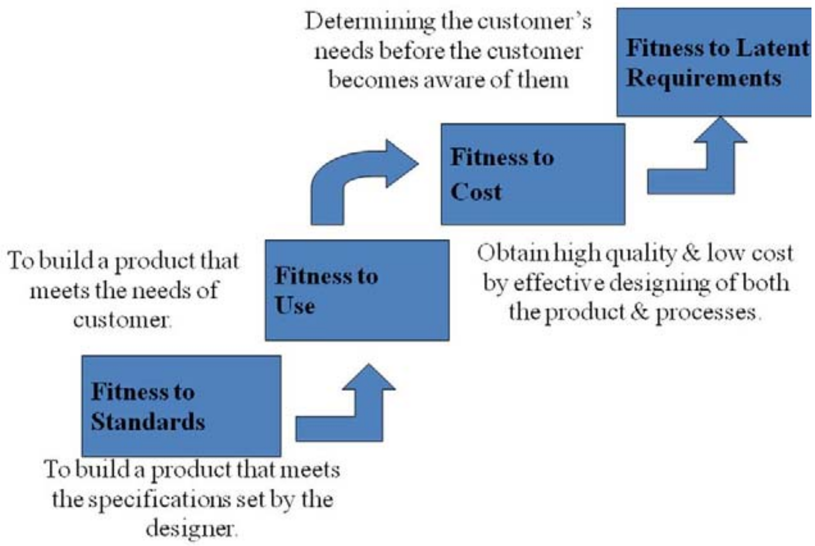


Figure 34.2: Quality Evolution and Quality Stages in Japan

34.6 TOTAL QUALITY MANAGEMENT (TQM) AND ITS PHILOSOPHY:

34.6.1 Quality as a Management Framework:

In the 1970s a General Electric (GE) task force studied consumer perceptions of the quality of various GE product lines. Lines with relatively poor reputations for quality were found to deemphasize customer's viewpoint, regard quality as synonymous with tolerance and conformance to specifications, tic quality objectives to manufacturing flow, express quality objectives as the number of defects per unit, and use formal quality control systems only in manufacturing. In contrast, product lines that received customer praise were found to emphasize satisfying customer expectations, determine customer needs through market research, use customer-based quality performance measures, and have formalized quality control systems in place for all business functions, not just for manufacturing. The task force concluded that quality must not be viewed solely as a technical discipline, but rather as a management discipline. That is, quality issues permeate all aspects of business enterprise: design, marketing, manufacturing, human resource management, supplier relations, and financial management, to name just a few.

As companies came to recognize the broad scope of quality, the concept of total quality (TQ) emerged. A definition of total quality was endorsee! In 1992 by the chairs and CUOs of nine major U.S. corporations in cooperation with deans of business and engineering departments of major universities, and recognized consultants:

Total Quality (TQ) is a people-focused management system that aims at continual increase in customer satisfaction at continually lower real cost. TQ is a total system approach (not a separate area or program) and an integral pan of high-level strategy; it works horizontally across functions and departments, involves all employees, top to bottom, and extends backward and forward to include the supply chain and the customer chain. TQ stresses learning and adaptation to continual change as keys to organizational success.

The foundation of total quality is philosophical: the scientific method. TQ includes systems, methods, and tools. The systems permit change, the philosophy stays the same. TQ is anchored in values that stress the dignity of the individual and the power of community action.

Procter and Gamble uses a concise definition: Total quality is the unyielding and continually improving effort by everyone in an organization to understand, meet, and exceed the expectations of customers.

Actually, the concept of TQ has been around for some time. A. V. Feigenbaum recognized the importance of a comprehensive approach to quality in the 1950s and coined the term Total quality control. Feigenbaum observed that the quality of products and services is directly influenced by what he terms the 9 Ms: markets, money, management, men and women, motivation, materials, machines and mechanization, modern information methods, and mounting product requirements. Although he developed his ideas from an engineering perspective, his concepts apply more broadly to general management.

The Japanese adopted Feigenbaum's concept and renamed it companywide quality control. Wayne S. Keiker listed five aspects of total quality control practiced in Japan:

1. Quality emphasis extends through market analysis, design, and customer service rather than only the production stages of making a product.
2. Quality emphasis is directed toward operations in every department from executives to clerical personnel.
3. Quality is the responsibility of live individual and the work group, not sonic other group, such as inspection.
4. The two types of quality characteristics as viewed by customers are those that satisfy and those that motivate. Only the latter are strongly related to repeat sales and a "quality" image.
5. The first customer for a part or piece of information is usually the next department in the production process.

The term *total quality management* was developed by the Naval Air Systems Command to describe its Japanese-style approach to quality improvement and became popular with businesses in the United States during the 1980s. As we noted earlier, TQM has fallen out of favor, and many people simply use TQ.

34.6.2 Principles of Total Quality:

Whatever the language, total quality is based on three fundamental principles:

1. A focus on customers and stakeholders.
2. Participation and teamwork by everyone in the organization.
3. A process focus supported by continuous improvement and learning.

Despite their obvious simplicity, these principles are quite different from traditional management practices. Historically, companies did little to understand external customer requirements, much less those of internal customers. Managers and specialists controlled and directed production systems; workers told what to do and how to do it, and rarely were asked for their input. Teamwork was virtually nonexistent. As certain amount of waste and error was tolerable and was controlled by postproduction inspection. Improvements in quality generally resulted from technological breakthroughs instead of a relentless mindset of continuous improvement. With total quality, an organization actively seeks to identify customer needs and expectations, to build quality into work processes by tapping the knowledge and experience of its workforce/ and to continually improve every facet of the organization.

Customer and Stakeholder Focus the customer is the principal judge of quality. Perceptions of value and satisfaction are influenced by many factors throughout the customer's overall purchase, ownership, and service experiences. To accomplish this task, a company's efforts need to extend well beyond merely meeting specifications, reducing defects and errors, or resolving complaints. They must include both designing new products that truly delight the customer and responding rapidly to changing consumer and market demands. A company close to its customer knows what the customer wants, how the customer uses its products, and anticipates needs that the customer may not even be able to express. It also continually develops new ways of enhancing customer relationships. A firm also must recognize that internal customers are as important in assuring quality as are external customers who purchase the product. Employees who view themselves as both customers of and suppliers to other employees understand how their work links to the final product. After all, the responsibility of any supplier is to understand and meet customer requirements in the most efficient and effective way possible.

Customer focus extends beyond the consumer and internal customer relationships, however. Employees and society represent important stakeholders. An organization's success depends on the knowledge, skills, creativity, and motivation of its employees and partners. Therefore, a TQ organization must demonstrate commitment to employees, provide opportunities for development and growth, provide recognition beyond normal compensation systems, share knowledge, and encourage risk taking. Viewing society as a stakeholder is an attribute of a world-class organization. Bus-mess ethics, public health and safety, the environment, and community and professional support are necessary activities that fall under *social responsibility.*

Participation and Teamwork Joseph Juran credited Japanese managers' full use of the knowledge and creativity of the entire workforce as one of the reasons for Japan's rapid quality achievements. When managers give employees the tools to make good decisions and the freedom and encouragement to make contributions, they virtually guarantee that better quality products and production processes will result. Employees who are allowed to participate—both individually and in teams—in decisions that affect their jobs and customer can make substantial contributions to quality. His attitude represents a profound shift in the typical philosophy of senior management; the traditional view was that the workforce should be "managed"—or to put it less formally, the workforce should leave their brains at the door. Good intentions alone are not enough to encourage employee involvement. Management's task includes formulating the systems and procedures and then putting them in place to ensure that participation becomes a part of the culture.

QUALITY IN PROJECT MANAGEMENT (CONTD.)

BROAD CONTENTS

The Quality Movement
Quality Development Stages
Quality Audit
Deming Philosophy

35.1 THE QUALITY MOVEMENT:

During the past 100 years, the views of quality have changed dramatically. Prior to World War I, quality was viewed predominantly as inspection, sorting out the good items from the bad. Emphasis was on problem identification. Following World War I and up to the early 1950s, emphasis was still on sorting good items from bad.

However, quality control principles were now emerging in the form of:
- Statistical and mathematical techniques
- Sampling tables
- Process control charts

From the early 1950s to the late 1960s, quality control evolved into quality assurance, with its emphasis on problem avoidance rather than problem detection. Additional quality assurance principles emerged, such as:

- The cost of quality
- Zero-defect programs
- Reliability engineering
- Total quality control

35.2 DEVELOPMENT OF QUALITY STAGES:

This comprises of the following "five level model"***:***

1. Inspection
2. Quality Control
3. Quality Assurance
4. Quality Management
5. Total Quality Management

1. Inspection:

"Activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformity is achieved for each characteristic" (ISO 8402)

2. Quality Control:

Quality control is a collective term for activities and techniques, within the process, that are intended to create specific quality characteristics. Such activities include continually monitoring processes, identifying and eliminating problem causes, use of statistical process control to reduce the variability and to increase the efficiency of processes. Quality control certifies that the organization's quality objectives are being met.

Quality control is also referred to as the technical aspect of quality management. They set up the technical processes and procedures that ensure that each step of the project provides a quality output from design and development through implementation and maintenance. Each step's output must conform to the overall quality standards and quality plans, thus ensuring that quality is achieved.

A good quality control system will:

- Select what to control
- Set standards that provide the basis for decisions regarding possible corrective action
- Establish the measurement methods used
- Compare the actual results to the quality standards
- Act to bring nonconforming processes and material back to the standard based on the information collected
- Monitor and calibrate measuring devices
- Include detailed documentation for all processes

3. Quality Assurance:

Quality assurance is the collective term for the formal activities and managerial processes that are planned and undertaken in an attempt to ensure that products and services that are delivered are at the required quality level. Quality assurance also includes efforts external to these processes that provide information for improving the internal processes. It is the quality assurance function that attempts to ensure that the project scope, cost, and time functions are fully integrated.

The Project Management Institute Guide to the Body of Knowledge (PMBOK) refers to quality assurance as the management section of quality management. This is the area where the project manager can have the greatest impact on the quality of his project. The project manager needs to establish the administrative processes and procedures necessary to ensure and, often, prove that the scope statement conforms to the actual requirements of the customer. The project manager must work with his team to determine which processes they will use to ensure that all stakeholders have confidence that the quality activities will be properly performed. All relevant legal and regulatory requirements must also be met.

A good quality assurance system will:

- Identify objectives and standards.
- Be multifunctional and prevention oriented.
- Plan for collection and use of data in a cycle of continuous improvement.
- Plan for the establishment and maintenance of performance measures.
- Include quality audits.

4. Quality Management:

During the past twenty years, there has been a revolution toward improved quality. The improvements have occurred not only in product quality, but also in quality leadership and quality project management. Unfortunately, it takes an economic disaster or a recession to get management to recognize the need for improved quality. Prior to the recession of 1979–1982, Ford, General Motors, and Chrysler viewed each other as the competition rather than the Japanese. Prior to the recession of 1989–1994, high-tech engineering companies never fully recognized the need for shortening product development time and the relationship between project management, total quality management, and concurrent engineering. The push for higher levels of quality appears to be customer driven. Customers are now demanding:

- Higher performance requirements
- Faster product development
- Higher technology levels
- Materials and processes pushed to the limit
- Lower contractor profit margins
- Fewer defects/rejects

One of the critical factors that can affect quality is market expectations. The variables that affect market expectations include:

- Salability: the balance between quality and cost
- Produceability: the ability to produce the product with available technology and workers, and at an acceptable cost
- Social acceptability: the degree of conflict between the product or process and the values of society (i.e., safety, environment)
- Operability: the degree to which a product can be operated safely
- Availability: the probability that the product, when used under given conditions, will perform satisfactorily when called upon
- Reliability: the probability of the product performing without failure under given conditions and for a set period of time
- Maintainability: the ability of the product to be retained in or restored to a performance level when prescribed maintenance is performed

Customer demands are now being handled using total quality management (TQM). Total quality management is an ever-improving system for integrating various organizational elements into the design, development, and manufacturing efforts, providing cost-effective products or services that are fully acceptable to the ultimate customer. Externally, TQM is customer oriented and provides for more meaningful customer satisfaction. Internally, TQM reduces production line bottlenecks and operating costs, thus enhancing product quality while improving organizational morale.

5. Total Quality Management (TQM):

For this, we first explain what ***"total quality"*** is. Total Quality means:

- Quality of work
- Quality of Service
- Quality of information
- Quality Process
- Quality of Organization
- Quality of People
- Quality of Company
- Quality of Objectives

Mature organizations today readily admit that they cannot accurately define quality. The reason for this is because quality is defined by the customer. The Kodak definition of quality is those products and services that are perceived to meet or exceed the needs and expectations of the customer at a cost that represents outstanding value.

The ISO 9000 definition is "the totality of feature and characteristics of a product or service that bears on its ability to satisfy stated or implied needs." Terms such as fitness for use, customer satisfaction, and zero defects are goals rather than definitions. Most organizations today view quality more as a process than a product. To be more specific, it is a continuously improving process where lessons learned are used to enhance future products and services in order to:

- Retain existing customers
- Win back lost customers
- Win new customers

Therefore, companies today are developing quality improvement processes. Figure 35.1 shows the five quality principles that support Kodak's quality policy. Figure 35.2 shows a more detailed quality improvement process.

Total Quality Management (TQM) is a management strategy aimed at embedding awareness of quality in all organizational processes. Total Quality Management (TQM) has been widely used in manufacturing, education, government, and service industries, as well as NASA space and science programs.

Total Quality provides an umbrella under which everyone in the organization can strive and create customer satisfaction at continually lower real costs.

Total Quality Management (TQM) is the management of total quality. We know that management consists of planning, organizing, directing, control, and assurance. Then, one has to define "total quality". Total quality is called **total** because it consists of the following three qualities:

1. **Quality** of return to satisfy the needs of the shareholders
2. **Quality** of products and services to satisfy some specific needs of the consumer (end user)
3. **Quality** of life - at work and outside work - to satisfy the needs of the people in the organization.

This is achieved with the help of upstream and downstream partners of the enterprise. To this, we have to add the corporate citizenship, that is the ***social, technological, economical, political, and ecological (STEPE)*** responsibility of the enterprise concerning its internal (its people) and external (upstream and downstream) partners, and community. Therefore, total quality management goes well beyond satisfying the customer, or merely offering quality products (goods and/or services). Note that we use the term consumer or end customer. The reason is that in a Supply Chain Management approach, we do not have to satisfy our customers' needs but the needs of our customers' customers' all the way to the end customer, the consumer of a product and/or service.

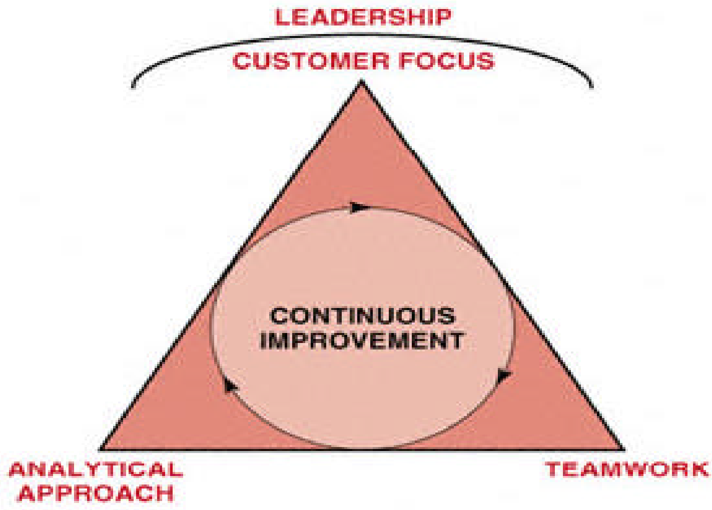


Figure 35.1: Kodak's Five Quality Principles

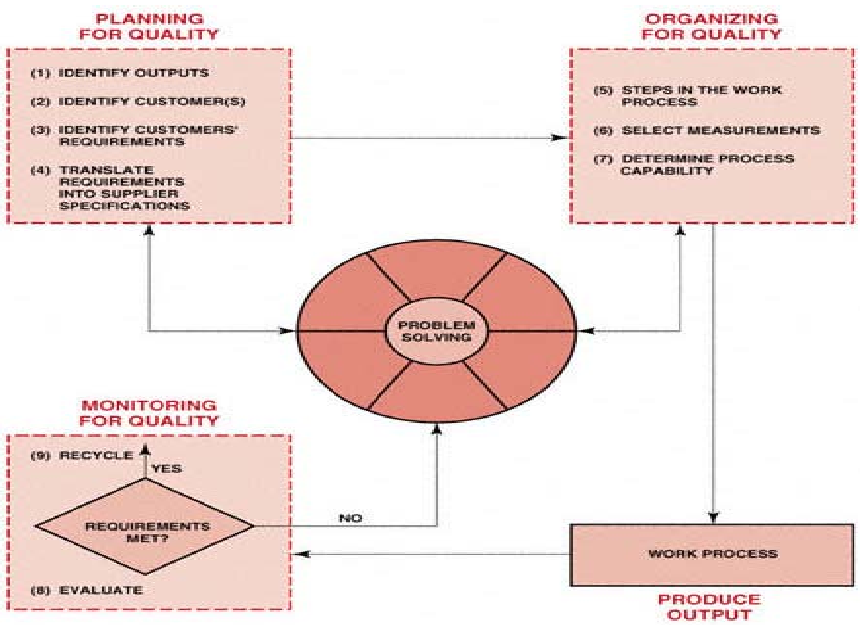


Figure 35.2: The Quality Improvement Process

These two figures (35.1 and 35.2) seem to illustrate that organizations are placing more emphasis on the quality process than on the quality product and, therefore, are actively pursuing quality improvements through a continuous cycle.

35.3 QUALITY AUDIT:

A quality audit is an independent evaluation performed by qualified personnel that ensures that the project is conforming to the project's quality requirements and is following the established quality procedures and policies.

A good quality audit will ensure that:

- The planned quality for the project will be met.
- The products are safe and fit for use.
- All pertinent laws and regulations are followed.
- Data collection and distribution systems are accurate and adequate.

- Proper corrective action is taken when required.
- Improvement opportunities are identified.

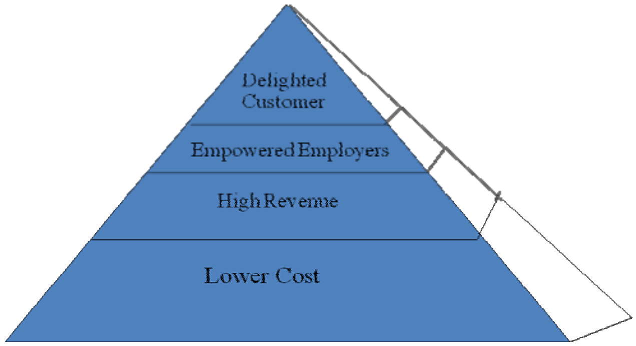


Figure 35.3: The Result of Total Quality

35.4 DEMING'S PHILOSOPHY:

Deming postulated that 85 percent of all quality problems required management to take the initiative and change the process. Only 15 percent of the quality problems could be controlled by the workers on the floor. As an example, the workers on the floor were not at fault because of the poor quality of raw materials that resulted from management's decision to seek out the lowest cost suppliers. Management had to change the purchasing policies and procedures. Management had to develop long-term relationships with vendors.

- Dr. Deming's Dreadful Diseases:

1. Looking elsewhere for examples, or concluding that "our problems are different.
2. "Creative accounting" rather than "commitment"
3. Purchasing to an "acceptable level of quality.
4. Management's failure to delegate responsibility.
5. That employees cause all the problems.
6. Quality can be "assured by inspection".
7. False starts: no organization-wide commitment.

Although many experts have contributed to the success of the quality movement; the three most influential contributors in this country and internationally are W. Edwards Deming, Joseph M. Juran, and Phillip B. Crosby. Dr. Deming pioneered the use of statistics and sampling methods from 1927 to 1940 at the U.S. Department of agriculture. Dr. Deming applied Dr. Shewhart's Plan/Do/Check/Act cycle to clerical tasks. Figure 35.4 shows the Deming Cycle for Improvement.

Deming contended that workers simply cannot do their best. They had to be shown what constitutes acceptable quality and that continuous improvement is not only possible, but necessary. For this to be accomplished, workers had to be trained in the use of statistical process control charts. Realizing that even training required management's approval, Deming's lectures became more and more focused toward management and what they must do.

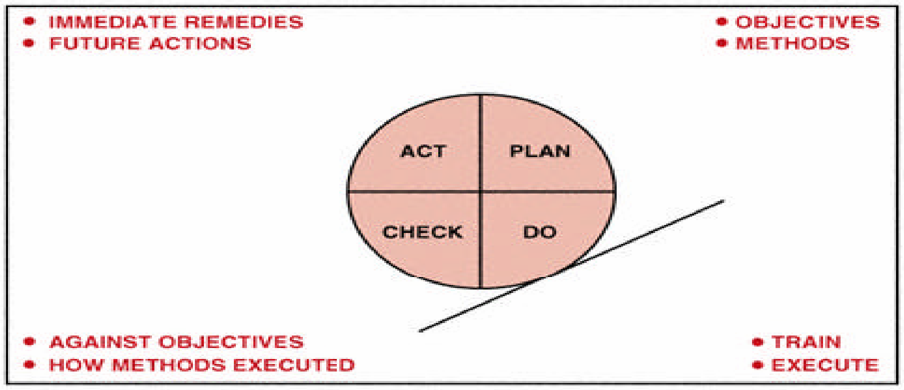


Figure 35.4: **The Deming Cycle for Improvement**

Conventional Wisdom	Deming's Approach
Quality is meeting conformance standards.	Quality is meeting & exceeding customer expectation.
Quality is an intangible good.	Quality is defined by the customer.
Finding and Fixing problems results in improvements, which may or may not be sustainable.	Making changes to the system to prevent problems results in sustainable improvements.
Effectiveness & efficiency are achieved by meeting acceptable defect levels.	Effectiveness & efficiency are achieved by continually improving.
Crisis management is the dominant management mode.	Preventative management.
Performance standards & quotas improve productivity.	Changes in the process improve productivity.
Decisions are made by "superiors."	Decisions are made through collaboration between staff & management.

Table 35.1

PRINCIPLES OF TOTAL QUALITY

BROAD CONTENTS

Definitions of Total Quality
Total Quality Practices
Principles of Total Quality
Scope of Total Quality Management (TQM)
Empowerment
Cost of Quality

36.1 DEFINITIONS OF TOTAL QUALITY:

1. According to Crosby:
   - Quality is not only free, it is profit maker
   - Increase of 5% -10% in profitability by concentrating on quality
   - Quality provides a lot of money for free

2. PandG Total Quality Management (TQM) Definition:

   Total Quality is the unyielding and continually improving effort by everyone is an organization to understand, meet, and exceed the expectations of customers**.**

3. A V. Feigenbaum:

   As already discussed in lecture 34, A V. Feigenbaum introduced comprehensive approach to quality in 50s by virtue of which, quality of products and services were influenced by the following 9Ms*:*
   - *Market*
   - *Money*
   - *Material*
   - *Management*
   - *Machines*
   - *Men/Women*
   - *Motivation*
   - *Mechanizations*
   - *Modern Information Methods*
   - *Mounting Products Requirements*

As already discussed in the previous lecture, total quality is a people-focused management system that aims at continual increase in customer satisfaction at continually lower real cost. Not a separate area or program.

- Integral part of high-level strategy
- Works horizontally across functions and departments
- Involves all employees, top to bottom
- Extends backward and forward to include “supply chain and customer chain”

36.2 TOTAL QUALITY PRACTICES:

It includes the following:

- Encouraging openness

- Creating climates of trust and eliminate fear
- Listening and providing feedback
- Leading and participating in group meetings
- Solving problems with data
- Clarifying goals and resolving conflicts
- Delegating and coaching
- Implementing change
- Making continuous improvement a way of life

36.3 PRINCIPLES OF TOTAL QUALITY:

There are three basic principles of total quality. These are as follows:

- Customer Focus
- Participation and Team work
- Continuous improvement (CI) and learning

36.4 SCOPE OF TOTAL QUALITY MANAGEMENT:

The figure 36.1 below depicts the scope of Total Quality Management (TQM). It is explained in the ensuing paragraphs.

Figure 36.1: Scope of Total Quality Management (TQM)

Infrastructure: Basic management system necessary to function as a high performing organization.

Practices: Activities that occurs within a management system to achieve high performance objectives.

Tools: A wide variety of graphical and statistical methods to plan work activities, collect data analyze results, monitor progress, and solve problems.

36.5 EMPOWERMENT:

Empowerment means that managers must relinquish some of power that they previously held. Power shift creates management fears that workers will abuse this privilege.

Employees have authority and responsibility to make things happen. No one can be best at everything. But when all of us combine our talents, we can be best at virtually anything. Everyone in organization is "captain of his game". He thinks of his work unit as his "own business", and perceives that his "work unit" is key part of "corporate enterprise". It builds "confidence in workers" by showing them that company has confidence in them "to make decision" on their own. Empowerment can be viewed as vertical teamwork between managerial and non-managerial personnel. People can be trusted to make important decisions about management of their work activities. When people make decisions about management of their work, its result is greater organizational effectiveness.

As a whole participation and empowerment assumes that employees are willing to improve their "daily work process" and "relationships". Employee participation is essential active, enthusiastic participation by employees essential to success of performance improvement initiative.

Workers know what goes wrong and where hurdle in their processes. If given targets and support they are best to develop creative and effective ideas for "positive change".

Problem for many project based organization reduction of "bureaucratic red tape" "that prevents employees from seizing the initiative.

36.5.1 Participative Management:

Participative organizations are those that give:

- Information
- Knowledge
- Power
- Rewards to all employees so that everyone can be involved in organization's performance Participative management. It is essential basis for empowered workforce. Put "everybody's intellect" to work good thinking is not solely province of managers. Different points of view can help shape better decision.

Participative management require that "responsibility and accountability" takes to lowest possible level empowerment- for three eyes only creation of "corporate" spirit of participation required that workforce have information, involvement and influence.

Participative management does not imply abrogation by management of its responsibility it does imply workforce involvement in decision making process, but final decision on corporate matters remains responsibility of manager.

When empowered employees become convinced that their duty is to their "process" not to their "boss", wonderful things begin to happen. Teams shoulder responsibility for their "process", and new, more "cooperative style" of work evolves.

Empowerment encourages "innovation" because employees have authority to "try out" new ideas and make decisions that result in new ways of doing things. Access to information when employees are given access to information their willingness to cooperation and to use empowerment is enhanced.

Due to this "Accessibility", Teams "Manage and Control Opportunity" More Effectively Than under old "Hierarchical Rules and Structure" where access to info provided on A Need to Know Basis".

36.5.2 Accountability:

Employees empowered to make decision, yet also held accountable for results. Accountability is not to punish person or to generate immediate, short term results.

Intent is to ensure that empowered employees are:

Giving their best efforts

a) Working toward "agreed-upon goals"
b) Behaving responsibly toward each other

36.5.3 Empowerment – Some Key Principles:

- People are valuable resource because they have "knowledge and ideas".
- People want to participate.
- When people participate, they feel empowered; they think like owners.
- When people participate, they look for ways to improved opportunities.
- When people have importance into "corporate and department decisions", better solutions are developed.
- People should be treated fairly and with respect.

Organizations should make long term commitment for development of people because it makes them valuable to organization. People can develop knowledge to make important decision about management of their work activities.

36.5.4 Six Ways of Empowering Employees for Quality Improvement in Projects:

1. Involve employees in developing strategies for continuous improvement.
2. Provide employees with skills required solving problems and making decisions.
3. Define involvement and empowerment based on mission of organization.
4. Establish organizational and individual goals.
5. Establish customer-driven performance measurement at individual level.
6. Involve and empower everyone to focus on continuous improvement.

Successful empowerment of employees requires:

- Employees should be provided with:
    - Education
    - Resources
    - Encouragement
- Policies and procedures should be examined for needless restrictions.
- Atmosphere of trust should be fostered rather than resentment and punishment for failure.
- Information should be shared "freely" rather than "closely guarded" as "source of control and power".

36.6 COST OF QUALITY:

To verify that a product or service meets the customer's requirements requires the measurement of the cost of quality. For simplicity's sake, the costs can be classified as "the cost of conformance" and "the cost of nonconformance." Conformance costs include items such as training, indoctrination, verification, validation, testing, maintenance, calibration, and audits. Nonconforming costs include items such as scrap, rework, warranty repairs, product recalls, and complaint handling.

Trying to save a few project dollars by reducing conformance costs could prove disastrous. For example, an American company won a contract as a supplier of Japanese parts. The initial contract called for the delivery of 10,000 parts. During inspection and testing at the customer's (that is, Japanese) facility, two rejects were discovered. The Japanese returned all 10,000 components to the American supplier stating that this batch was not acceptable. In this example, the nonconformance cost could easily be an order of magnitude greater than the conformance cost. The moral is clear:

Feigenbaum divided cost of quality into two categories and four sub categories:

- *Costs of Control*
  - Prevention costs
  - Appraisal costs

- *Costs of Failure of Control*
  - Internal defect costs
  - External defect costs

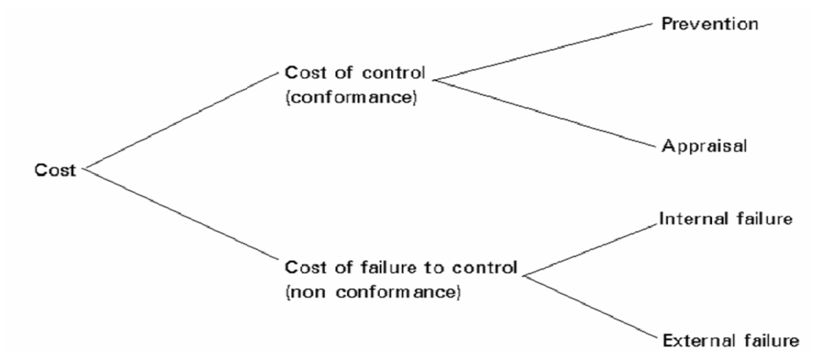


Figure 36.2: **Cost of Quality**

- **Prevention costs** are the up-front costs oriented toward the satisfaction of customer's requirements with the first and all succeeding units of product produced without defects. Included in this are typically such costs as design review, training, quality planning, surveys of vendors, suppliers, and subcontractors, process studies, and related preventive activities.

- **Appraisal costs** are costs associated with evaluation of product or process to ascertain how well all of the requirements of the customer have been met. Included in this are typically such costs as inspection of product, lab test, vendor control, in-process testing, and internal–external design reviews.

- **Internal failure costs** are those costs associated with the failure of the processes to make products acceptable to the customer, before leaving the control of the organization. Included in this area are scrap, rework, repair, downtime, defect evaluation, evaluation of scrap, and corrective actions for these internal failures.

- **External failure costs** are those costs associated with the determination by the customer that his requirements have not been satisfied. Included are customer returns and allowances, evaluation of customer complaints, inspection at the customer, and customer visits to resolve quality complaints and necessary corrective action.

Prevention costs are expected to actually rise as more time is spent in prevention activities throughout the organization. As processes improve over the long run, appraisal costs will go down as the need to inspect in quality decreases. The biggest savings will come from the internal failure areas of rework, scrap, reengineering, redo, etc. The additional time spent in up-front design and development will really pay off here. And, finally, the external costs will also come down as processes yield first-time quality on a regular basis. The improvements will continue to affect the company on a long-term basis in both improved quality and lower costs. Also, as project management begins to mature, there should be further decreases in the cost of both maintaining quality and developing products.

Prevention costs actually decrease without sacrificing the purpose of prevention if we can identify and eliminate the costs associated with waste, such as waste due to:

- Rejects of completed work
- Design flaws
- Work in progress
- Improperly instructed manpower
- Excess or noncontributing management (who still charge time to the project)
- Improperly assigned manpower
- Improper utilization of facilities
- Excessive expenses that do not necessarily contribute to the project (that is, unnecessary meetings, travel, lodgings, etc.)

Cost of Quality

Prevention	Appraisal
1. Quality planning	1. Test and inspection of incoming material
2. Process control	2. Lab-based acceptance sampling
3. Data acquisition and analysis	3. In-line inspection and testing
4. Training and personnel development	4. Setup for test and inspection
5. Design verification	5. Test/inspection equipment and supplies
6. Quality system development and management	6. Quality audits
7. Quality reporting	7. Quality endorsements (ISO etc.)
8. Improvement projects	8. Field testing
	9. Test/inspection equipment maintenance

Cost of Quality

Internal	External
1. Scrap	1. Customer Complaints
2. Rework	2. Warranty Costs
3. Retest	3. Service and Repair Expense
4. Downtown	4. Product Liability
5. Yield Losses	5. Recall Expense and Management
6. Disposition	6. Returned Material Processing
7. Engineering Analysis	7. Credit Allowance
8. Tracking and Reporting	8. Loss of Goodwill
9. Expediting	

Table 36.1: Cost of Quality

CUSTOMER FOCUSED PROJECT MANAGEMENT

BROAD CONTENTS

Who is customer?
Key Goals for Businesses
Type of customers
Customer Driven Project Organizations
Customer identification
Kano Model
Customer Satisfaction Measurement
CRM (Customer Relationship Management)
Gathering Customer Information
Four Steps to Quality Customer Service

37.1 Who is a customer in any project?

World class projects and organizations are obsessed with meeting and exceeding customer expectations. Firms should learn to have "customer focused projects", often in response to competitive crises. Customers in any project refer to:

1. Any individual or group that receives and must be satisfied with the work product or output of a process.
2. Individual or group whose request a process is intended to fulfill.
3. Anyone who is impacted by the product or process.

Looking at your project organization from you customers' point of view and "improving processes" to enable you to meet and exceed your customers' expectations is the only way to achieve quality.

It important to meet customer expectations as it is the prime responsibility of every organization to meet the needs of its customers. Understanding of one's customers leads to customer satisfaction. Japanese relate quality to customer satisfaction.

Figure 37.1: Importance of Customer Satisfaction (CS) in Project Management

37.2 Key goals for businesses:

Following are the four key goals for any business:

1. Satisfy customers
2. Achieve higher customer satisfaction than competitors
3. Retain customers in long run
4. Gain market share

To achieve aims and goals, a business must deliver ever-improving value to its customers. Value refers to "quality related to price". It is important as consumers no longer buy solely on the basis of price.

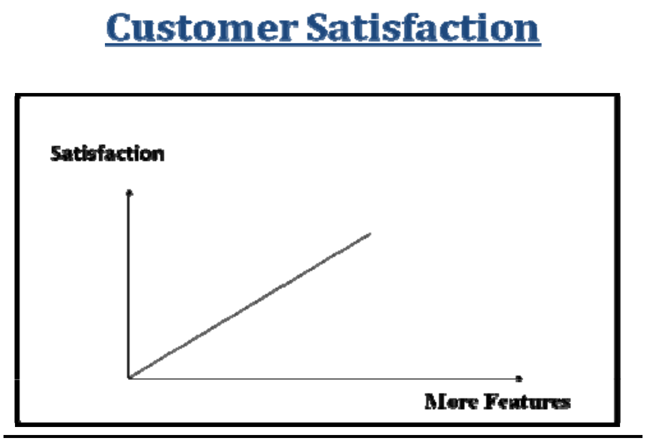


Figure 37.2: Customer Satisfaction

37.3 Types of Customers:

- ***Primary:***

  "Direct receiver of output of the process" (bank loan seeker, lab test report receiver). It is the source of product and process requirement.
- ***Secondary:***

  Secondary customers are from "outside of process" boundaries, who also receive any process output, but not reason for "process' existence" (bank's head office receiver secondary output)
- ***Indirect:***

  When original boundaries do not receive process output directly but are affected if process output is incorrect or late (logistic department)
- ***External Customers:***

  Those who are located outside the organizational boundaries, receive end product or service but is not the actual user. (Power supplier for computers manufacturing, distributors)
- ***Consumer End User:***

  This refers to the final user of the product. Sometimes the external customers and consumers are the same.
- ***Intermediary:***

  In between producer and end user (Transporter).

- ***False:***

  When a process that performs activities that do not add value to product or service. Inspectors doing 100 % inspection. It needs to be eliminated.

- ***Internal:***

  Next person to whom product passed on for further processing. His requests must be met, but not at cost of external customers.

37.4 Customer-Driven Project Organizations:

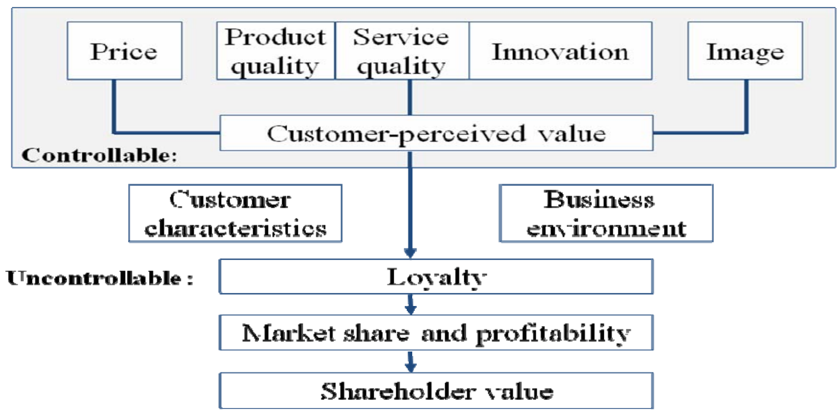


Figure 37.3: **Customer Value Package**

If competitors offer better choices for similar price, consumers naturally select package with highest "perceived quality".

37.5 Customer Identification:

37.5.1 Fundamental Questions in Identifying Customers:

Identifying customers begins with asking some fundamental questions:

- What products/services are produced?
- Who uses products/ services?
- Do employees call/ write to/ answer questions for?
- Supplies inputs

37.5.2 Importance of Identifying Customer Types:

Every customer type, source of product, product requirements must be identified and process effectiveness must be measured.

Information on what satisfies customer, and what improvements are necessary. It comes from lost, prospective, and competitors' customer, who provide useful insights.

37.6 Kano Model:

The Kano Model of Customer (Consumer) Satisfaction classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction. These classifications are useful for guiding design decisions in that they indicate when good is good enough, and when more is better.

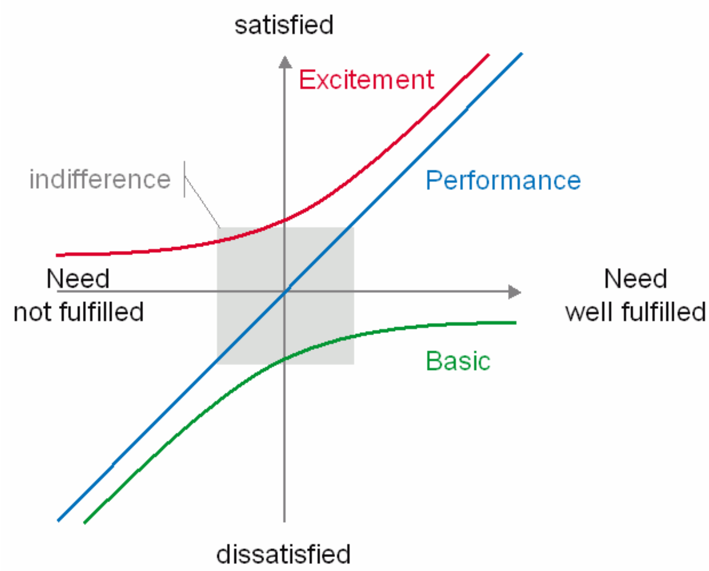


Figure 37.4: Analyzing Customer Satisfaction Data – Kano Model

Project activities in which the Kano Model is useful:

1. Identifying customer needs
2. Determining functional requirements
3. Concept development
4. Analysing competitive products

Other tools that are useful in conjunction with the Kano Model:

1. Eliciting Customer Input
2. Prioritisation Matrices
3. Quality Function Deployment
4. Value Analysis

Introduction

The Kano Model of Customer satisfaction (Figure 37.4) divides product attributes into three categories: threshold, performance, and excitement. A competitive product meets basic attributes, maximises performances attributes, and includes as many "excitement" attributes as possible at a cost the market can bear.

Threshold Attributes

Threshold (or basic) attributes are the expected attributes or "musts" of a product, and do not provide an opportunity for product differentiation. Increasing the performance of these attributes provides diminishing returns in terms of customer satisfaction; however the absence or poor performance of these attributes results in extreme customer dissatisfaction. An example of a threshold attribute would be brakes on a car.

Kano Model Analysis

Threshold attributes are not typically captured in QFDs (Quality Function Deployment) or other evaluation tools as products are not rated on the degree to which a threshold attribute is met, the attribute is either satisfied or not.

Performance Attributes

Performance attributes are those for which more is generally better, and will improve customer satisfaction. Conversely, an absent or weak performance attribute reduces customer satisfaction. Of the needs customers verbalise, most will fall into the category of performance attributes. These attributes will form the weighted needs against which product concepts will be evaluated. The price for which customer is willing to pay for a product is closely tied to performance attributes. For example, customers would be willing to pay more for a car that provides them with better fuel economy.

Excitement Attributes

Excitement attributes are unspoken and unexpected by customers but can result in high levels of customer satisfaction, however their absence does not lead to dissatisfaction. Excitement attributes often satisfy latent needs – real needs of which customers are currently unaware. In a competitive marketplace where manufacturers' products provide similar performance, providing excitement attributes that address "unknown needs" can provide a competitive advantage. Although they have followed the typical evolution to a performance then a threshold attribute, cup holders were initially excitement attributes.

Other Attributes

Products often have attributes that cannot be classified according to the Kano Model. These attributes are often of little or no consequence to the customer, and do not factor into consumer decisions. An example of this type of attribute is a plate listing part numbers can be found under the hood on many vehicles for use by repairpersons.

Application of the Kano Model Analysis

A relatively simple approach to applying the Kano Model Analysis is to ask customers two simple questions for each attribute:
1. Rate your satisfaction if the product has this attribute?; and
2. Rate your satisfaction if the product did not have this attribute?

Kano Model Analysis

Customers should be asked to answer with one of the following responses:
A) Satisfied;
B) Neutral (Its normally that way);
C) Dissatisfied;
D) Don't care.

Basic attributes generally receive the "Neutral" response to Question 1 and the "Dissatisfied" response to Question 2. Exclusion of these attributes in the product has the potential to severely impact the success of the product in the marketplace.

- Eliminate or include performance or excitement attributes that their presence or absence respectively lead to customer dissatisfaction. This often requires a trade-off analysis against cost. As Customers frequently rate most attributes or functionality as important, asking the question "How much extra would you be willing to pay for this attribute or more of this attribute?" will aid in trade-off decisions, especially for performance attributes. Prioritisation matrices can be useful in determining which excitement attributes would provide the greatest returns on Customer satisfaction.
- Consideration should be given to attributes receiving a "Don't care" response as they will not increase customer satisfaction nor motivate the customer to pay an increased price for the product. However, do not immediately dismiss these attributes if they play a critical role to the product functionality or are necessary for other reasons than to satisfy the customer. The

information obtained from the Kano Model Analysis, specifically regarding performance and excitement attributes, provides valuable input for the Quality Function Deployment process.

37.7 CUSTOMER SATISFACTION MEASUREMENT:

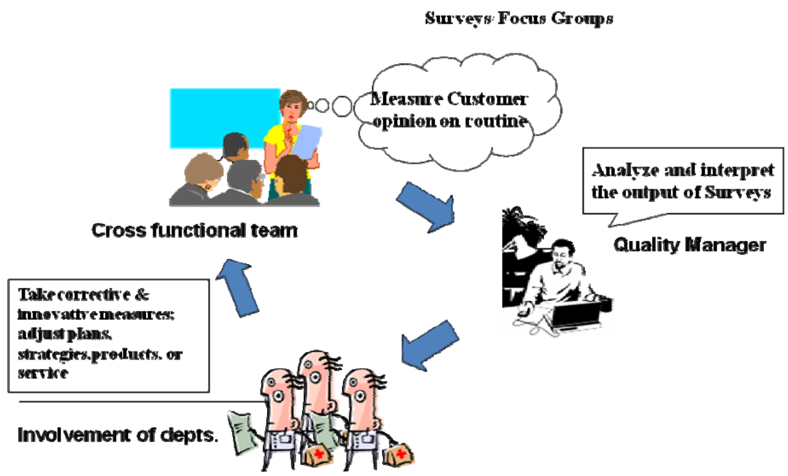


Figure 37.5: Measuring Customer Satisfaction Levels

37.7.1 Methods of Customer Retention:

Following are the methods for retaining customers:

- Establish honest relationship and empathize
- Reward loyalty (airline's frequent flyer)
- Reward usage (Coupons, credit points, preferential treatment)
- Provide unpaid service (free product targets, after sales service)

37.7.2 Seven Steps to Customer Satisfaction System:

- Step 1: Total management commitment
- Step 2: Get to know your customers
- Step 3: Develop "performance and process standards" of service quality
- Step 4: Hire, train, and compensate good staff
- Step 5: Reward service accomplishments
- Step 6: Stay close to your customers
- Step 7: Work towards continuous improvement in "service quality performance

37.7.3 Customer Defections:

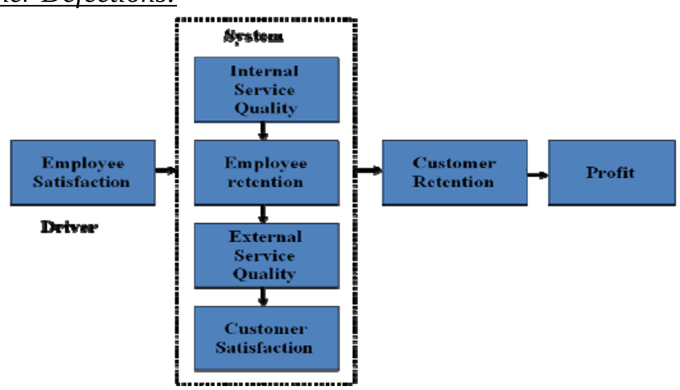


Figure 37.6: Customer Retention and Profitability

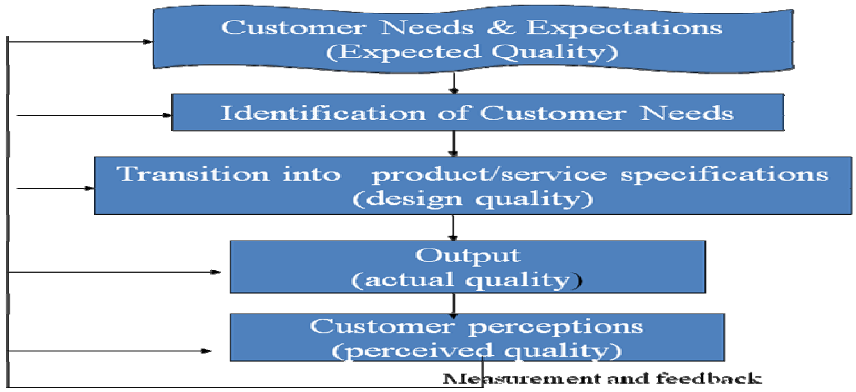


Figure 37.7: Customer Driven Quality Cycle

1. Leading practices for *profitability and market share* must understand linkages between voice of customer and design, production, and delivery processes.
2. Ensures that no critical requirements fall through cracks and minimizes potential gaps between expected quality and actual quality.
3. Make commitment to customer that promotes trust and confidence in products and services.
4. Must have effective Customer Relationship Management (CRM)" processes by which customer can easily seek assistance, comment, complain and receive prompt resolution of their concerns.

37.7.4 Must measure Customer Satisfaction:

1. Compare results relative to competitors
2. Use information to evaluate
3. Improve internal processes

37.7.5 Methods of Measuring Customer Satisfaction:

There are the following two methods of measuring customer satisfaction:

1. Quality Dimension Development
2. Generate Critical Incidents

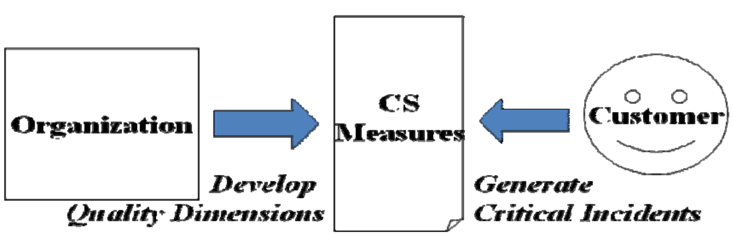


Figure 37.8: Methods of Measuring Customer Satisfaction

37.7.5.1Quality Dimensions Development Method:

Step 1: Creating list of quality dimensions (Table 37.1):

a) Read professional literature and enlist quality dimensions
b) Generate list from personal experience

Step 2: Write definitions of each dimensions:

a) Definition can be in general terms

Step 3: Develop specific examples for each quality dimension:

a) Examples: Specific-reflecting service or product
b) Examples: Specific behaviors of providers
c) Declarative statements

Product Quality Dimensions	Service Quality Dimensions
• Basic Functions	• Truthfulness
• Features	• Respectfulness
• Reliability	• Responsiveness
• Conformance	• Reliability
• Durability	• Competence
• Serviceability	• Communication
• Aesthetics	• Courtesy
• Perceived Quality	• Access
	• Credibility
	• Confidentiality/security
	• Empathy
	• Tangibles

Table 37.1: Quality Dimensions

37.7.5.2Five Key Dimensions of Service Quality:

1. **Reliability:**
   - Ability to provide what was promised, dependably and accurately.
   - Customer service representatives respond in promised time.
   - Following customer instructions.
   - Providing error free invoices and statements.
   - Making repairs correctly first time.
   - Assurance: Knowledge and courtesy of employees.
   - Their ability to convey "trust and confidence".
   - Ability to answer questions.
   - Having capabilities to do necessary work.
   - Monitoring credit card transactions to avoid possible fraud.
   - Being polite and pleasant during customer transactions.

2. **Tangibles:**
   - Physical facilities
   - Equipment and appearance of persons include:
     - Attractive facilities
     - Appropriately dressed employees
     - Well designed forms that are easy to read and interpret

3. **Empathy:**
   - Degree of Caring and include attention provided to customer
   - Explaining "Tech Jargon" in: layman's language
   - Recognizing regular customers by name

4. **Responsiveness:**
   - Willingness to help customer and provide prompt service. For example:
     - Acting quickly to resolve problems
     - Promptly crediting returned merchandise
     - Rapidly replacing defective products

Quality Dimension	Manufactured Product (stereo Amplifier)	Service Product (Checking Account)
Performance	Signal-to-noise ratio; power	Time to process customer requests
Features	Remote Control	Automatic Bill Paying
Conformance	Workmanship	Accuracy
Reliability	Mean time to failure	Variability of time to process requests
Durability	Useful Life	Keeping pace with industry trends
Serviceability	Ease of Repair	Resolution of errors
Aesthetics	Oak Cabinet	Appearance of bank lobby

Table 37.2: Quality Dimensions of a Manufactured Product and Service

5. **Timeliness of Support:**
   - They completed the job when expected
   - They met my deadlines
   - They finished their responsibilities within stated time frame
   - The project was completed on time

6. **Responsiveness of Support:**
   - They were quick to respond when I asked for help
   - They immediately helped me when I needed help
   - I waited a short period of time to get help after I asked for it

37.8 Customer Relationship Management (CRM):

Customer Relationship Management (CRM) includes attention to:

- Target and developing customer contact employees.
- Empowering them to do whatever is necessary to satisfy customers.

37.9 Gathering Customer Information:

- **Customer requirements called "voice of customer":**

  There are a variety of methods to "listen" to the Voice of Customer. To do it effectively, information needs to be collected about the customer like:

  a) Needs and expectations
  b) Importance
  c) Satisfaction with company's performance

37.10 Four Steps to Quality Customer Service:

There are the following four steps to quality customer service:

Step 1: Send positive attitude:

- Product Knowledge / command
- Appearance (dress, quality, cleanliness, orderliness, etc)
- Body language (head, arms facial, smile, body movement, eye contact)
- Sound of your voice (tone and how you say it)
  - Face to face
  - On telephone (telephone skills)
- Staying energized
- Empathize (concern for customer's benefits)

Step 2: Identify needs of your customers, guests, clients

a) Human Needs: (welcomed, respected, comfortable, orderly, understood, helped, important, appreciated, recognized)
b) Timing Needs: (hold time on telephone, waiting in office, letter response, return calls, appropriate time to meet, width and depth of product/service needs)
c) Location Needs:
d) Product Needs: (stated, unstated, basic, delighter)
e) Create an environment to listen
f) Careful Listening and Understanding
g) Feedback / Evaluation

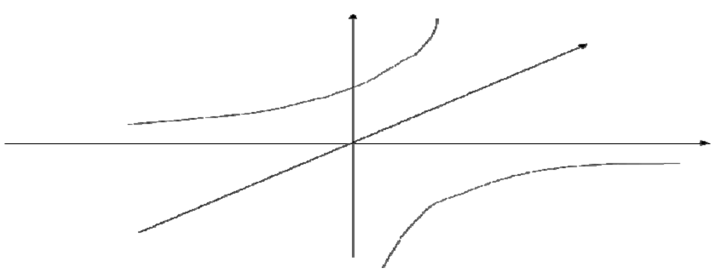


Figure 37.9: Use of Kano Model to Identify Must-be, Delighters and One Dimensional Qualities

Step 3: Provide for needs of your customers, guests, clients

- Are you ready to fulfill the human, timing, location, and product needs of the customer?
- Are you capable to fulfill the human, timing, location, and product needs of the customer?
- Do you have the required product / service to meet the needs of the customer?
- Have you actually fulfilled the human, timing, location, and product needs of the customer?

Step 4: Make sure your customers, clients, guests return to you

- Make sure you delivered both the procedures and the personal
- Be sensitive to check your performance by the outcomes before, during and after the service delivery
- Handling complaint for cases of gaps, customers will complain (within themselves, gestures, light words, strong words, strong reactions).
  - Listen to their stated and non-stated complains carefully

- o Empathize
- o Repeat and confirm whether you understood clearly
- o Apologize genuinely
- o Acknowledge sympathy
- o Correct the situation
- o Identify root-causes and prevent recurrence

- Types of difficult customers with whom you have to deal nicely
  - o Angry
  - o Nasty or Obnoxious
  - o Demanding
  - o Constant Critic
  - o Non-Stop Talker
  - o Indecisive
  - o Intoxicated
  - o Argumentative
- They are usually difficult for their own reasons - not because of you

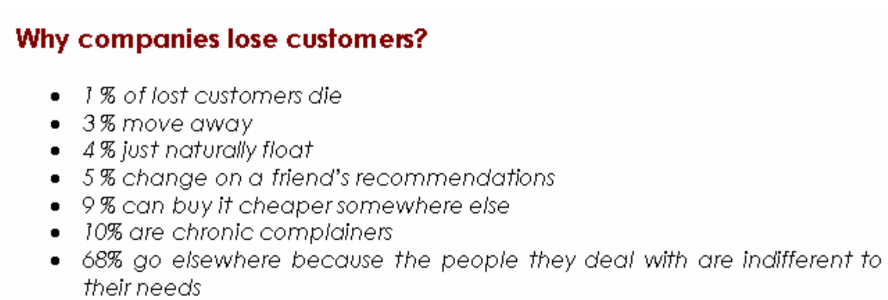


Figure 37.10: ***Why Companies Lose Customers?***

- **Reasons Why Customers are Difficult:**
  - o Negative experience
  - o Frustrated
  - o Confused
  - o Satisfy their ego or self-esteem
  - o Ignored
  - o Treated poorly
  - o In bad mood

- **Get Difficult Customers on Your Side:**
  - o Do not take it personally, hold on to your confidence
  - o Remain calm; listen carefully
  - o Do not just protect yourself or your company, share his/her grievance
  - o Focus on the problem, not the person
  - o Turn the difficult one into a satisfied, consider it an accomplishments

- **Take an extra step - surprise the customer. For example:**
  - o Ticket agent: would you like me to select a seat for your return flight now?
  - o Salesperson: I will deliver it personally this afternoon
  - o Nurse: Since you are awake, let me give you a drink
  - o Waiter: may I bring extra glass of coffee
  - o Hotel desk clerk: may I call a cab for you
  - o Mechanic: since car will take long, may I give you a newspaper
  - o Grocer: may I give you help to carry your goods
  - o Bank Cashier: may I give you brand new notes

Re-engineer your Customer Satisfaction into Quality Customer Satisfaction:

- Customer Satisfaction Vision and Policy
- Customer Satisfaction Training
- Customer Satisfaction Personality Grooming and Development
- Customer Satisfaction Systems and Procedures
- Customer Satisfaction Consistency
- Customer Satisfaction Measurement (e.g. customer retention rate)
- Develop and regularize Customer Satisfaction Delighters

1. Determine Questions:

- Be Concise, Precise
- Be Direct
- Discard Superfluous Words
- Be Unambiguous

Examples: How are these questions?

- The SDO was good
- The bank manager listened to me and took a short time to handle my complaint
- The SDO was not available when he was needed
- The SDO was available when he was needed
- **The staff was courteous**

2. Response Format:

a) Checklist Format (yes/no)
b) Liker-type (1-5 scale)

1	2	3	4	5
Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Very Dissatisfied	Dissatisfied	Neither satisfied nor dissatisfied	Satisfied	Very Satisfied
Very Poor	Poor	Neither Poor nor Good	Good	Very Good

Table 37.3: Liker Scale

"Introduction" to Questionnaires:

For example: "To better serve you, we would like to know your opinion of the quality of our service at XYZ Company. You recently received service from our company. Please indicate the extent to which you agree or disagree with the following statements about the service you received from the staff. Circle the appropriate number using the scale below.

1, 2, 3, 4, 5

Finally, select appropriate questions; ensure critical customer requirements are addressed properly.

Sampling

Some of the common sampling techniques used are briefly defined below:

1. Census

- To gather information from all of customers (sample is the total population) for example, doctors response by drug manufacturers.

2. Judgmental Sampling

- Use judgment in the selection of customers.

3. Statistical Sampling

- Select sample based on statistical probability (rely on chance). It becomes easy to generalize, if not biased.

LESSON 38

QUALITY IMPROVEMENT TOOLS

BROAD CONTENTS

Seven Basic Tools of Statistical Process Control

38.1 Seven Basic Tools of Statistical Process Control (SPC):

They are as follows:
1. Data Tables
2. Cause-and Effect Analysis
3. Histograms
4. Pareto Analysis
5. Scatter Diagrams
6. Trend Analysis
7. Process Control Charts

Quality Improvement Tools:

Over the years, statistical methods have become prevalent throughout business, industry, and science. With the availability of advanced, automated systems that collect, tabulate, and analyze data; the practical application of these quantitative methods continues to grow. Statistics today plays a major role in all phases of modern business.

More important than the quantitative methods themselves is their impact on the basic philosophy of business. The statistical point of view takes decision making out of the subjective autocratic decision-making arena by providing the basis for objective decisions based on quantifiable facts.

This change provides some very specific benefits:

- Improved process information
- Better communication
- Discussion based on facts
- Consensus for action
- Information for process changes

Statistical Process Control (SPC) takes advantage of the natural characteristics of any process. All business activities can be described as specific processes with known tolerances and measurable variances. The measurement of these variances and the resulting information provide the basis for continuous process improvement. The tools presented here provide both a graphical and measured representation of process data. The systematic application of these tools empowers business people to control products and processes to become world-class competitors.

The basic tools of statistical process control are data figures, Pareto analysis, cause-and-effect analysis, trend analysis, histograms, scatter diagrams, and process control charts. These basic tools provide for the efficient collection of data, identification of patterns in the data, and measurement of variability.

The following Figure 38.1 shows the relationships among these seven tools and their use for the identification and analysis of improvement opportunities. We will review these tools and discuss their implementation and applications.

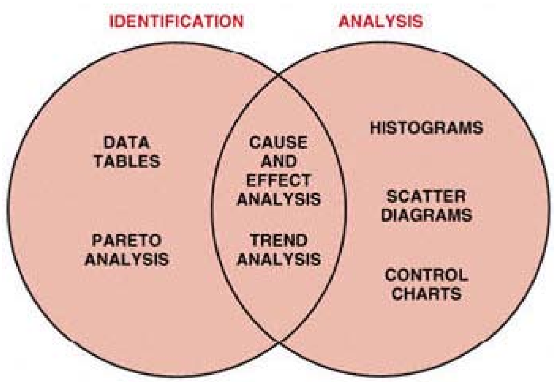


Figure 38.1: Seven Quality Improvement Tools

38.1.1 Data Tables:

Data tables or data arrays provide a systematic method for collecting and displaying data. In most cases, data tables are forms designed for the purpose of collecting specific data. These tables are used most frequently where data is available from automated media. They provide a consistent, effective, and economical approach to gathering data, organizing them for analysis, and displaying them for preliminary review. Data tables sometimes take the form of manual check sheets where automated data are not necessary or available. Data figures and check sheets should be designed to minimize the need for complicated entries. Simple-to-understand, straightforward tables are a key to successful data gathering.

Figure 38.2 is an example of an attribute (pass/fail) data figure for the correctness of invoices. From this simple check sheet several data points become apparent. The total number of defects is 34. The highest number of defects is from supplier A, and the most frequent defect is incorrect test documentation. We can subject this data to further analysis by using Pareto analysis, control charts, and other statistical tools.

In this check sheet, the categories represent defects found during the material receipt and inspection function. The following defect categories provide an explanation of the check sheet:

- *Incorrect invoices:* The invoice does not match the purchase order.
- *Incorrect inventory:* The inventory of the material does not match the invoice.
- *Damaged material:* The material received was damaged and rejected.
- *Incorrect test documentation:* The required supplier test certificate was not received and the material was rejected.

DEFECT	SUPPLIER				
	A	B	C	D	TOTAL
INCORRECT INVOICE	////	/		//	7
INCORRECT INVENTORY	/////	//	/	/	9
DAMAGED MATERIAL	///		//	///	8
INCORRECT TEST DOCUMENTATION	/	///	////	//	10
TOTAL	13	6	7	8	34

Figure 38.2: Check Sheet for "Material Receipt and Inspection"

38.1.2 Cause-and -Effect Analysis (C and EA) "Fishbone":

After identifying a problem, it is necessary to determine its cause. The cause-and-effect relationship is at times obscure. A considerable amount of analysis often is required to determine the specific cause or causes of the problem.

Cause-and-effect analysis uses diagramming techniques to identify the relationship between an effect and its causes. *Cause-and-effect diagrams are also known as **fishbone diagrams***. Figure 38.3 demonstrates the basic fishbone diagram. Six steps are used to perform a cause-and-effect analysis.

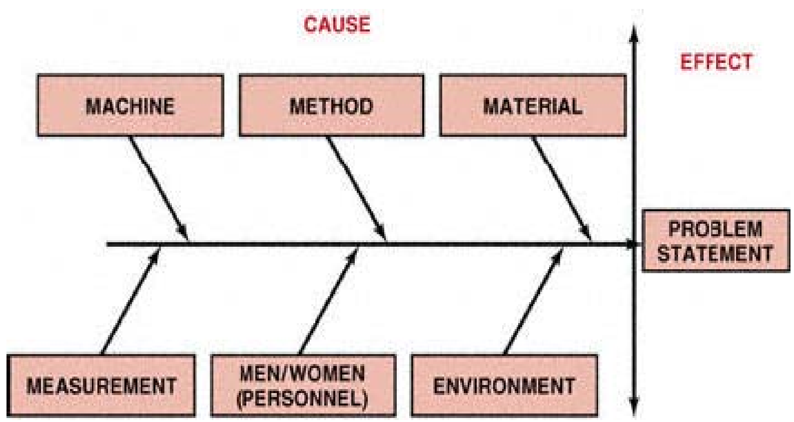


Figure 38.3: Cause-and-Effect Diagram

Step 1 – Identify the problem:
This step often involves the use of other statistical process control tools, such as Pareto analysis, histograms, and control charts, as well as brainstorming. The result is a clear, concise problem statement.

Step 2 – Select interdisciplinary brainstorming team:
Select an interdisciplinary team, based on the technical, analytical, and management knowledge required determining the causes of the problem.

Step 3 – Draw problem box and prime arrow:
The problem contains the problem statement being evaluated for cause and effect. The prime arrow functions as the foundation for their major categories.

Step 4 – Specify major categories:
Identify the major categories contributing to the problem stated in the problem box. The six basic categories for the primary causes of the problems are most frequently

personnel, method, materials, machinery, measurements, and environment, as shown in Figure 38.3. Other categories may be specified, based on the needs of the analysis.

Step 5 – Identify defect causes:

When you have identified the major causes contributing to the problem, you can determine the causes related to each of the major categories. There are three approaches to this analysis: *the random method, the systematic method, and the process analysis method.*

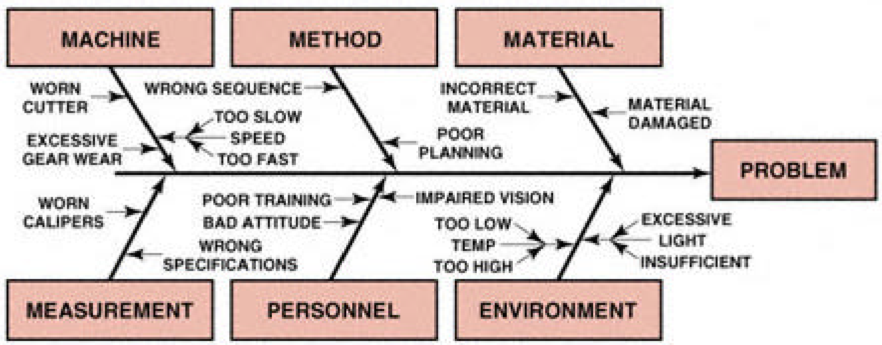


Figure 38.4: Random Method

Random method: List all six major causes contributing to the problem at the same time. Identify the possible causes related to each of the categories, as shown in Figure 38.4.

Systematic method: Focus your analysis on one major category at a time, in descending order of importance. Move to the next most important category only after completing the most important one. This process is diagrammed in Figure 38.5.

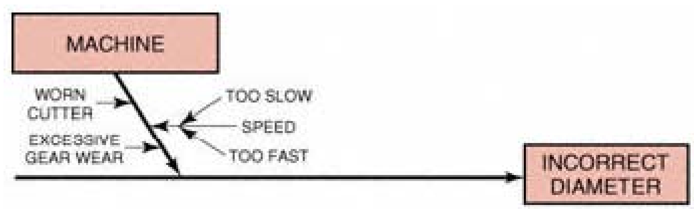


Figure 38.5: Systematic Method

Process analysis method: Identify each sequential step in the process and perform cause-and-effect analysis for each step, one at a time. Figure 38.6 represents this approach.

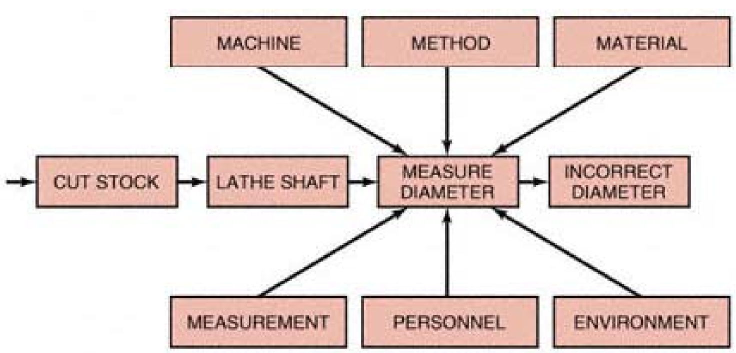


Figure 38.6: Process Analysis Methods

Step 6 – Identify corrective action:

Based on (1) the cause-and-effect analysis of the problem and (2) the determination of causes contributing to each major category, identify corrective action.

The corrective action analysis is performed in the same manner as the cause-and-effect analysis. The cause-and-effect diagram is simply reversed so that the problem box becomes the corrective action box. Figure 38.7 displays the method for identifying corrective action.

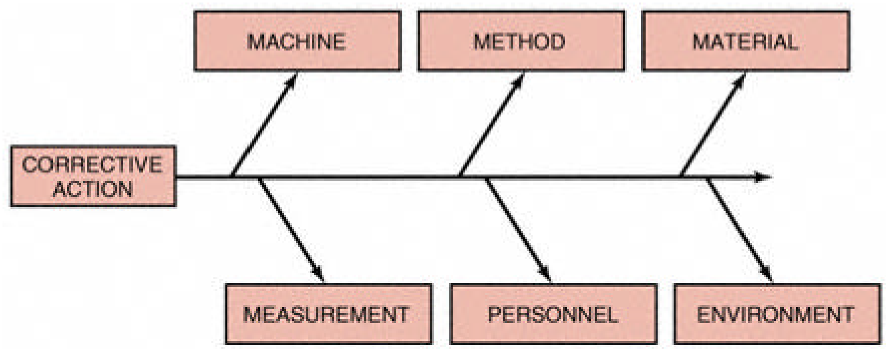


Figure 38.7: Identify Corrective Action

38.1.3 Histogram-(HG):

A histogram is a graphical representation of data as a frequency distribution. This tool is valuable in evaluating both attribute (pass/fail) and variable (measurement) data. Histograms offer a quick look at the data at a single point in time; they do not display variance or trends over time. A histogram displays how the cumulative data looks *today*. It is useful in understanding the relative frequencies (percentages) or frequency (numbers) of the data and how that data are distributed. Figure 38.8 illustrates a histogram of the frequency of defects in a manufacturing process.

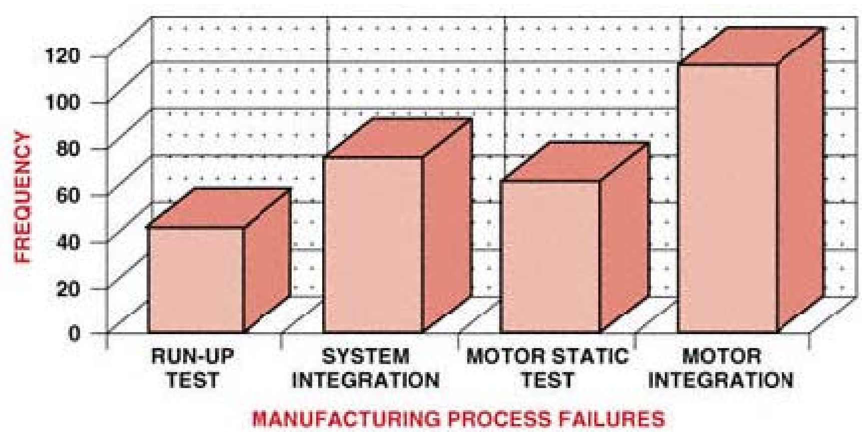


Figure 38.8: Histogram for Variables

38.1.4 Pareto Analysis (PA):

A Pareto diagram is a special type of histogram that helps us to identify and prioritize problem areas. The construction of a Pareto diagram may involve data collected from data figures, maintenance data, repair data, parts scrap rates, or other sources. By identifying types of nonconformity from any of these data sources, the Pareto diagram directs attention to the most frequently occurring element.

There are three uses and types of Pareto analysis:

1. The basic Pareto analysis identifies the vital few contributors that account for most quality problems in any system.
2. The comparative Pareto analysis focuses on any number of program options or actions.
3. The weighted Pareto analysis gives a measure of significance to factors that may not appear significant at first— such additional factors as cost, time, and criticality.

The basic Pareto analysis chart provides an evaluation of the most frequent occurrences for any given data set. By applying the Pareto analysis steps to the material receipt and inspection process described in Figure 38.9, we can produce the basic Pareto analysis demonstrated in Figure 38.10. This basic Pareto analysis quantifies and graphs the frequency of occurrence for material receipt and inspection and further identifies the most significant, based on frequency.

MATERIAL RECEIPT AND INSPECTION FREQUENCY OF FAILURES			
SUPPLIER	FAILING FREQUENCY	PERCENT FAILING	CUMULATIVE PERCENT
A	13	38	38
B	6	17	55
C	7	20	75
D	9	25	100

Figure 38.9: Material Receipt and Inspection Frequency of Failures

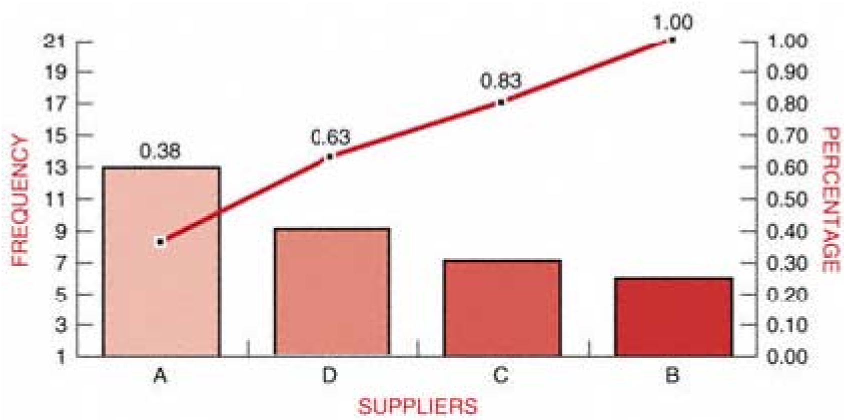


Figure 38.10: Basic Pareto Analysis

A review of this basic Pareto analysis for frequency of occurrences indicates that supplier A is experiencing the most rejections with 37 percent of all the failures.

Pareto analysis diagrams are also used to determine the effect of corrective action, or to analyze the difference between two or more processes and methods. Figure 38.11

displays the use of this Pareto method to assess the difference in defects after corrective action.

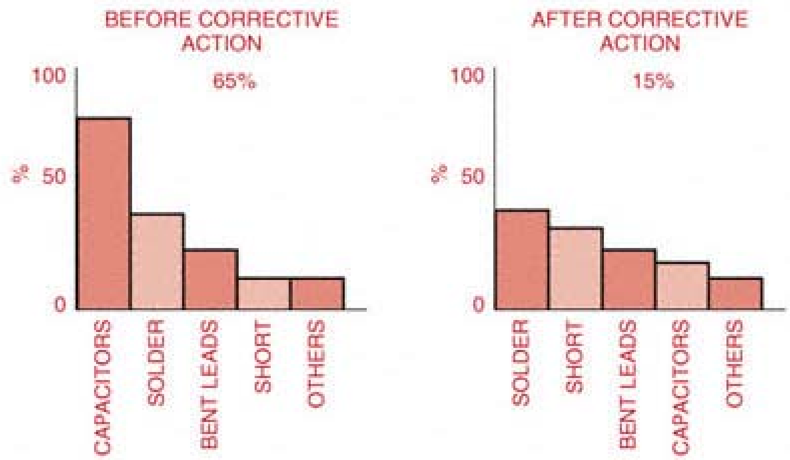


Figure 38.11: Comparative Pareto Analysis

38.1.5 Scatter Diagrams:

Another pictorial representation of process control data is the scatter plot or scatter diagram. A scatter diagram organizes data using two variables: an independent variable and a dependent variable. These data are then recorded on a simple graph with *X* and *Y* coordinates showing the relationship between the variables. Figure 38.12 displays the relationship between two of the data elements from solder qualification test scores. The independent variable, experience in months, is listed on the *X*-axis. The dependent variable is the score, which is recorded on the *Y*-axis.

Figure 38.12: Solder Certification Test Score

These relationships fall into several categories, as shown in Figure 38.13 below. In the first scatter plot there is no correlation— the data points are widely scattered with no apparent pattern.

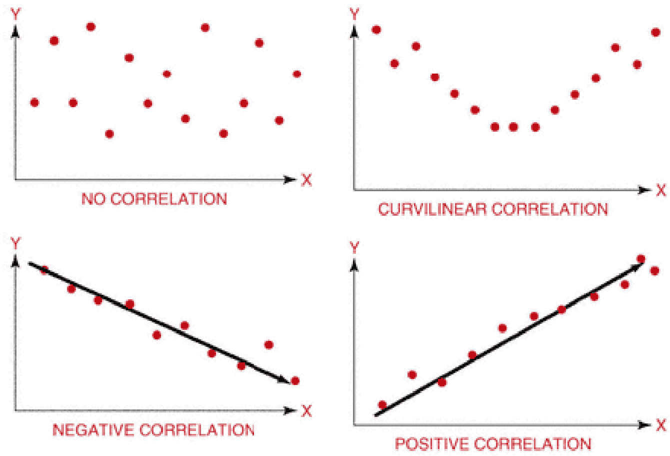


Figure 38.13: Scatter Plot Correlation

The second scatter plot shows a curvilinear correlation demonstrated by the U shape of the graph. The third scatter plot has a negative correlation, as indicated by the downward slope. The final scatter plot has a positive correlation with an upward slope.

From Figure 38.12 we can see that the scatter plot for solder certification testing is somewhat curvilinear. The least and the most experienced employees scored highest, whereas those with an intermediate level of experience did relatively poorly. The next tool, trend analysis, will help clarify and quantify these relationships.

38.1.6 Trend Analysis (T/A):

Trend analysis is a statistical method for determining the equation that best fits the data in a scatter plot. Trend analysis quantifies the relationships of the data, determines the equation, and measures the fit of the equation to the data. This method is also known as curve fitting or least squares.

Trend analysis can determine optimal operating conditions by providing an equation that describes the relationship between the dependent (output) and independent (input) variables. An example is the data set concerning experience and scores on the solder certification test (see Figure 38.14).

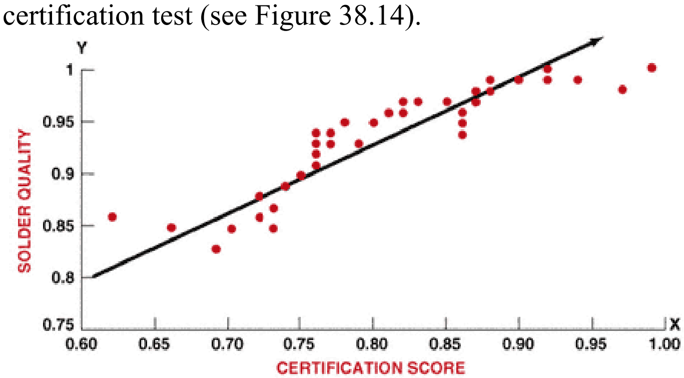


Figure 38.14: Scatter Plot Solder Quality and Certification Score

The equation of the regression line, or trend line, provides a clear and understandable measure of the change caused in the output variable by every incremental change of the input or independent variable. Using this principle, we can predict the effect of changes in the process.

One of the most important contributions that can be made by trend analysis is forecasting. Forecasting enables us to predict what is likely to occur in the future. Based on the regression line we can forecast what will happen as the independent variable attain values beyond the existing data.

38.1.7 Process Control Charts (C/C):

The use of control charts focuses on the prevention of defects, rather than their detection and rejection. In business, government, and industry, economy and efficiency are always best served by prevention. It costs much more to produce an unsatisfactory product or service than it does to produce a satisfactory one. There are many costs associated with producing unsatisfactory goods and services. These costs are in labor, materials, facilities, and the loss of customers. The cost of producing a proper product can be reduced significantly by the application of statistical process control charts.

- ***Control Charts and the Normal Distribution:***
  The construction, use, and interpretation of control charts is based on the normal statistical distribution as indicated in Figure 38.15. The centerline of the control chart represents the average or mean of the data ( ). The *upper and lower control limits (UCL and LCL)*, respectively, represent this mean plus and minus three standard deviations of the data either the lowercase *s* or the Greek letter σ (sigma) represents the standard deviation for control charts.

  The normal distribution and its relationship to control charts are represented on the right of the figure. The normal distribution can be described entirely by its mean and standard deviation. The normal distribution is a bell-shaped curve (sometimes called the Gaussian distribution) that is symmetrical about the mean, slopes downward on both sides to infinity, and theoretically has an infinite range. In the normal distribution 99.73 percent of all measurements lie within and; this is why the limits on control charts are called three-sigma limits.

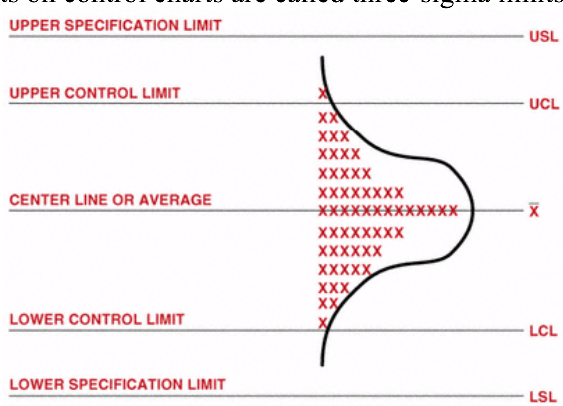


Figure 38.15: The Control Chart and Normal Curve

Companies like Motorola have embarked upon a six-sigma limit rather than a three-sigma limit. The benefit is shown in Table 38.1 below. With a six-sigma limit, only two defects per billion are allowed. The cost to maintain a six-sigma limit can be extremely expensive unless the cost can be spread out over, say, 1 billion units produced

Control chart analysis determines whether the inherent process variability and the process average are at stable levels, whether one or both are out of statistical control (not stable), or whether appropriate action needs to be taken. Another purpose of using control charts is to distinguish between the inherent, random variability of a process and the variability attributed to an assignable cause. The sources of random variability are often referred to as common causes. These are the sources that cannot be changed readily, without significant restructuring of the process. Special cause variability, by contrast, is subject to correction within the process under process control.

Common cause variability or variation: This source of random variation is always present in any process. It is that part of the variability inherent in the process itself. The cause of this variation can be corrected only by a management decision to change the basic process.

Special cause variability or variation: This variation can be controlled at the local or operational level. Special causes are indicated by a point on the control chart that is beyond the control limit or by a persistent trend approaching the control limit.

TABLE 1. ATTRIBUTES OF THE NORMAL (STANDARD) DISTRIBUTION

Specification Range (in ± Sigmas),	Percent within Range,	Defective Parts
1	68.27	317,300,000
2	95.45	430,000
3	99.73 2,	730,000
4	99.9937	63,000
5	99.999943	57
6 99.	9999998	2

Table 38.1: Attributes of the Normal (Standard) Distribution

To use process control measurement data effectively, it is important to understand the concept of variation. No two product or process characteristics are exactly alike, because any process contains many sources of variability. The differences between products may be large, or they may be almost immeasurably small, but they are always present. Some sources of variation in the process can cause immediate differences in the product, such as a change in suppliers or the accuracy of an individual's work. Other sources of variation, such as tool wear, environmental changes, or increased administrative control, tend to cause changes in the product or service only over a longer period of time.

To control and improve a process, we must trace the total variation back to its sources. Again the sources are common cause and special cause variability. Common causes are the many sources of variation that always exist within a process that is in a state of statistical control. Special causes (often called assignable causes) are any factors causing variation that cannot be adequately explained by any single distribution of the process output, as would be the case if the process were in statistical control. Unless all the special causes of variation are identified and corrected, they will continue to affect the process output in unpredictable ways.

The factors that cause the most variability in the process are the main factors found on cause-and-effect analysis charts: people, machines, methodology, materials, measurement, and environment. These causes can either result from special causes or be common causes inherent in the process.

The theory of control charts suggests that if the source of variation is from chance alone, the process will remain within the three-sigma limits. When the process goes out of control, special causes exist. These need to be investigated and corrective action must be taken.

- ***Control Chart Types:***

Just as there are two types of data, continuous and discrete, there are two types of control charts: variable charts for use with continuous data and attribute charts for use with discrete data. Each type of control chart can be used with specific types of data. Table 38.2 provides a brief overview of the types of control charts and their applications.

Variables charts: Control charts for variables are powerful tools that we can use when measurements from a process are variable. Examples of variable data are the diameter of a bearing, electrical output, or the torque on a fastener.

Variables Charts	Attributes Charts
$\bar{X}$ and R charts: To observe changes in the mean and range (variance) of a process.	p chart: For the fraction of attributes nonconforming or defective in a sample of varying size.
$\bar{X}$ and s charts: For a variable average and standard deviation.	np charts: For the number of attributes nonconforming or defective in a sample of constant size.
$\bar{X}$ and s^2 charts: for a variable average and variance.	c charts: For the number of attributes nonconforming or defects in a single item within a subgroup, lot, or sample area of constant size.
	u charts: For the number of attributes nonconforming or defects in a single item within a subgroup, lot, or sample area of varying size.

Table 38.2: Types of Control Charts and Application

As shown in Table 38.2, $\bar{X}$ and R charts are used to measure control processes whose characteristics are continuous variables such as weight, length, ohms, time, or volume. The p and NP charts are used to measure and control processes displaying attribute characteristics in a sample. We use p charts when the number of failures is expressed as a fraction, or NP charts when the failures are expressed as a number. The c and u charts are used to measure the number or portion of defects in a single item. The c control chart is applied when the sample size or area is fixed, and the u chart when the sample size or area is not fixed.

Attribute charts: Although control charts are most often thought of in terms of variables, there are also versions for attributes. Attribute data have only two values (conforming/nonconforming, pass/fail, go/no-go, present/absent), but they can still be counted, recorded, and analyzed. Some examples are: the presence of a required label, the installation of all required fasteners, the presence of solder drips, or the continuity of an electrical circuit. We also use attribute charts for characteristics that are measurable, if the results are recorded in a simple yes/no fashion, such as the conformance of a shaft diameter when measured on a go/no-go gauge, or the acceptability of threshold margins to a visual or gauge check.

It is possible to use control charts for operations in which attributes are the basis for inspection, in a manner similar to that for variables but with certain differences. If we deal with the fraction rejected out of a sample, the type of control chart used is called a p chart. If we deal with the actual number rejected, the control chart is called an NP chart. If articles can have more than one nonconformity, and all are counted for subgroups of fixed size, the control chart is called a c chart. Finally, if the number of nonconformities per unit is the quantity of interest, the control chart is called a u chart.

The power of control charts (Shewhart techniques) lies in their ability to determine if the cause of variation is a special cause that can be affected at the process level, or a common cause that requires a change at the management level. The information from the control chart can then be used to direct the efforts of engineers, technicians, and managers to achieve preventive or corrective action.

The use of statistical control charts is aimed at studying specific ongoing processes in order to keep them in satisfactory control. By contrast, downstream inspection aims to identify defects. In other words, control charts focus on prevention of defects rather than detection and rejection. It seems reasonable, and it has been confirmed in practice, that economy and efficiency are better served by prevention rather than detection.

- ***Control Chart Components:***

  All control charts have certain features in common (Figure 38.16). Each control chart has a centerline, statistical control limits, and the calculated attribute or control data. Additionally, some control charts contain specification limits.

  The centerline is a solid (unbroken) line that represents the mean or arithmetic average of the measurements or counts. This line is also referred to as the X bar line ( ). There are two statistical control limits: the upper control limit for values greater than the mean and the lower control limit for values less than the mean.

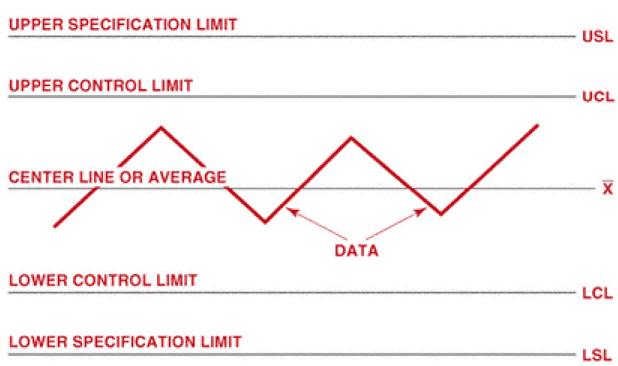


Figure 38.16: Control Chart Elements

Specification limits are used when specific parametric requirements exist for a process, product, or operation. These limits usually apply to the data and are the pass/fail criteria for the operation. They differ from statistical control limits in that they are prescribed for a process, rather than resulting from the measurement of the process.

The data element of control charts varies somewhat among variable and attribute control charts. We will discuss specific examples as a part of the discussion on individual control charts.

- ***Control Chart Interpretation:***

  There are many possibilities for interpreting various kinds of patterns and shifts on control charts. If properly interpreted, a control chart can tell us much more than simply whether the process is in or out of control. Experience and training can lead to much greater skill in extracting clues regarding process behavior, such as that shown in Figure 38.17. Statistical guidance is invaluable, but an intimate knowledge of the process being studied is vital in bringing about improvements.

  A control chart can tell us when to look for trouble, but it cannot by itself tell us where to look, or what cause will be found. Actually, in many cases, one of the greatest benefits from a control chart is that it tells when to leave a process alone. Sometimes the variability is increased unnecessarily when an operator keeps trying to make small corrections, rather than letting the natural range of variability stabilize. The following paragraphs describe some of the ways the underlying distribution patterns can behave or misbehave.

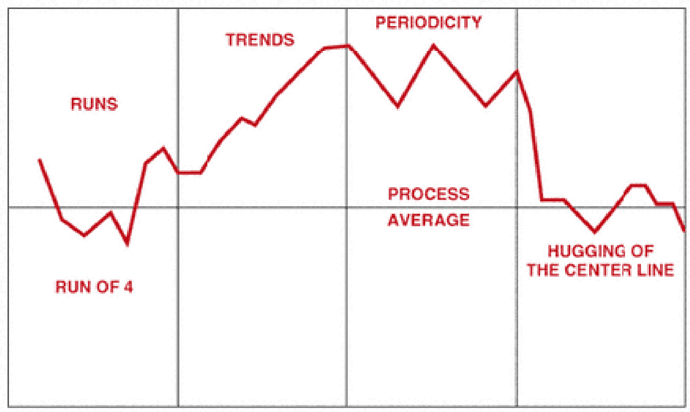


Figure 38.17: Control Chart Interpretation

Runs: When several successive points line up on one side of the central line, this pattern is called a run. The number of points in that run is called the length of the run. As a rule of thumb, if the run has a length of seven points, there is an abnormality in the process. Figure 38.18 demonstrates an example of a run.

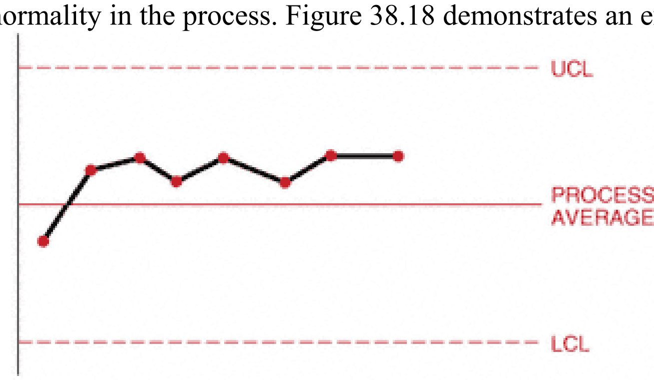


Figure 38.18: Process Run

Trends: If there is a continued rise of all in a series of points, this pattern is called a trend. In general, if seven consecutive points continue to rise or fall, there is an abnormality. Often, the points go beyond one of the control limits before reaching seven. Figure 38.19 demonstrates an example of trends.

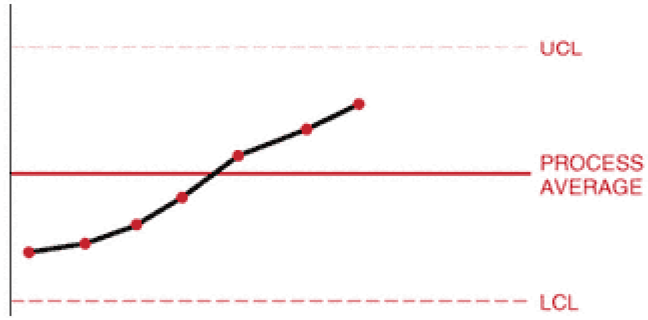


Figure 38.19: Control Chart Trends

Periodicity: Points that show the same pattern of change (rise or fall) over equal intervals denote periodicity. Figure 38.20 demonstrates an example of periodicity.

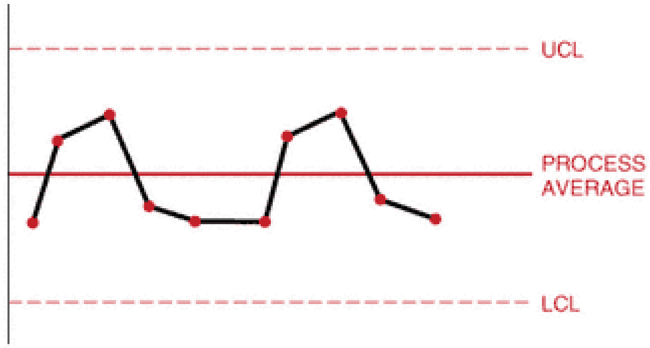


Figure 38.20: Control Chart Periodicity

Hugging the centerline or control limit. Points on the control chart that are close to the central line or to the control limit are said to hug the line. Often, in this situation, different types of data or data from different factors have been mixed into the subgroup. In such cases it is necessary to change the sub-grouping, reassemble the data, and redraw the control chart. To decide whether there is hugging of the center line, draw two lines on the control chart, one between the centerline and the UCL and the other between the center line and the LCL. If most of the points are between these two lines, there is an abnormality. To see whether there is hugging of one of the control limits; draw line two-thirds of the distance between the center line and each of the control lines. There is abnormality if 2 out of 3 points, 3 out of 7 points, or 4 out of 10 points lie within the outer one-third zone. The abnormalities should be evaluated for their cause(s) ad the corrective action taken. Figure 38.21 demonstrates data hugging the LCL.

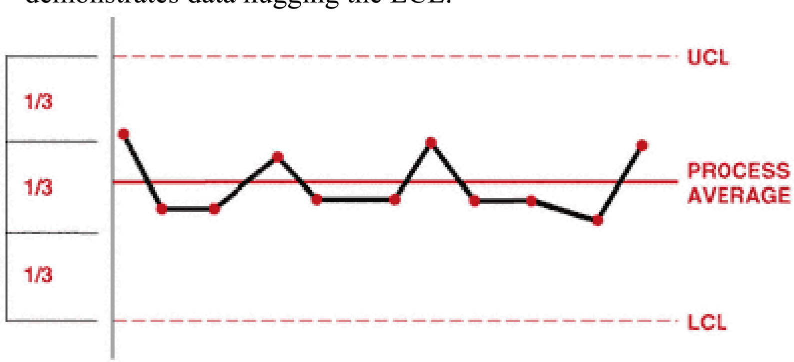


Figure 38.21: Hugging the Centerline

Out of control: An abnormality exists when data points exceed either the upper or lower control limits. Figure 38.22 illustrates this occurrence.

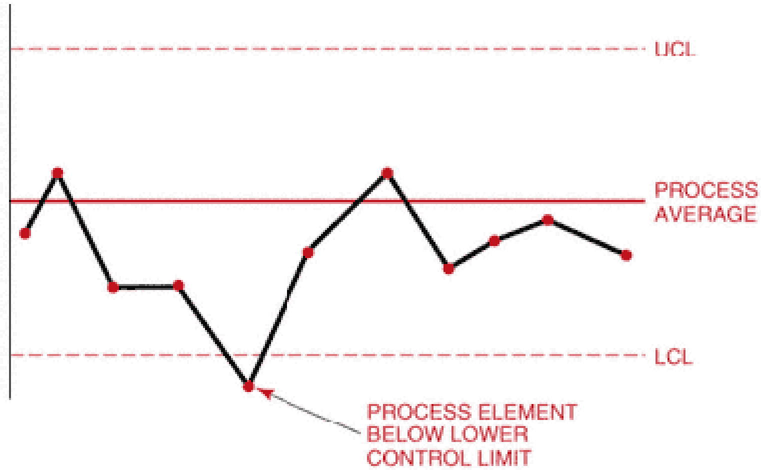


Figure 38.22: Control Chart Out of Control

In control: No obvious abnormalities appear in the control chart. Figure 38.23 demonstrates this desirable process state.

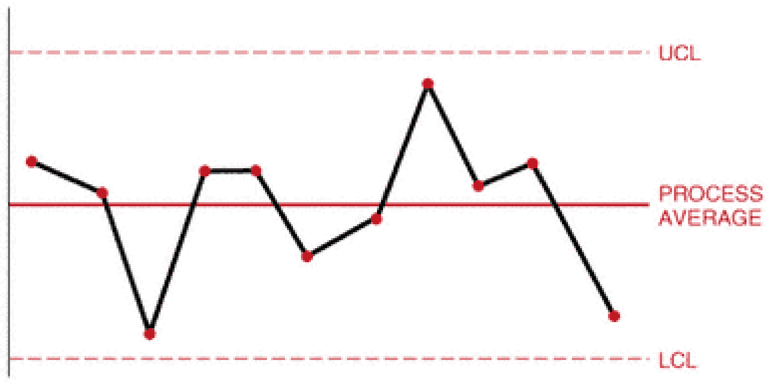


Figure 38.23: Process in Control

PROJECT EFFECTIVENESS THROUGH ENHANCED PRODUCTIVITY

BROAD CONTENTS

Competitiveness
Productivity in the Context of PM
Definitions of Effectiveness and Efficiency
Types of Productivity
White Collar Productivity
Critical Barriers/ Problems to Productivity
Causes of Productivity Decline in Organizations
Productivity Improvement
Categories of Productivity Factors
Soft Factors

39.1 **Competitiveness:**

Competitiveness emerged strongly in new era of globalization describes "economic strength" of any "organization" or position of certain company" with respect to its competitors in market place.

Competitiveness is process by which one entity strives to outperform another. Competitiveness in Organization is Ability to get customers to choose your prod or svc over competing alternatives on sustainable basis.

Competitiveness continually "sustained incorporated in productivity" resulting in high wages and living standards competitiveness - demonstrated by "ability to meet, rest of free international markets" while "expanding real income."

39.1.1 Indicators of Competitiveness:

Macro level competitiveness of nations reflects standard of living of their citizens. National competitiveness consolidation of micro-level performances of company's and individual is true "Agents of Economic Growth".

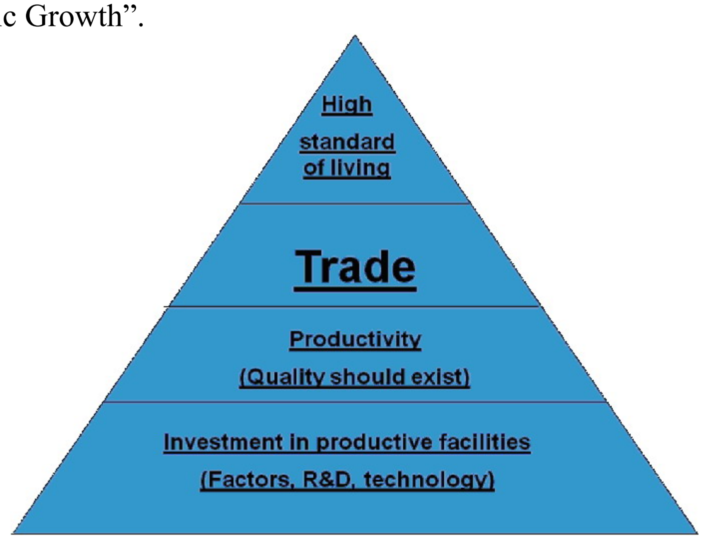


Figure 39.1: Competitiveness Pyramid

Competitiveness depends on productivity:

"Standard of living is determined by productivity of a nation's economy which is measured by the value of goods and services (products) produced per unit of the nation's human, capital and natural resources".

Indicators of competitiveness:

Productivity: Efficiency with which goods and services are produced and provided and determined by:

- Previous investments
- Quality and performance of workforce,
- Technology innovation
- Quality of plant and equipment
- Efficiency with which these factors of production are utilized

Productivity of "local" industries is of fundamental importance to competitiveness. It depends on:

1. Sophistication with "which company's compete"
2. Quality of "microeconomic business environment".

When productivity and quality considered together competitiveness can be enhanced. Definition of productivity successful project management organization create surplus through productive output, productivity is output input agreement on consideration "quality and time".

Productivity = Outputs (Time /Quality) Inputs

39.2 Productivity in the Context of Project Management:

39.2.1 Definition of Productivity:

1. Ratio of output to input by large number of professionals.
2. ILO Definition: "Ratio between "output of wealth produced" and "input resources used up" in "process of production".
3. Comparative tool for managers, industrial engineers, economists, and politicians.

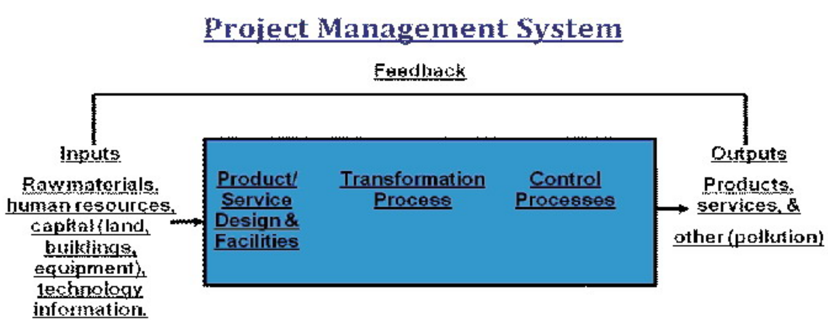


Figure 39.2: Project Management System

39.2.2 Difference between Production and Productivity:

Production*: Concerned with activity of "producing goods and or services".*

Productivity: *"Efficient utilization of resources" (input) in "producing goods/services" (output).*

The basic differences between production and productivity are as follows:

- Production is quantity of output produced.
- Productivity "ratio of output produced in input (s) used".
- Higher productivity means accomplishing more with same "amount of resources" or achieving higher output In terms of volume/quality for same input.

39.2.3 Messages of Productivity:

Taylor's Message of Productivity:

- Various pay plans based on output for surplus increase labor productivity not possible work order:
  a. Provided ample reward
  b. Adequate targets
  c. Managerial help
- Careful advance planning by manager
- Managers to design work system for worker to do their best.

Fredrick Concluded:

Low productivity is matter of ignorance on part of labor and management ignorance. "Fair day's work" and "fair day pay" productivity enhancement answer to high wages/profits.

Peter Drucker Says:

Problem faced in developing countries is problem not of "underdevelopment but rather of under management". Actually productivity is most serious challenge confronting management.

39.2.4 Perspectives on Productivity:

Productivity – Manager's Perspective:

Use "accounting ratios" for management-usually interested in productivity measures that enable it to easily assess the present profitability of company.

Productivity – Engineer's Perspective:

- Seek measures of physical assets and other resources. For example: Production/hour.
- Man hours/unit
- Material required/unit, material/consumption, utilization,
- Space utilization

May fail to relate to overall productivity.

Productivity – Behaviorist's Perspective:

View productivity of people in organization in terms of time they spend at work versus total time available a misleading measure.

Productivity – Accountant's Perspective:

"Costing and budgeting" approach to productivity budget figure, rather than optimum achievable values, used as standards can be a false impression of high productivity.

Productivity – Economist's Perspective:

Partial measures, such as "labor productivity" employed by economists, total factor and total productivity but again definitions do not agree.

39.3 **Definition of Effectiveness and Efficiency:**

Productivity implies* effectiveness *and* efficiency *both individual and organization performance.

- ***Effectiveness*** *is* "achievement of objectives". *It entails promptly achieving stated objective.*
- ***Efficiency*** *is "*achievement of ends with least amount of resources. *Resources to achieve objective weighted against what is actually accomplished.*

39.3 Types of Productivity:

1. Partial Productivity
2. Total Factor Productivity
3. Total Productivity

Total – Factor Productivity:

Ratio of "net output to sum of associated labor and capital" (factor) inputs net output- total output minus intermediate goods and services purchased.

Finding of Survey in Different Industries

- Average, only 4.4 hours per day used productively
- 1.2 hours lost due to personal and other unavoidable delays
- hrs are simply wasted because of management's inability to effectively "plan and control" the worker's tasks.

Productivity Loss:

- Percent due to poor: "Planning and scheduling" of work.
- 25 Percent due to: "Unclear and untimely instructions".
- Percent due to: "Inability to adjust staff size" and duties during "peak and valley workload periods".
- 25 Percent due to: "Poor co-ordination" of material flow, unavailability of needed tools, excess travel time.

39.5 **White-Collar Productivity:**

Productivity of "white-collar workers" is no less important than that of direct labor or manufacturing employees. It is usually least known, least analyzed, and least managed of all factors of productivity. White collar employees are productive only 50% of time. Remainder is non-productive time and can be traced to personal delays (15%) and improper management (35%).

Examples of White Collar Waste:

- Poor staffing
- Inadequate communication
- Unproductive meeting and telephone conversations

- Poor scheduling
- Slack start and quiet times
- Lack of communication between function
- Information overload

39.6 Critical Barriers/Problems to Productivity:

- Family-controlled industry
- Earning easy money
- Monopolistic market, in some segments, some high competitive
- Erratic inflow of orders
- Lack of productivity and quality culture
- Shortage of funds low level codification
- Automation -not encouraged
- Low priority of market and commercial activities
- Poor after service
- Complicated government policy, rules and regulations
- Poor infra structure support/road transport
- Energy shortage
- Poor working conditions, light, ventilation, safety, housekeeping
- Non availability of basic material components (to be imported)
- Unreliable suppliers

39.7 Causes of Productivity Decline in Organizations:

- Inability to measure, evaluates, and manages productivity of white collar employees. This causes shocking waste of resources.
- Rewards and benefits given without requiring equivalent in productivity and accountability
- Diffused authority and inefficiency in complex organizations, thereby, causing delays and time lags.
- Organization expansion lowers productivity growth result in soaring costs.
- Low motivation among rising number of affluent workers with new attitudes.
- Late Deliveries caused by schedule have been disrupted by limited materials.
- Unresolved human conflicts difficulties in teamwork, resulting in project inefficiencies.
- Include legislative intrusions antiquated laws, resulting in constrained “management options and prerogatives”.
- Specialization in work processes resulting in monotony and Boredom.
- Rapid technology changes and high costs, resulting in decline in new opportunities and innovation.
- Include demand of leisure time causing disruption in operations.
- Project manager’s inability to keep pace with the latest information and knowledge.

39.8 Productivity Improvement (PI):

- How can projects improve their productivity?

Productivity is composed of:

- People
- Operations variables

To improve productivity, management needs to focus on the following two points:

- Productivity does not just happen by “trying harder”. It must be planned.
- But how do you plan for productivity, and what factors are involved?

Improvement means “increase ratio of output of goods and services produced divided by input used to produce”. Ratio can be included by either increase output, reducing input or both.

Financial and social benefits of "productivity improvement strategy" in project manager should be greater than "implementation cost", in long run.

Task of project manager is to evaluate those factors that have bearing on productivity and take appropriate measures to use effectively. In order to raise productivity and to reduce cost, we must eliminate bad features in design and specifications that cause excessive work contents.

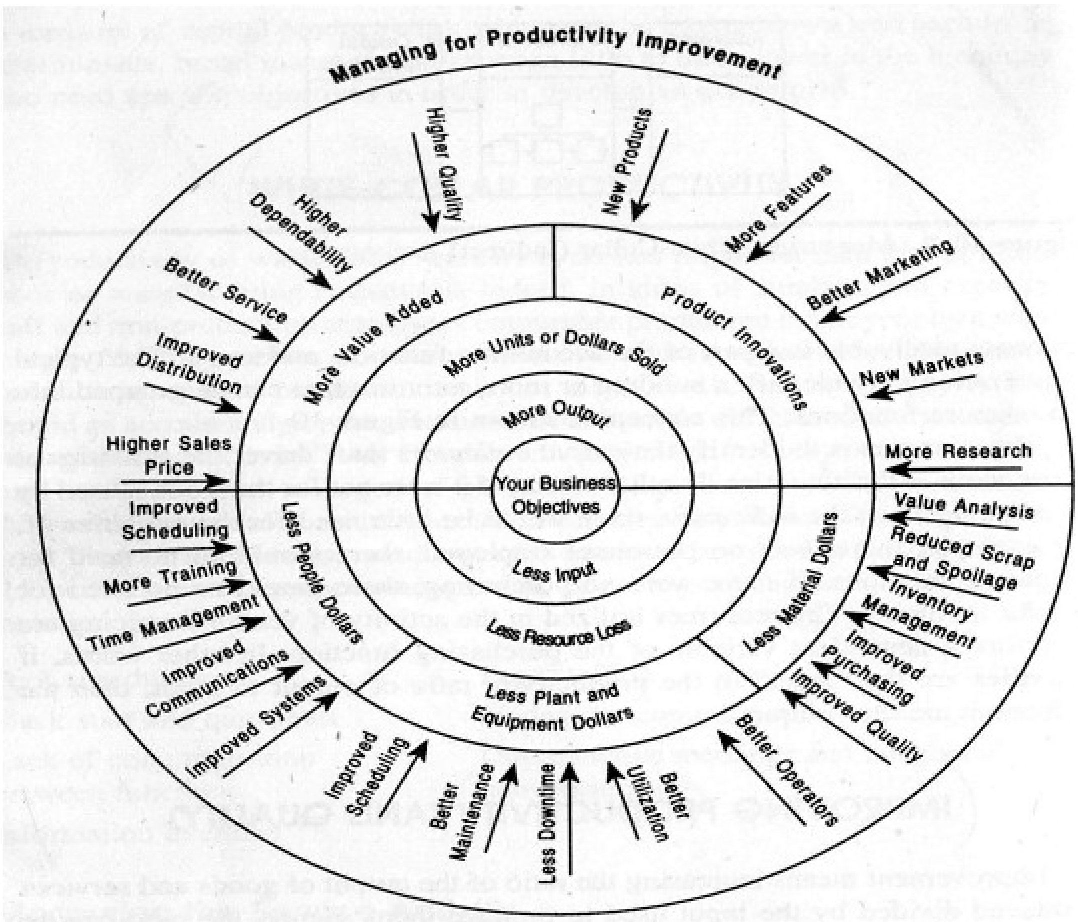


Figure 39.3: Productivity Wheel

39.8.1 Productivity Improvement Factors:

Productivity improvement (PI) is not just "doing things better", but more importantly, it is "doing right things better". Inter-relationships between labor, capital and socio-organizational environment are important in a way that they are balanced and co-ordinate into integrated whole.

Three Main Productivity Factor Groups:

There are three major productivity factor groups:

- Job-related
- Resource-related
- Environment-related

39.9 Categories of Productivity Factors:

There are the two following major categories of productivity factors:

- o External (not controllable)
- o Internal (controllable)

External Factors: Beyond control of individual enterprise. Understanding of them can motivate certain actions which migrates change enterprise's or project behavior and its productivity in LR.

Internal Factors: Within its control first step towards productivity improvement is to identify problem areas within these factor groups.

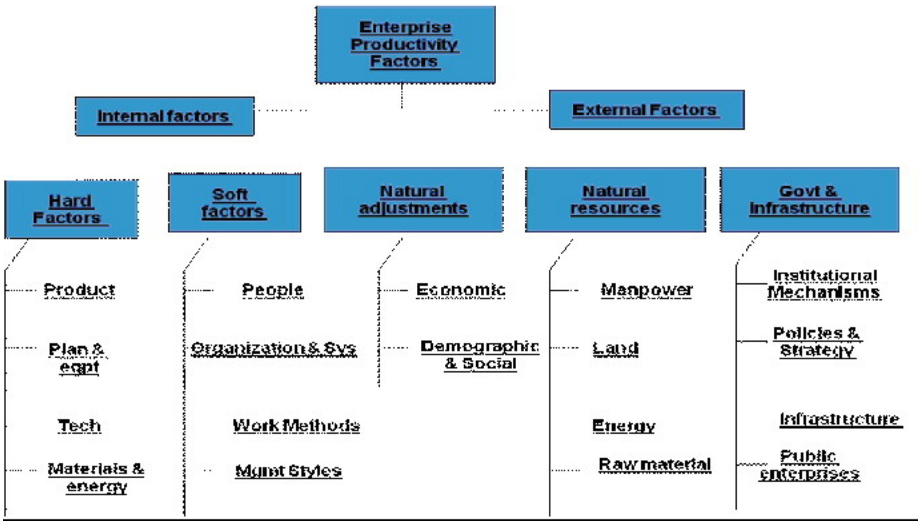


Figure 39.4: Integrated Model of Project Productivity Factors

39.10 Soft Factors:

People: Principal resource central factor in productivity improvement, drives people in organization all have role to play as workers, engineers, managers, entrepreneurs, trade union members.

Each role has two aspects:

- o Application
- o Effectiveness

Application: Degree to which people apply themselves to their work. People differ not only in their ability but also in their will to work.

Law of Behavior: Motivation decreases if it is either satisfied or blocked from satisfaction. Workers may do their jobs work order working hard (no motivation), but even if they work to their full capacity they would not be satisfied (motivation is blocked from satisfaction).

Motivation is basic to all human behavior and to efforts in productivity improvement. Material needs predominant, but does not mean that non-financial incentives not effective or have no place.

Project manager see what stimulates and maintains motivation to bring about changes in attitude of managers, engineers and workers. Develop set of values conducive to higher productivity.

Workers' success in increasing productivity by:

- Rewards
- Improving recognition
- Involvement

- Learning Opportunities
- Elimination of negative rewards

Execute effective incentive schemes, result significant improvement in productivity. Wage incentives related to amount of change accomplishes.

Project manager should work to encourage workers to apply their creative talents by taking special interest in their problems by promoting favorable social climate.

2.Effectiveness: E*ffectiveness is extent to which application of human effort brings desired results in output and quality. It is the ability to do productive job improved through:*

- Training and development
- Job rotation and placements, systematic job progression (promotion)
- Career planning

Key approaches, methods and techniques to improve labor productivity:

- Wages and salaries
- Training and education
- Social security – pensions and health plans
- Rewards
- Incentive plans
- Participation or co-determination
- Contract negotiations
- Attitudes to work, to supervision and to change
- Motivation to higher productivity
- Co-operation
- Organization development
- Improved communications
- Suggestion systems
- Career planning
- Attendance
- Turnover
- Job security

Financial Incentives (Individual and Group):

Individual plan ***is made to give financial incentives on basis of individual performance.***

Types of Individual Plan:

- Piece work plan
- Standard hour plan
- Measured day work plan
- Emerson pla**n**

Group plan is made to give financial incentives on basis of group performance.

Types of Group Plan*:*

- Scanlon plan
- Ruker plan
- Kaiser plan
- Tonnage plane
- Dollar sales plan

- Profit sharing
- Improshare

Fringe Benefits:

Some intangible means of rewarding and encouraging management employee. These are referred to as "fringes" and include the following:

- Free Medical
- Insurance
- Free Air
- Fares
- Entertainment
- Company Car
- Telephone
- Subsidized education etc.

Employee Promotion:

- Both financial and non-financial form of motivation: Up gradation of employee status is natural way to recognize skill knowledge, proficiency, and efforts to job.

Maslow's Hierarchy of Needs.

Only dissatisfied needs can motivate workers to high productivity,) physiological, safety, security, belongingness, self esteem, self actualization (realizations of one potential)

- Japanese on basis of seniority
- USA on basis of extra ordinary performance
- Debatable issue

Job Enrichment:

Non-financial-motivation technique that provides

- Variety in assigned tasks
- Employment autonomy and discretion in performing talks
- Feed back on performance
- Herzberg's two-factor theory applied

Two Factors Theory:

"Motivators" factors leading to job satisfaction. Achievement recognition, nature of work responsibility, growth etc. Factors leading to dissatisfaction avoidance are Hygiene, Company's policy, admin, supervision, pay status

Job Enlargement:

- Enlargement of responsibilities associated with job.
- Enhanced scope and responsibility. Proponents say job get to be boring and monotonous, causing high absenteeism, high turnover, and low morale, with consequent low productivity.
- Volvo Sweden. Worker could stamp name on engine.

Job Rotation:

Involves rotation of workers in different jobs for short periods of time provide "all-rounder" in company's op –for which - not originally hired for:

- Relieves boredom by flexibility in job assignments.
- Not retraining conscious -on going basis effort to provide opportunity to exercise freedom in staying on a job for a fixed period.

Workers Participation and Empowerment:

Over coming resistance to change through employee involvement in planning and implementing change, mental and emotional involvement in groups encourage workers to contribute in group goals sharing of responsibility**.**

Workers Participation Approaches:

Following are the approaches for workers participation in quality culture change and empowerment:

- Quality control circles
- Productivity quality teams
- Productivity action teams
- Productivity circles
- Productivity maintenance group
- Employee participation group

Skill Enhancement:

Formalized techniques to increase skills needed to perform job. Skill training needed for employee when employee's attitude is positive but his abilities are low.

- In information age there is a great need for skill at all levels.

Management by Objectives (MBO):

Managerial motivation techniques, aids motivation on all participation by having superior and subordinate managers jointly identify common goals, carefully define them. Together monitor progress towards achieving results to both employer and employee.

- In setting up goals care must be taken.
- Set simplistic goals.
- Set goals without adequate resources.
- Not set harsh goals that cause resentment.
- If properly administered, MBO can create joint goals and can help in team building.
- MBO goals provide fairness to both employee and employer.

Working Condition Improvement – Quality of Work Life (QWL):

It is often emphasized but rarely applied technique that involves detailed audit of working conditions designing improved conditions of working installing and maintaining improvements in working conditions.

Designing Improved Factors:

They include:

- Temperature, light and humidity
- Noise
- Colors of surroundings
- Extent of handling hazardous material, parts or product
- Extent of manual handling of heavy items

Training:

- Seeks to achieve improved human productivity by increasing ability levels of workforce
- Seeks to meet demands of growth and change
- Training may actually decrease total productivity initially
- Some type of training
- On the job targets
- Apprenticeship
- Internship
- Outside course
- Visitation training

Role Perception:

- Refer to manner in which individual defines his or her job
- Type of effort employee believes is essential for effective job performance.
- If workers see high or low productivity as path to attainment of one or more of their personal goals in work situation, they will tend to be high or low processors.

Quality of Supervision:

- Concerned with work of creating and maintaining environments in which people can accomplish goals efficiently and effectively.
- In order to improve supervision quality itself, supervisors must be trained in
  - Interpersonal skills
  - Human management
  - Group dynamic
  - Other behavioral tools

Recognition:

Management shows acknowledgement of employee's outstanding performance in terms of improved productivity, ideas, or any act of good workmanship. They include:

- Pay raise
- Bonus
- Awards
- Certificate of appreciation
- Special highlights in company newsletter
- Special parking provision
- Engraving on plaque in cafeteria

Punishment:

- Punishment contingency attempt to decrease likelihood of particular behavior occurring by making punishment contingency on behavior.
- Common punishment contingencies used in work organizations include:
  - Disciplinary layoffs
  - Transfer to undesirable jobs
  - Withholding salary increases

Quality Circles: Group of employees who voluntarily cooperative to solve problems related to production, quality, work environment, maintenance scheduling, or anything that affects these areas.

Productivity and Quality Teams:

Small groups of people doing similar tasks meet regularly to select, investigate, and solve problems related to workplace, products, and services. Effective means of improving employee morale, quality, and productivity in organizations. Team spirit, positive thinking, and philosophy of achieving excellence are three important characteristics of productivity and quality teams.

Zero Defects:

Zero defects program attempts to improve quality by changing workers attitudes. Their theme, "do it right first time" stresses error free performance. It relies on workers to identify error prone situations with assumption that people best prepared to eliminate errors are those who create them.

Time Management:

- Powerful technique, particularly for white collar, supervisory and management personnel
- Time management involves minimization of wasteful elements of person's administrative work.
- Interruptions by drop-in visitors (without appointment)
- Attending lengthy and unnecessary meetings that accomplish very little
- Inability to say "no" for some tasks
- Procrastination and lack of decisiveness
- Inability to delegate work
- Taking on much more than can be handled
- Lack of responsibility and authority to do certain jobs
- Delayed, inaccurate or inadequate information
- Taking orders from too many people
- Handling too many "crisis" situations
- Lack of organization of tasks by priority or target dates
- Lack of determination to complete tasks assigned
- Lack of organization on and around desk
- Unnecessary socialization
- Poor filling system
- Making unnecessary trips to people, departments, copy machines etc.
- Excessive conversation time
- Too many rescheduling of meeting, personal engagements etc.

To minimize these "time-wasters", time management applies simple, common-sensible but very effective programming rules to very item of work, one of which is: "never handle same paper twice". Time management always improves human productivity. It is too often ignored, particular by management people who preach productivity to their subordinates.

Flex Time:

- Employees are given freedom in determining their hours of work
- Core time (hours when all employees must be at work)
- Flexible time (hours when employees can vary their time of arrival and departure)

Compressed Work Week:

- Working for same number of hours but for fewer days week
- Hours
- 08 hours 05 days
- 10 hours 04 days

Harmonization:

Integration of interest of stockholders, board of directors, management at all levels and all employees in consistent manner both within and outside physical boundaries of organization.

LESSON 40

COST MANAGEMENT AND CONTROL IN PROJECTS

BROAD CONTENTS

Cost Management
Cost Control
Management Cost and Control System (MCCS)
Understanding Control
Operating Cycle
Cost Account Codes
Budgets

40.1 Cost Management:

It is widely used in business today and is the process whereby companies use cost accounting to report or control various costs of doing business. Cost Management generally describes approach and activities of managers in short range and long range planning and cost decisions that incorporate value for customer and lower costs of product and services.

Manager make decisions on amount and kind of material used, changes of plant processes, changes in product designs and information from accounting system helps managers make such decisions, but information and accounting system not "cost management" project cost management broad focus includes continuous control of costs. Planning and cost is usually linked with revenue and profit planning.

In the context of project:

Cost management involves overall planning, co-ordination, and control and reporting of all cost-related aspects from "project initiation" to "operation and maintenance".

Process of identifying all costs associated with investment, making informed choices about options that will deliver best "value for money" and managing those costs throughout life of project. Techniques (value management) help to improve value and reduce costs.

40.2 Cost Control:

Cost control is equally important to all companies, regardless of size. Small companies generally have tighter monetary controls, mainly because of the risk with the failure of as little as one project, but with less sophisticated control techniques. Large companies may have the luxury to spread project losses over several projects, whereas the small company may have few projects.

Cost control is not only "monitoring" of costs and recording perhaps massive quantities of data, but also analyzing of the data in order to take corrective action before it is too late. Cost control should be performed by all personnel who incur costs, not merely the project office. Cost control implies good cost management, which must include:

- Cost estimating
- Cost accounting
- Project cash flow
- Company cash flow
- Direct labor costing
- Overhead rate costing
- Others, such as incentives, penalties, and profit-sharing

40.3 Management Cost and Control System (MCCS):

Cost control is actually a subsystem of the *Management Cost and Control System (MCCS)* rather than a complete system per se. This is shown in Figure 40.1**,** where the Management Cost and Control System (MCCS) is represented as a two cycle process: a planning cycle and an operating cycle. The operating cycle is what is commonly referred to as the cost control system. Failure of a cost control system to accurately describe the true status of a project does not necessarily imply that the cost control system is at fault. Any cost control system is only as good as the original plan against which performance will be measured. It is more common for the plan to be at fault than the control system.

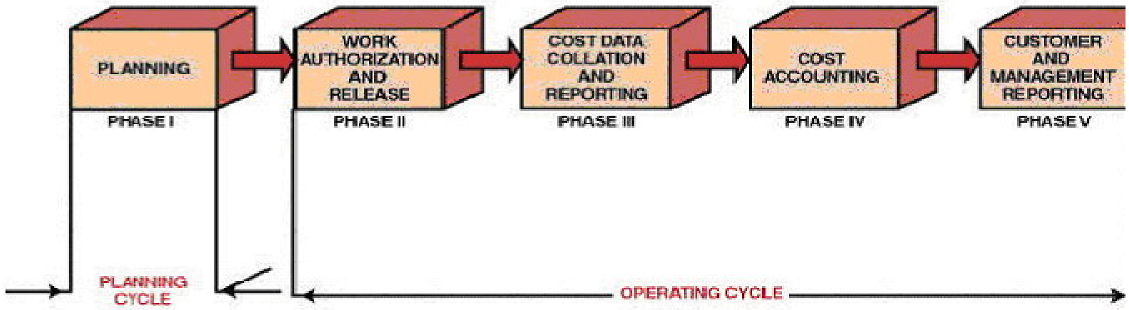


Figure 40.1: Phases of a Management Cost and Control System

Therefore, the designing of a company's planning system must take into account the cost control system as well. *For this reason, it is common for the planning cycle to be referred to as planning and control, whereas the operating cycle is referred to as cost and control.*

Note that the planning and control system selected must be able to satisfy management's needs and requirements in order that they can accurately project the status toward objective completion. The purpose of any management cost and control system is to establish policies, procedures, and techniques that can be used in the day-to-day management and control of projects and programs. The planning and control system must, therefore, provide information that:

- Gives a picture of true work progress
- Will relate cost and schedule performance
- Identifies potential problems with respect to their sources.
- Provides information to project managers with a practical level of summarization
- Demonstrates that the milestones are valid, timely, and auditable

The planning and control system, in addition to being a tool by which objectives can be defined that is *hierarchy of objectives* and *organization accountability*, exists as a tool to develop planning, measure progress, and control change. As a tool for planning, the system must be able to:

- Plan and schedule work
- Identify those indicators that will be used for measurement
- Establish direct labor budgets
- Establish overhead budgets
- Identify management reserve

The project budget that is the final result of the planning cycle of the MCCS must be reasonable, attainable, and based on contractually negotiated costs and the statement of work. The basis for the budget is historical cost, best estimates, or industrial engineering standards.

The budget must identify planned manpower requirements, contract-allocated funds, and management reserve. Establishing budgets requires that the planner fully understand the meaning of standards.

We should know that there are two categories of standards. Performance results standards are quantitative measurements and include such items as quality of work, quantity of work, cost of work, and time-to-complete. Process standards are qualitative, including personnel, functional, and physical factors relationships.

Standards are advantageous in that they provide a means for unity, a basis for effective control, and an incentive for others. The disadvantage of standards is that performance is often frozen, and employees are quite often unable to adjust to the differences. As a tool for measuring progress and controlling change, the systems must be able to:

- Measure resources consumed
- Measure status and accomplishments
- Compare measurements to projections and standards
- Provide the basis for diagnosis and re-planning

In using the Management Cost and Control System (MCCS), the following guidelines usually apply:

- The level of detail is specified by the project manager with approval by top management.
- Centralized authority and control over each project are the responsibility of the project management division.
- For large projects, the project manager may be supported by a project team for utilization of the Management Cost and Control System (MCCS).

Almost all project planning and control systems have identifiable design requirements. These include:

- A common framework from which to integrate time, cost, and technical performance
- Ability to track progress of significant parameters
- Quick response
- Capability for end-value prediction
- Accurate and appropriate data for decision making by each level of management
- Full exception reporting with problem analysis capability
- Immediate quantitative evaluation of alternative solutions

Management Cost and Control System (MCCS) planning activities include:

- Contract receipt (if applicable)
- Work authorization for project planning
- Work breakdown structure (WBS)
- Subdivided work description
- Schedules
- Planning charts
- Budgets

Management Cost and Control System (MCCS) planning charts are worksheets used to create the budget. These charts include planned labor in hours and material dollars. Management Cost and Control System (MCCS) planning is accomplished in one of these ways:

- One level below the lowest level of the Work Breakdown Structure (WBS)
- At the lowest management level
- By cost element or cost account

Even with a fully developed planning and control system, there are numerous benefits and costs. The appropriate system must consider a cost-benefit analysis, and include such items as:

- **Project benefits:**
  - Planning and control techniques facilitate:
    - — Derivation of output specifications (project objectives)
    - — Delineation of required activities (work)
    - — Coordination and communication between organizational units
    - — Determination of type, amount, and timing of necessary resources
    - — Recognition of high-risk elements and assessment of uncertainties
    - — Suggestions of alternative courses of action
    - — Realization of effect of resource level changes on schedule and output performance
    - — Measurement and reporting of genuine progress
    - — Identification of potential problems
    - — Basis for problem solving, decision making, and corrective action
    - — Assurance of coupling between planning and control

- **Project cost:**
  - Planning and control techniques require:
    - — New forms (new systems) of information from additional sources and incremental processing (managerial time, computer expense, etc.)
    - — Additional personnel or smaller span of control to free managerial time for planning and control tasks (increased overhead)
    - — Training in use of techniques (time and materials)

A well-disciplined Management Cost and Control System (MCCS) will produce the following results:

- Policies and procedures that will minimize the ability to distort reporting
- Strong management emphasis on meeting commitments
- Weekly team meetings with a formalized agenda, action items, and minutes.
- Top-management periodic review of the technical and financial status
- Simplified internal audit for checking compliance with procedures

Furthermore, for Management Cost and Control System (MCCS) to be effective, both the scheduling and budgeting systems must be disciplines and formal in order to prevent inadvertent or arbitrary budget or schedule changes. This does *not* mean that the baseline budget and schedule, once established, is static or inflexible. Rather, it means that changes must be controlled and result only from deliberate management actions.

Disciplined use of Management Cost and Control System (MCCS) is designed to put pressure on the project manager to perform exceptionally good project planning so that changes will be minimized. As an example, government subcontractors may not:

- Make retroactive changes to budgets or costs for work that has been completed.
- Re-budget work-in-progress activities
- Transfer work or budget independently of each other
- Reopen closed work packages

In some industries, the Management Cost and Control System (MCCS) must be used on all contracts of $2 million or more, including firm fixed-price efforts. The fundamental test of whether to use the MCCS is to determine whether the contracts have established end-item deliverables, either hardware or computer software, that must be accomplished through measurable efforts.

Currently, two new programs are being used by the government and industry in conjunction with the Management Cost and Control System (MCCS) as an attempt to improve effectiveness in cost control. The zero-base budgeting program was established to provide better estimating techniques for the verification portion of control. The design-to-cost program assists the decision-making part of the control process by identifying a decision-making framework from which re-planning can take place.

40.4 Understanding Control:

Effective management of a program during the operating cycle requires that a well-organized cost and control system be designed, developed, and implemented so that immediate feedback can be obtained, whereby the up-to-date usage or resources can be compared to target objectives established during the planning cycle. The requirements for an effective control system (for both cost and schedule/performance) should include:

- Thorough planning of the work to be performed to complete the project
- Good estimating of time, labor, and costs
- Clear communication of the scope of required tasks
- A disciplined budget and authorization of expenditures
- Timely accounting of physical progress and cost expenditures
- Periodic re-estimation of time and cost to complete remaining work
- Frequent, periodic comparison of actual progress and expenditures to schedules and budgets, both at the time of comparison and at project completion

It is essential that the management must compare the time, cost, and performance of the program to the budgeted time, cost, and performance, not independently but in an integrated manner. Being within one's budget at the proper time serves no useful purpose if performance is only 75 percent. Likewise, having a production line turn out exactly 200 items, when planned, loses its significance if a 50 percent cost overrun is incurred.

All three resource parameters (time, cost, and performance) must be analyzed as a group, or else we might "win the battle but lose the war." The use of the expression "management cost and control system" is vague in that the implication is made that only costs are controlled. This is not true— an effective control system monitors schedule and performance as well as costs by setting budgets, measuring expenditures against budgets and identifying variances, assuring that the expenditures are proper, and taking corrective action when required.

Previously, we defined the Work Breakdown Structure (WBS) as the element that acts as the source from which all costs and controls must emanate. The Work Breakdown Structure (WBS) is the total project broken down into successively lower levels until the desired control levels are established. The Work Breakdown Structure (WBS) therefore serves as the tool from which performance can be subdivided into objectives and sub-objectives. As work progresses, the WBS provides the framework on which costs, time, and schedule/performance can be compared against the budget for each level of the WBS.

The first purpose of control therefore becomes a verification process accomplished by the comparison of actual performance to date with the predetermined plans and standards set forth in the planning phase. The comparison serves to verify that:

- The objectives have been successfully translated into performance standards.
- The performance standards are, in fact, a reliable representation of program activities and events.
- Meaningful budgets have been established such that actual versus planned comparisons can be made.

In other words, the comparison verifies that the correct standards were selected, and that they are properly used. The second purpose of control is that of decision making. Three useful reports are required by management in order to make effective and timely decisions:

- The project plan, schedule, and budget prepared during the planning phase.
- A detailed comparison between resources expended to data and those predetermined. This includes an estimate of the work remaining and the impact on activity completion.
- A projection of resources to be expended through program completion.

Afterwards, these reports are then supplied to both the managers and the doers. Three useful results arise through the use of these three reports, generated during a thorough decision-making stage of control:

- Feedback to management, the planners, and the doers.
- Identification of any major deviations from the current program plan, schedule, or budget.
- The opportunity to initiate contingency planning early enough that cost, performance, and time requirements can undergo corrected action without loss of resources.
- These reports, if properly prepared, provide management with the opportunity to minimize downstream changes by making proper corrections here and now. As shown in Figures 40.2 and 40.3, possible cost reductions are usually available more readily in the early project phases, but are reduced as we go further into the project life-cycle phases. Downstream the cost for changes could easily exceed the original cost of the project. This is an example of the "iceberg" syndrome, where problems become evident too late in the project to be solved easily, resulting in a very high cost to correct them.

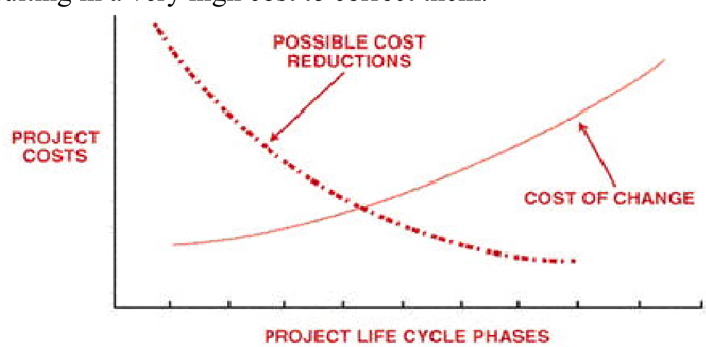


Figure 40.2: Cost Reduction Analysis

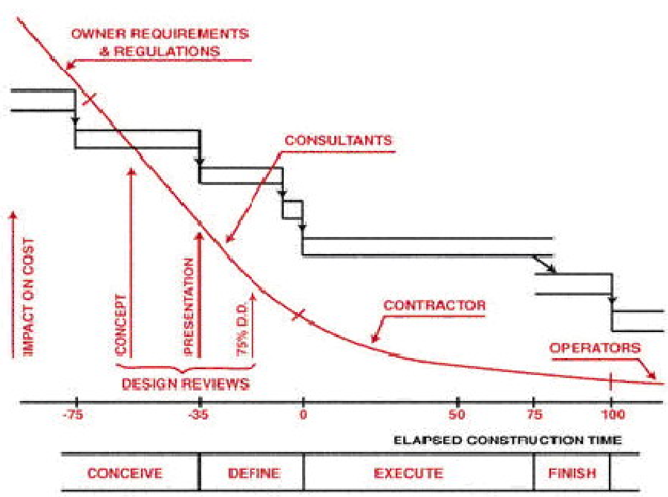


Figure 40.3: Ability to Influence Cost

40.5 Operating Cycle:

The Management Cost and Control System (MCCS) takes on paramount importance during the operating cycle of the project. The operating cycle is composed of four phases:

- Work authorization and release (phase II)
- Cost data collection and reporting (phase III)
- Cost analysis (phase IV)
- Reporting: customer and management (phase V)

These four phases, when combined with the planning cycle **(phase I),** constitute a closed system network that forms the basis for the management cost and control system.

Phase II is considered as work release. After planning is completed and a contract is received, work is authorized via a work description document. The work description, or project work authorization form, is a contract that contains the narrative description, organization, and time frame for *each* Work Breakdown Structure (WBS) level. This multipurpose form is used to release the contract, authorize planning, record detail description of the work outlined in the Work Breakdown Structure (WBS), and release work to the functional departments.

Note that the contract services may require a work description form to release the contract. The contractual work description form sets forth general contractual requirements and authorizes program management to proceed.

Program management may then issue a subdivided work description form to the functional units so that work can begin. The subdivided work description may also be issued through the combined efforts of the project team, and may be revised or amended when either the scope of time frame changes. The subdivided work description generally is not used for efforts longer than ninety days and must be "tracked" as if a project in itself. This subdivided work description form sets forth contractual requirements and planning guidelines for the applicable performing organizations.

Also, the subdivided work description package established during the proposal and updated after negotiations by the program team is incrementally released by program management to the work control centers in manufacturing engineering, publications, and program management as the authority for release of work orders to the performing organizations. The subdivided work description specifies how contractual requirements are to be accomplished, the functional organizations involved, and their specific responsibilities, and authorizes the expenditure of resources within a particular time frame.

The work control center assigns a work order number to the subdivided work description form, if no additional instructions are required, and releases the document to the performing organizations. If additional instructions are required, the work control center can prepare a more detailed work release document (shop traveler, tool order, work order release), assign the applicable work order number, and release it to the performing organization.
In addition to this, a work order number is required for all in-house direct and indirect charging. The work order number also serves as a cross-reference number for automatic assignment of the indentured work breakdown structure number to labor and material data records in the computer.

In case of small companies, they can avoid this additional paperwork cost by going directly from an awarded contract to a single work order, which may be the only work order needed for the entire contract.

40.6 Cost Account Codes:

It must be noted that since project managers control resources through the line managers rather than directly, project managers end up controlling direct labor costs by opening and closing work orders. Work orders define the charge numbers for each cost account. By definition, a cost account is an identified level at a natural intersection point of the work breakdown structure and the *Organizational Breakdown Structure (OBS)* at which functional responsibility for the work is assigned, and actual direct labor, material, and other direct costs are compared with actual work performed for management control purposes.

Cost accounts are the focal point of the Management Cost and Control System (MCCS) and may comprise several work packages, as shown in Figure 40.4. Work packages are detailed short –span job or material items identified for the accomplishment of required work. To illustrate this, consider the cost account code breakdown shown in Figure 40.5 and the work authorization form shown in Figure 40.6. The work authorization form specifically identifies the cost centers that are "open" for this charge number, the man-hours available for each cost center, and the operational time period for the charge number. Because the exact dates of operation are completely defined, the charge number can be assigned perhaps as much as a year in advance of the work-begin date. This can be shown pictorially, as in Figure 40.7.

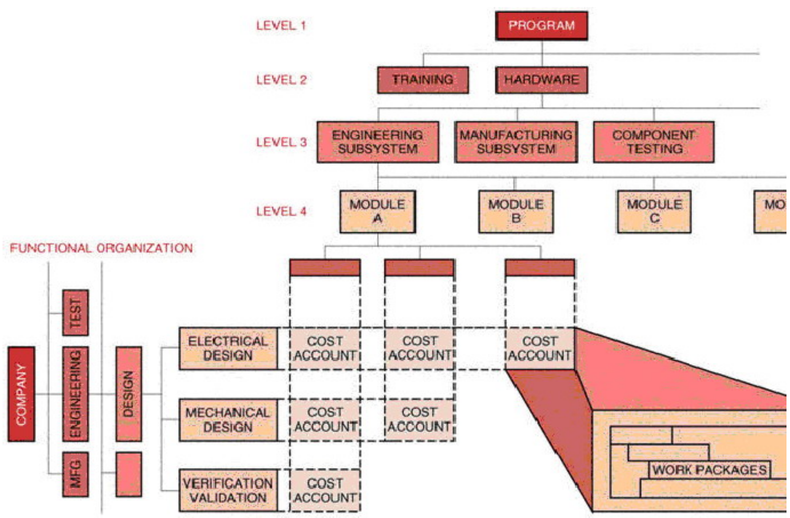


Figure 40.4: Cost Account Intersection

If the man-hours are assigned to cost center 2400, then any 24xx cost center can use this charge number. If the work authorization form specifies cost center 2610, then any 261x cost center can use the charge number.

However, if cost center 2623 is specified, then no lower cost accounts exist, and this is the only cost center that can use this work order charge number. In other words, if a charge number is opened up at the department level, then the department manager has the right to subdivide the assigned man-hours among the various sections and subsections.

Company policy usually identifies the permissible cost center levels that can be assigned in the work authorization form. These permissible levels are related to the work breakdown structure level. For example, cost center 5000 (i.e., divisional) can be assigned at the project level of the work breakdown structure, but only department, sectional, or sub-sectional cost accounts can be assigned at the task level of the work breakdown structure.

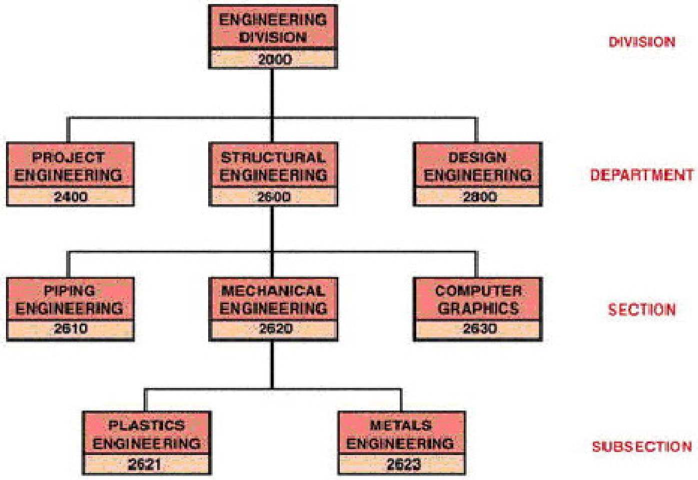


Figure 40.5: Cost Account Code Breakdown

WORK AUTHORIZATION FORM

WBS NO: 31-03-02 WORK ORDER NO: D1385
DATE OF ORIGINAL RELEASE: 3 FEB 93
DATE OF REVISION: : 18 MAR 93
REVISION NUMBER: : C

DESCRIPTION	COST CENTERS	HOURS	WORK BEGINS	WORK ENDS
TEST MATERIAL VB-2 IN ACCORDANCE WITH THE PROGRAM PLAN AND MIL STANDARD G1483-52. THIS TASK INCLUDES A WRITTEN REPORT.	2400 2610 2621 2623 5000*	150 160 140 46 600	1 AUG 93	15 SEPT 93

PROJECT OFFICE AUTHORIZATION SIGNATURE ____________

*NOTE: SOME COMPANIES DO NOT PERMIT DIVISION COST CENTERS TO CHARGE AT LEVEL 3 OF THE WBS

Figure 40.6: Work Authorization Form

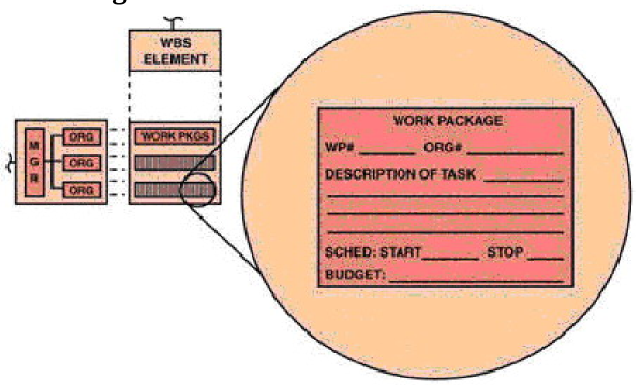
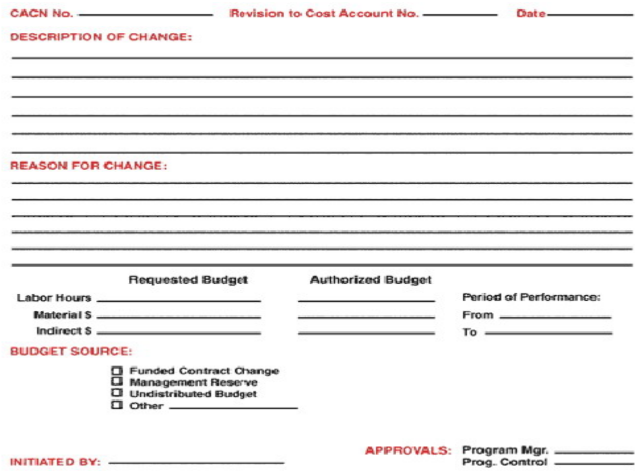


Figure 40.7: Planning and Budgeting Describe, Plan, and Schedule the Work

If a cost center needs additional time or additional man-hours, then a cost account change notice form must be initiated, usually by the requesting cost center, and approved by the project office.

The following Figure 40.8 shows a typical cost account change notice form.


CACN No. ____ Revision to Cost Account No. ____ Date ____

DESCRIPTION OF CHANGE:

REASON FOR CHANGE:

	Requested Budget	Authorized Budget	
Labor Hours	____	____	Period of Performance:
Material $	____	____	From ____
Indirect $	____	____	To ____

BUDGET SOURCE:

- ☐ Funded Contract Change
- ☐ Management Reserve
- ☐ Undistributed Budget
- ☐ Other ____

INITIATED BY: ____ APPROVALS: Program Mgr. ____ Prog. Control ____

Figure 40.8: Cost Account Change Notice (CACN)

Almost all large companies have computerized cost control and reporting systems. Small companies have manual or partially computerized systems. The major difficulty in using the cost account code breakdown and the work authorization form (shown in Figures 40.5 and 40.6) is related to whether the employees fill out time cards, and frequency with which the time cards are filled out.

Project-driven organizations fill out time cards at least once a week, and the cards are inputted to a computerized system. Non–project-driven organizations fill out time cards on a monthly basis, with computerization depending on the size of the company.

Cost data collection and reporting constitute the second phase of the operating cycle of the Management Cost and Control System (MCCS). *Actual cost for work performed (ACWP)* and the *budgeted cost for work performed (BCWP)* for each contract or in-house project are accumulated in detailed cost accounts by cost center and cost element, and reported in accordance with the flow charts shown in Figure 40.9. These detailed elements, for both actual costs incurred and the budgeted cost for work performed, are usually printed out monthly for all levels of the work breakdown structure. In addition, weekly supplemental direct labor reports can be printed showing the actual labor charge incurred, and can be compared to the predicted efforts.

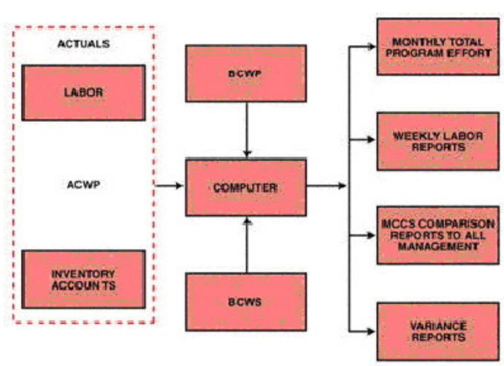


Figure 40.9: Cost Data Collection and Reporting Flow Chart

The following Table 40.1 shows a typical weekly labor report. The first column identifies the Work Breakdown Structure (WBS) number. If more than one work order were assigned to this Work Breakdown Structure (WBS) element, then the work order number would appear under the WBS number. This procedure would be repeated for all work orders under the same WBS number. The second column contains the cost centers charging to this WBS element (and possibly work order numbers). Cost Center 41xx represents department 41 and is a rollup of Cost Centers 4110, 4115, and 4118. Cost Center 4xxx represents the entire division and is a rollup of all 4000-level departments. Cost Center xxxx represents the total for all divisions charging to this Work Breakdown Structure (WBS) element. The weekly labor reports must list all cost centers authorized to charge to this WBS element, whether or not they have incurred any costs over the last reporting period.

WBS No:	Cost Center	H $	Weekly Actual	Current Month Subtotal	Previous Month		Year to Date		
					ACWP	BCWP	ACWP	BCWP	BC
01-03-06	4110	H	200	300	300	300	1000	1000	1
		$	1000	1500	1500	1500	5000	5000	5
	4115	H	200	300	300	300	1000	1000	1
		$	1000	1500	1500	1500	5000	5000	5
	4118	H	200	300	300	300	1000	1000	1
		$	1000	1500	1500	1500	5000	5000	5
	41XX	H	600	900	900	900	900	900	[illegible]
		$	3000	4500	4500	4500	4500	4500	4
	4443	H	100	200	400	360	800	700	1
		$	600	1200	2400	2260	4800	4200	8
	4446	H	200	400	1000	1200	2000	2000	2
		$	800	1600	4000	4800	8000	8000	9
	4448	H	300	600	1000	1200	2000	2000	2
		$	1500	3000	5000	6000	10000	10000	11
	44XX	H	600	1200	2400	2760	4800	4700	6
		$	2900	5800	11400	13060	22800	22200	29
	4XXX	H	1200	2100	3300	3660	5700	5600	6
		$	5900	10300	15900	17560	27300	26700	33
	XXXX	H	8000	18000	20000	19000	50000	48000	47
		$	56000	126000	140000	133000	350000	336000	329

Table 40.1: Weekly Labor Report

Note that most weekly labor reports provide current month subtotals and previous month totals. Although these also appear on the detailed monthly report, they are included in the weekly report for a quick and dirty comparison. Year-to-date totals are usually not on the weekly report unless the users request them for an immediate comparison to the *estimate at completion (EAC)* and the work order release.

Weekly labor output is a vital tool for members of the program office in that these reports can indicate trends in cost and performance in sufficient time for contingency plans to be established and implemented. If these reports are not available, then cost and labor overruns would not be apparent until the following month when the detailed monthly labor, cost, and materials output was obtained. In Table 40.1, Cost Center 4110 has spent its entire budget. The work appears to be completed on schedule. The responsible program office team may wish to eliminate this cost center's authority to continue charging to this Work Breakdown Structure (WBS) element by issuing a new SWD or work order canceling this department's efforts. Cost Center 4115 appears to be only halfway through.

If time is becoming short, then Cost Center 4115 must add resources in order to meet requirements. Cost Center 4443 appears to be heading for an overrun. This could also indicate a management reserve. In this case the responsible program team member feels that the work can be accomplished in fewer hours.

Work order releases are used to authorize certain cost centers to begin charging their time to a specific cost reporting element. Work orders specify hours, not dollars. The hours indicate the "targets" that the program office would like to have the department shoot for. If the program office wished to be more specific and "compel" the departments to live within these hours, then the *budgeted cost for work scheduled (BCWS)* should be changed to reflect the reduced hours.

Four categories of cost data are normally accumulated:

- Labor
- Material
- Other direct charges
- Overhead

We know that the project managers can maintain reasonable control over labor, material, and other direct charges.

On the other hand, overhead costs are calculated yearly or monthly and applied retroactively to all applicable programs. Management reserves are often used to counterbalance the effects of adverse changes in overhead rates.

40.7 Budgets:

The project budget, which is the final result of the planning cycle of the Management Cost and Control System (MCCS), must be **reasonable, attainable,** and based on:

- Contractually negotiated costs, and
- The statement of work

The basis for the budget is:

- Historical cost,
- Best estimates, or
- Industrial engineering standards

The budget must identify:

- Planned manpower requirements,
- Contract allocated funds, and
- Management reserve.

All budgets must be traceable through the budget "log," which includes:

- Distributed budget
- Management reserve
- Undistributed budget
- Contract changes

It is important to note that the management reserve is the dollar amount established by the project office to budget for all categories of unforeseen problems and contingencies resulting in out-of-scope work to the performers. Management reserve should be used for tasks or dollars, such as rate changes, and not to cover up bad planning estimates or budget overruns. When a significant change occurs in the rate structure, the total performance budget should be adjusted.

In addition to the "normal" performance budget and the management reserve budget, there also exists the following:

- **Undistributed budget**, which is that budget associated with contract changes where time constraints prevent the necessary planning to incorporate the change into the performance budget. (This effort may be time-constrained.)
- **Unallocated budget**, which represents a logical grouping of contract tasks that have not yet been identified and/or authorized.

Variance:

A variance is defined as any schedule, technical performance, or cost deviation from a specific plan. Variances are used by all levels of management to verify the budgeting system and the scheduling system. The budgeting and scheduling system variance must be compared together because:

- The cost variance compares deviations only from the budget and does not provide a measure of comparison between work scheduled and work accomplished.

- The scheduling variance provides a comparison between planned and actual performance but does not include costs.

There are two primary methods of measurement:

- ***Measurable efforts:*** Discrete increments of work with a definable schedule for accomplishment, whose completion produces tangible results.
- ***Level of effort:*** Work that does not lend itself to subdivision into discrete scheduled increments of work, such as project support and project control.

Variances are used on both types of measurement:
In order to calculate variances we must define the three basic variances for budgeting and actual costs for work scheduled and performed. Archibald defines these variables:

- Budgeted cost for work scheduled (BCWS) is the budgeted amount of cost for work scheduled to be accomplished plus the amount or level of effort or apportioned effort scheduled to be accomplished in a given time period.
- Budget cost for work performed (BCWP) is the budgeted amount of cost for completed work, plus budgeted for level of effort or apportioned effort activity completed within a given time period. This is sometimes referred to as "earned value."
- Actual cost for work performed (ACWP) is the amount reported as actually expended in completing the work accomplished within a given time period.

COST MANAGEMENT AND CONTROL IN PROJECTS

BROAD CONTENTS

Budget
Variances & Earned Value
ACWP, BCWS, BCWP
Cost & Schedule Variance
CPI, SPI
Variance Analysis (V/A)
Depreciation & Ethics

41.1 Budgets

The project budget, which is the final result of the planning cycle of the MCCS, must be reasonable, attainable, and based on:
- Contractually Negotiated Costs And
- The Statement of Work.

The basis for the budget is:
- Historical Cost,
- Best Estimates, Or
- Industrial Engineering Standards.

The budget must identify:
- Planned Manpower Requirements,
- Contract Allocated Funds, And
- Management Reserve.

All budgets must be traceable through the budget "log," which includes:
- Distributed budget
- Management reserve
- Undistributed budget
- Contract changes

Management reserve is the dollar amount established by the project office to budget for all categories of unforeseen problems and contingencies resulting in out-of-scope work to the performers. Management reserve should be used for tasks or dollars, such as rate changes, and not to cover up bad planning estimates or budget overruns. When a significant change occurs in the rate structure, the total performance budget should be adjusted.
In addition to the "normal" performance budget and the management reserve budget, there also exists the following: Undistributed budget, which is that budget associated with contract changes where time constraints prevent the necessary planning to incorporate the change into the performance budget. (This effort may be time-constrained.) Unallocated budget, which represents a logical grouping of contract tasks that have not yet been identified and/or authorized.

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Measurable efforts: discrete increments of work with a definable schedule for accomplishment, whose completion produces tangible results.
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Actual cost for work performed (ACWP) is the amount reported as actually expended in completing the work accomplished within a given time period.

Planned Value (PV) What Plan should be worth at this point in “Schedule”. Also BCWS: Budgeted amount of “Cost for work Schedule” to be accomplished Plus “Amount or level of effort for “Schedule” to be Accomplished at a given time period.

Earned Value (EV) Physical work completed to date & with in authorized “Budget” for that.
The budget at completion is the sum of all budgets (BCWS) allocated to the project. This is often synonymous with the project baseline. This is what the total effort should cost. The estimate at completion identifies either the dollars or hours that represent a realistic appraisal of the work when performed. It is the sum of all direct and indirect costs to date plus the estimate of all authorized work remaining (EAC = cumulative actuals + the estimate-to-complete).
Using the above definitions, we can calculate the variance at completion (VAC):

$$VAC = BAC - EAC$$

The estimate at completion (EAC) is the best estimate of the total cost at the completion of the project.
The EAC is a periodic evaluation of the project status, usually on a monthly basis or until a significant change has been identified. It is usually the responsibility of the performing organization to prepare the EAC.

These costs can then be applied to any level of the work breakdown structure (i.e., program, project, task, subtask, work package) for work that is completed, in-program, or anticipated. Using these definitions, the following variance definitions are obtained:
Cost variance (CV) calculation:

$$CV = BCWP - ACWP$$

A negative variance indicates a cost-overrun condition.
Schedule variance (SV) calculation:

$$SV = BCWP - BCWS$$

A negative variance indicates a behind-schedule condition.
In the analysis of both cost and schedule, costs are used as the lowest common denominator. In other words, the schedule variance is given as a function of cost. To alleviate this problem, the variances are usually converted to percentages:

$$\text{Cost variance \% (CVP)} = \frac{CV}{BCWP}$$

$$\text{Schedule variance \% (SVP)} = \frac{SV}{BCWS}$$

The schedule variance may be represented by hours, days, weeks, or even dollars.
As an example, consider a project that is scheduled to spend $100K for each of the first four weeks of the project. The actual expenditures at the end of week four are $325K. Therefore, BCWS = $400K and ACWP = $325K. From these two parameters alone, there are several possible explanations as to project status. However, if BCWP is now known, say $300K, and then the project is behind schedule and overrunning costs.

Variances are almost always identified as critical items and are reported to all organizational levels.
Critical variances are established for each level of the organization in accordance with management policies.

Not all companies have a uniform methodology for variance thresholds. Permitted variances may be dependent on such factors as:

- Life-cycle phase
- Length of life-cycle phase
- Length of project
- Type of estimate
- Accuracy of estimate

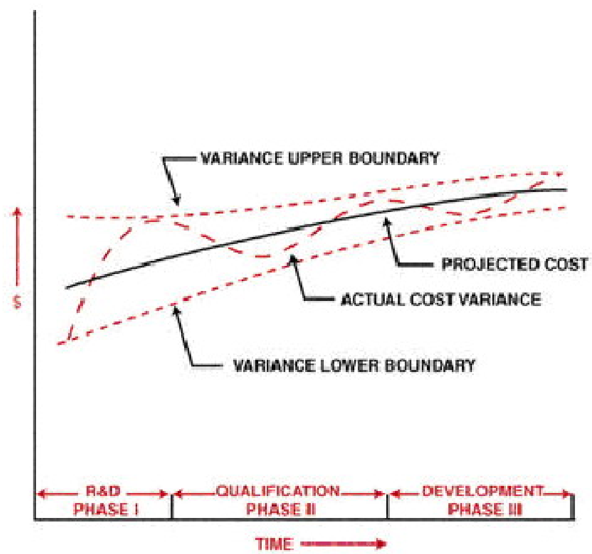

Figure 41.1: Project variance projections

Figure 41.1 shows time-phased cost variances for a program requiring research and development, qualification, and production phases. Since the risk should decrease as time goes on, the variance boundaries are reduced. Figure 41.2 shows that the variance envelope in such a case may be dependent on the type of estimate.

LIFE CYCLE PHASE	MANPOWER REQUIRED	$ REQUIRED	TIME DURATION	TYPE OF ESTIMATE	ACCURACY	PERMITTEI VARIANCE
MAIN	16,000 HRS.	1,285,600	6 MOS	HISTORY	±5%	± 2%

Figure 41.2: Methodology to variance

By using both cost and schedule variance, we can develop an integrated cost/schedule reporting system that provides the basis for variance analysis by measuring cost performance in relation to work accomplished. This system ensures that both cost budgeting and performance scheduling are constructed on the same database.

COST PERFORMANCE INDEX (CPI)

41.2.2 In addition to calculating the cost and schedule variances in terms of dollars or percentages, we also want to know how efficiently the work has been accomplished. The formulas used to calculate the performance efficiency as a percentage of BCWP are:

$$\text{Cost performance index (CPI)} = \frac{\text{BCWP}}{\text{ACWP}}$$

$$\text{Schedule performance index (SPI)} = \frac{\text{BCWP}}{\text{BCWS}}$$

If CPI = 1.0, we have perfect performance. If CPI > 1.0, we have exceptional performance. If CPI < 1.0, we have poor performance. The same analysis can be applied to the SPI.

Variance Analysis

41.2.3 The cost and schedule performance index is most often used for trend analysis as shown in Figure 41.3. Companies use either three-month, four-month, or six-month moving averages to predict trends. The usefulness of trend analysis is to take corrective action to alleviate unfavorable trends by having an early warning system. Unfortunately, effective use of trend analysis may be restricted to long-term projects because of the time needed to correct the situation.

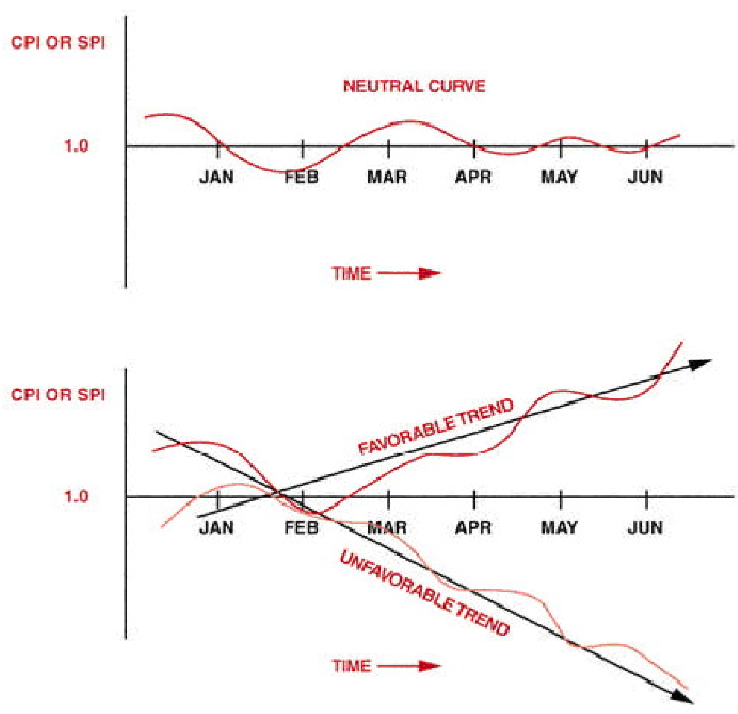

Figure 41.3: The performance index

Figure 41.4 shows an integrated cost/schedule system. The figure identifies a performance slippage to date. This might not be a bad situation if the costs are proportionately under-run. However, from the upper portion of Figure 41.4, we find that costs are overrun (in comparison to budget costs), thus adding to the severity of the situation.

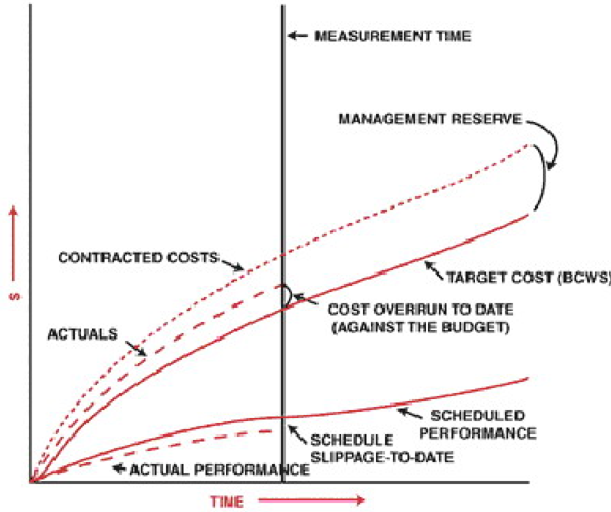

Figure 41.4: Integrated cost/schedule system

Also shown in Figure 41.4 is the management reserve. This is identified as the difference between the contracted cost for projected performance to date and the budgeted cost. Management reserves are the contingency funds established by the program manager to counteract unavoidable delays that can affect the project's critical path.
For variance analysis, goal of cost account Manager To take action that will correct problem within original budget or justify a new estimation.

Five Questions must be addressed during variance analysis:

- What is the problem causing the variance?
- What is the impact on time, cost, and performance?
- What is the impact on other efforts, if any?
- What corrective action is planned or under way?
- What are the expected results of the corrective action?

One of the key parameters used in variance analysis is the "earned value" concept, which is the same as BCWP. Earned value is a forecasting variable used to predict whether the project will finish over or under the budget. As an example, on June 1, the budget showed that 800 hours should have been expended for a given task. However, only 600 hours appeared on the labor report. Therefore, the performance is (800/600) × 100, or 133 percent, and the task is under running in performance. If the actual hours were 1,000, the performance would be 80 percent, and an overrun would be occurring.
The difficulty in performing variance analysis is the calculation of BCWP because one must predict the percent complete. To eliminate this problem, many companies use standard dollar expenditures for the project, regardless of percent complete. For example, we could say that 10 percent of the costs are to be "booked" for each 10 percent of the time interval. Another technique, and perhaps the most common, is the 50/50 rule:

50/50 rule

Half of the budget for each element is recorded at the time that the work is scheduled to begin, and the other half at the time that the work is scheduled to be completed. For a project with a large number of elements, the amount of distortion from such a procedure is minimal. 50/50 rule eliminate the necessity for the continuous determination of percent complete.

41.3 Depreciation

41.3.1 Depreciation is the technique used to compute "Estimated value" of any object after few years. Some types are:

1. Straight line depreciation same amount deprecated (reduced) from cost each year.
2. Double-declining balance First year - high "Deduction in value" Twice amount of straight line. Each year after that deduction 40% less than previous year.
3. Sum of year depreciation If life - 5 years. Total of 1-5 is 15 first year deduce 5/15 from cost, in 2nd year Deduce 4/15, & so on.

41.3.2 Parametric Modeling Estimation

This is the use of mathematical model to make estimation. Following are the two types of PME.

Regression Analysis: Mathematical model based upon historical information.

Learning Curve: Model based upon principal Cost/unit describes as more work, Gets completed.

41.3.3 Analogous Estimating

Estimation technique with characteristics Estimation based on past Project (historical information) less accurate compared to bottom-up estimation Top-down approach Takes less time compared to bottom-up estimation Form of an expert judgment.

41.3.4 Ethics

Ethics are standards of right & wrong that influence behavior. Right behavior is considered ethical & wrong behavior is considered unethical. Major concern to both managers & employee.

A set of beliefs about right & wrong principles of conduct governing an individual or a group behavior that is fair & just, over & above obedience to laws & regulations
Ethics guide people in dealings with stack holders & others, to determine appropriate actions. Project Manager often must choose between the conflicting interests of stakeholders.

LESSON 42

PROJECT MANAGEMENT THROUGH LEADERSHIP

BROAD CONTENTS

Leadership
Transformational leadership
Vision
Leadership grid & managerial grid

42.1 Leadership

Leadership is a process of getting things done through people. The quarterback moves the team toward a touchdown. The senior patrol leader guides the troop to a high rating at the camporee. The mayor gets the people to support new policies to make the city better. These leaders are getting things done by working through people -- football players, Scouts, and ordinary citizens. They have used the process of leadership to reach certain goals.

Leadership is not a science. So being a leader is an adventure because you can never be sure whether you will reach your goal -- at least this time. The touchdown drive may end in a fumble. The troop may have a bad weekend during the camporee. Or the city's citizens may not be convinced that the mayor's policies are right. So these leaders have to try again, using other methods. But they still use the same *process* the process of good leadership.

Leadership means responsibility. It's adventure and often fun, but it always means responsibility. The leader is the guy the others look to to get the job done. So don't think your job as a troop leader or a staff member will be just an honor. It's more than that. It means that the other Scouts expect you to take the responsibility of getting the job done. If you lead, they will do the job. If you don't, they may expect you to do the job all by yourself.

That's why it's important that you begin right now to learn what leadership is all about.
Wear your badge of office proudly. It does not automatically make you a good leader. But it identifies you as a Scout who others want to follow -- if you'll let them by showing leadership.

You are not a finished leader. No one ever is, not even a president or prime minister. But you are an explorer of the human mind because now you are going to try to learn how to get things done through people. This is one of the keys to leadership.

You are searching for the secrets of leadership. Many of them lie locked inside you. As you discover them and practice them, you will join a special group of people-skilled leaders.
Good exploring -- both in this handbook and with the groups you will have a chance to lead.

The Tasks of Leadership

In this section, we will consider several common statements about the people who serve in leadership positions throughout our world. After you have read the statement, decide for yourself whether you feel it is true or false and why you think it is.
Here is the first one. True or false?

The only people who lead have some kind of leadership job, such as chairman, coach, or king.
Do you think that's true? Don't you believe it. It's true that chairmen, coaches, and kings lead, but people who hold no leadership position also lead. And you can find some people who have a leader's title and ought to lead. But they don't.

In other words, you are not a leader because you wear the leader's hat or because you wear the patrol leader's insignia on your uniform. You are a leader only when you are getting things done through other people.

Leadership, then, is something people do. Some people inherit leadership positions, such as kings, or nobles, or heads of family businesses. Some are elected: chairman, governor, patrol leader. Some are appointed, such as a coach, a city manager, or a den chief. Or they may just happen to be there when a situation arises that demands leadership. A disaster occurs, or a teacher doesn't show up when class begins, or a patrol leader becomes sick on a campout.
Try this statement. Is it true or false?

Leadership is a gift. If you are born with it, you can lead. If you are not, you can't.
Some people will tell you that. Some really believe it. But it's not so.
Leadership does take skill. Not everyone can learn all the skills of leadership as well as anyone else. But most people can learn some of them -- and thus develop their own potential.
You don't have to be born with leadership. Chances are, you weren't. But you were born with a brain. If you can learn to swim or play checkers or do math, you can learn leadership skills.
How about this statement. True or false?

"Leader" is another word for "boss."
Well, what do you mean by "boss"? A guy who pushes and orders other people around? No, a leader is not one of those. (But some people try to lead this way.)
Or do you mean a boss is somebody who has a job to do and works with other people to get it done? This is true. A leader is a boss in that sense.
True or false?

Being a leader in a Scout troop is like being a leader anywhere else.
This one is true. When you lead in a Scout troop, you will do many of the same things as any leader anywhere.

The important thing now is Scouting gives you a chance to lead. You can learn *how* to lead in Scouting. You can practice leadership in Scouting. Then you can lead other groups, too. The skills you will need are very much the same.

What does a leader deal with?

Every leader deals with just two things. Here they are: the ***job*** and the ***group.***

The job is what's to be done. The "job" doesn't necessarily mean work. It could be playing a game. It could be building a skyscraper. It could be getting across an idea.
A leader is needed to get the job done. If there were no job, there would be no need for a leader.

The group, such as a patrol, is the people who do the job. And in many cases, the group continues after the job is done. This is where leading gets tough, as you'll see later.

Think about this situation. Mark has a lot of firewood to split. There he is, all alone with his ax. He's got a job to do. Is he a leader?

We have to say in this situation that Mark won't be leading. Why? No group. There's nobody on the job but Mark.

Here's another example. Danny and three of his friends are on their bikes. They have no place to go. They're just riding slowly, seeing how close they can get to each other.
Is Danny -- or any one of the others -- a leader?

From what we know, we have to say no. Why? No job. There's a group of friends, but nothing special to be done. You don't need a leader for that. (You don't need a group, either.)

The Job of a Leader

A leader works with two things: a job and a group. You can always tell when a leader succeeds, because:
1. The job gets done.
2. The group holds together.
Let's see why it takes both.

Frank was elected patrol leader. That same week, the patrol had a job cleaning up an old cemetery.
It was Frank's first leadership position, and he wanted it to go right. In his daydream he could see the Scoutmaster praising him for the great cleanup job. So, when Saturday morning came, Frank and the patrol went over to the cemetery, and Frank started to get the job done.
He hollered. He yelled. He threatened. He called them names. He worked like a tiger himself. It was a rough day, but the cemetery got cleaned up.
Frank went home sort of proud, sort of mad, and very tired.
"How'd things go, Frank?" the Scoutmaster asked a few days later.
"Good."
"No problems?"
"No." Frank wondered what he meant by that.
"Oh! Well, a couple of the boys in your patrol asked me if they could change to another patrol. I thought maybe something had gone wrong...."
And that was how Frank learned that getting the job done isn't all there is to leadership. He had really given the group a hard time, and now they wanted to break up.
Almost anybody with a whip and a mean temper can get a job done. But in doing it, they usually destroy the group. And that's not leadership. The group must go on.
Another new patrol leader called a meeting at his house. Everybody seemed to be hungry when they came. So they got some snacks from the kitchen. Then they tossed a football around. It began to get dark, and one by one they went home. Everybody had fun. But the patrol meeting -- the job -- never started.

One of the following statements is the message of this section. Which one?
a. Nice guys finish last.
b. Mean guys finish last.
c. Leaders get the job done and keep the group going.
d. Leaders have a special title or badge that makes others like to follow.
We'll take the third one. Will you?

What affects leadership?

Leadership is not magic that comes out of a leader's head. It's skill. The leader learns how to get the job done and still keep the group together.
Does this mean that the leader does the same things in every situation? No. Here's why.
Leadership differs with the *leader*, the *group*, and the *situation*.

Leaders -- like other people are all different. No leader can take over another leader's job and do it the same way.

Groups are different, too. A great football coach might have difficulty leading an orchestra. A good sergeant might be a poor Scoutmaster. So when a leader changes groups, he changes the way he leads.

Situations differ, too. The same leader with the same group must change with conditions. A fellow leading a group discussion needs to change his style of leadership when a fire breaks out. As a Scout leader, you probably can't lead the group in the rain the same as you do in the sunshine.
An effective leader, then, must be alert at all times to the reaction of the members of the group; the conditions in which he may find himself; and be aware of his own abilities and reactions.

Leadership Develops

Picture a long scale like a yardstick. On the low end, there are no leadership skills. On the other end, there is a complete set of leadership skills.
Everyone is somewhere between those ends!
Where do you find yourself at this time? Unknowingly, you may be further up the scale than you realize. As a staff member you'll now have the opportunity to find out.

Ten Characteristics of a Leader

After some years of carefully considering Greenleaf's original writings, I have identified a set of ten characteristics of the leader that I view as being of critical importance--central to the development of leaders. My own work currently involves a deepening understanding of the following characteristics and how they contribute to the meaningful practice of leadership. These ten characteristics include:

Listening: Leaders have traditionally been valued for their communication and decisionmaking skills. Although these are also important skills for the leader, they need to be reinforced by a deep commitment to listening intently to others. The leader seeks to identify the will of a group and helps to clarify that will. He or she listens receptively to what is being said and unsaid. Listening also encompasses getting in touch with one's own inner voice. Listening, coupled with periods of reflection, are essential to the growth and well-being of the leader.

Empathy: The leader strives to understand and empathize with others. People need to be accepted and recognized for their special and unique spirits. One assumes the good intentions of co-workers and colleagues and does not reject them as people, even when one may be forced to refuse to accept certain behaviors or performance. The most successful leaders are those who have become skilled empathetic listeners.

Healing: The healing of relationships is a powerful force for transformation and integration. One of the great strengths of leadership is the potential for healing one's self and one's relationship to others. Many people have broken spirits and have suffered from a variety of emotional hurts. Although this is a part of being human, leaders recognize that they have an opportunity *to help make whole* those with whom they come in contact. In his essay, *The Servant as Leader*, Greenleaf writes, "There is something subtle communicated to one who is being served and led if, implicit in the compact between leader and led, is the understanding that the search for wholeness is something they share."

Awareness: General awareness, and especially self-awareness, strengthens the leader. Awareness helps one in understanding issues involving ethics, power and values. It lends itself to being able to view most situations from a more integrated, holistic position. As Greenleaf observed: "Awareness is not a giver of solace--it is just the opposite. It is a disturber and an awakener. Able leaders are usually sharply awake and reasonably disturbed. They are not seekers after solace. They have their own inner serenity."

Persuasion: Another characteristic of leaders is a reliance on persuasion, rather than on one's positional authority, in making decisions within an organization. The leader seeks to convince others, rather than coerce compliance. This particular element offers one of the clearest distinctions between the traditional authoritarian model and that of leadership. The leader is effective at building consensus within groups. This emphasis on persuasion over coercion finds its roots in the beliefs of the Religious Society of Friends (Quakers)--the denominational body to which Robert Greenleaf belonged.

Conceptualization: Leaders seek to nurture their abilities to *dream great dreams*. The ability to look at a problem or an organization from a conceptualizing perspective means that one must think beyond day-to-day realities. For many leaders, this is a characteristic that requires discipline and practice. The traditional leader is consumed by the need to achieve short-term operational goals. The leader who wishes to also be a leader must stretch his or her thinking to encompass broader-based conceptual thinking. Within organizations, conceptualization is, by its very nature, the proper role of boards of trustees or directors. Unfortunately, boards can sometimes become involved in the day-to-day operations--something that should always be discouraged--and, thus, fail to provide the visionary concept for an institution. Trustees need to be mostly conceptual in their orientation, staffs need to be mostly operational in their perspective, and the most effective executive leaders probably need to develop both perspectives within themselves. Leaders are called to seek a delicate balance between conceptual thinking and a day-to-day operational approach.

Foresight: Closely related to conceptualization, the ability to foresee the likely outcome of a situation is hard to define, but easier to identify. One knows foresight when one experiences it. Foresight is a characteristic that enables the leader to understand the lessons from the past, the realities of the present, and the likely consequence of a decision for the future. It is also deeply rooted within the intuitive mind. Foresight remains a largely unexplored area in leadership studies, but one most deserving of careful attention.

Stewardship: Peter Block (author of *Stewardship* and *The Empowered Manager*) has defined stewardship as "holding something in trust for another." Robert Greenleaf's view of all institutions was one in which CEO's, staffs, and trustees all played significant roles in holding their institutions in trust for the greater good of society. Leadership, like stewardship, assumes first and foremost a commitment to serving the needs of others. It also emphasizes the use of openness and persuasion, rather than control.

Commitment to the growth of people: Leaders believe that people have an intrinsic value beyond their tangible contributions as workers. As such, the leader is deeply committed to the growth of each and every individual within his or her organization. The leader recognizes the tremendous responsibility to do everything in his or her power to nurture the personal and professional growth of employees and colleagues. In practice, this can include (but is not limited to) concrete actions such as making funds available for personal and professional development, taking a personal interest in the ideas and suggestions from everyone, encouraging worker involvement in decisionmaking, and actively assisting laid-off employees to find other positions.

Building community: The leader senses that much has been lost in recent human history as a result of the shift from local communities to large institutions as the primary shaper of human lives. This awareness causes the leader to seek to identify some means for building community among those who work within a given institution. Leadership suggests that true community can be created among those who work in businesses and other institutions. Greenleaf said, "All that is needed to rebuild community as a viable life form for large numbers of people is for enough leaders to show the way, not by mass movements, but by each leader demonstrating his or her unlimited liability for a quite specific community-related group."

These ten characteristics of leadership are by no means exhaustive. However, they do serve to communicate the power and promise that this concept offers to those who are open to its invitation and challenge.

Interest in the meaning and practice of leadership continues to grow. Hundreds of books, articles, and papers on the subject have now been published. Many of the companies named to *Fortune* magazine's annual listing of "The 100 Best Companies to Work For" espouse leadership and have integrated it into their corporate cultures. As more and more organizations and people have sought to put leadership into practice, the work of The Greenleaf Center for Leadership, now in its 36th year, continues to expand in order to help meet that need.

Leadership characteristics often occur naturally within many individuals; and, like many natural tendencies, they can be enhanced through learning and practice. Leadership offers great hope for the future in creating better, more caring, institutions.

Leadership vs. Management

What is the difference between management and leadership? It is a question that has been asked more than once and also answered in different ways. The biggest difference between managers and leaders is the way they motivate the people who work or follow them, and this sets the tone for most other aspects of what they do.

Many people, by the way, are both. They have management jobs, but they realize that you cannot buy hearts, especially to follow them down a difficult path, and so act as leaders too.

Managers have subordinates

By definition, managers have subordinates - unless their title is honorary and given as a mark of seniority, in which case the title is a misnomer and their power over others is other than formal authority.

Authoritarian, transactional style

Managers have a position of authority vested in them by the company, and their subordinates work for them and largely do as they are told. Management style is transactional, in that the manager tells the subordinate what to do, and the subordinate does this not because they are a blind robot, but because they have been promised a reward (at minimum their salary) for doing so.

Work focus

Managers are paid to get things done (they are subordinates too), often within tight constraints of time and money. They thus naturally pass on this work focus to their subordinates.

Seek comfort

An interesting research finding about managers is that they tend to come from stable home backgrounds and led relatively normal and comfortable lives. This leads them to be relatively risk-averse and they will seek to avoid conflict where possible. In terms of people, they generally like to run a 'happy ship'.

Leaders have followers

Leaders do not have subordinates - at least not when they are leading. Many organizational leaders do have subordinates, but only because they are also managers. But when they want to lead, they have to give up formal authoritarian control, because to lead is to have followers, and following is always a voluntary activity.

Charismatic, transformational style

Telling people what to do does not inspire them to follow you. You have to appeal to them, showing how following them will lead to their hearts' desire. They must want to follow you enough to stop what they are doing and perhaps walk into danger and situations that they would not normally consider risking.

Leaders with a stronger charisma find it easier to attract people to their cause. As a part of their persuasion they typically promise transformational benefits, such that their followers will not just receive extrinsic rewards but will somehow become better people.

People focus

Although many leaders have a charismatic style to some extent, this does not require a loud personality. They are always good with people, and quiet styles that give credit to others (and takes blame on themselves) are very effective at creating the loyalty that great leaders engender.
Although leaders are good with people, this does not mean they are friendly with them. In order to keep the mystique of leadership, they often retain a degree of separation and aloofness.
This does not mean that leaders do not pay attention to tasks - in fact they are often very achievement-focused. What they do realize, however, is the importance of enthusing others to work towards their vision.

Seek risk

In the same study that showed managers as risk-averse, leaders appeared as risk-seeking, although they are not blind thrill-seekers. When pursuing their vision, they consider it natural to encounter problems and hurdles that must be overcome along the way. They are thus comfortable with risk and will see routes that others avoid as potential opportunities for advantage and will happily break rules in order to get things done.
A surprising number of these leaders had some form of handicap in their lives which they had to overcome. Some had traumatic childhoods, some had problems such as dyslexia, others were shorter than average. This perhaps taught them the independence of mind that is needed to go out on a limb and not worry about what others are thinking about you

Manager versus Leader

Both a manager and a leader may know the business well. But the leader must know it better and in a different way. S/he must grasp the essential facts and the underlying forces that determine the past and present trends in the business, so that s/he can generate a vision and a strategy to bring about its future. One telling sign of a good leader is an honest attitude towards the facts, towards objective truth. A subjective leader obscures the facts for the sake of narrow self-interest, partisan interest or prejudice.
Effective leaders continually ask questions, probing all levels of the organization for information, testing their own perceptions, and rechecking the facts. They talk to their constituents. They want to know what is working and what is not. They keep an open mind for serendipity to bring them the knowledge they need to know what is true. An important source of information for this sort of leader is knowledge of the failures and mistakes that are being made in their organization.
To survive in the twenty-first century, we are going to need a new generation of leaders — leaders, not managers. The distinction is an important one. Leaders conquer the context — the turbulent, ambiguous surroundings that sometimes seem to conspire against us and will surely suffocate us if we let them — while managers surrender to it.
Leaders investigate reality, taking in the pertinent factors and analyzing them carefully. On this basis they produce visions, concepts, plans, and programs. Managers adopt the truth from others and implement it without probing for the facts that reveal reality.
There is profound difference — a chasm — between leaders and managers. A *good manager does things right.* A *leader does the right things.* Doing the right things implies a goal, a direction, an objective, a vision, a dream, a path, a reach.
Lots of people spend their lives climbing a ladder — and then they get to the top of the wrong wall. Most losing organizations are over-managed and under-led. Their managers accomplish the wrong things beautifully and efficiently. They climb the wrong wall.
Managing is about efficiency. Leading is about effectiveness. Managing is about how. Leading is about what and why. Management is about systems, controls, procedures, policies, and structure. Leadership is about trust — about people.

Leadership is about innovating and initiating. Management is about copying, about managing the status quo. Leadership is creative, adaptive, and agile. Leadership looks at the horizon, not just the bottom line.
Leaders base their vision, their appeal to others, and their integrity on reality, on the facts, on a careful estimate of the forces at play, and on the trends and contradictions. They develop the means for changing the original balance of forces so that their vision can be realized.
A leader is someone who has the capacity to create a compelling vision that takes people to a new place, and to translate that vision into action. Leaders draw other people to them by enrolling them in their vision. What leaders do is inspire people, empower them.
They pull rather than push. This "pull" style of leadership attracts and energizes people to enroll in a vision of the future. It motivates people by helping them identify with the task and the goal rather than by rewarding or punishing them.
There is a profound difference between management and leadership, and both are important "To manage" means "to bring about, to accomplish, to have charge of or responsibility for, to conduct." "Leading" is "influencing, guiding in direction, course, action, opinion." The distinction is crucial.

Management is….	**Leadership is....**
Coping with complexity	Coping with and promoting change
Planning and Budgeting	Setting a Direction
Organizing and Staffing	Aligning People
Controlling and Problem Solving	Motivating and Inspiring People
Effective Action	Meaningful Action

Both are necessary and important.

Managers are people who do things right and leaders are people who do the right thing. The difference may be summarized as activities of vision and judgment — *effectiveness* —versus activities of mastering routines — *efficiency.* The chart below indicates key words that further make the distinction between the two functions:

- The manager administers; the leader innovates.
- The manager is a copy; the leader is an original.
- The manager maintains; the leader develops.
- The manager accepts reality; the leader investigates it.
- The manager focuses on systems and structure; the leader focuses on people.
- The manager relies on control; the leader inspires trust.
- The manager has a short-range view; the leader has a long-range perspective.
- The manager asks how and when; the leader asks what and why.
- The manager has his or her eye always on the bottom line; the leader has his or her eye on the horizon.
- The manager imitates; the leader originates.
- The manager accepts the status quo; the leader challenges it.
- The manager is the classic good soldier; the leader is his or her own person.
- The manager does things right; the leader does the right thing.

The most dramatic differences between leaders and managers are found at the extremes: poor leaders are despots, while poor managers are bureaucrats in the worst sense of the word. Whilst leadership is a human process and management is a process of resource allocation, both have their place and managers must also perform as leaders. All first-class managers turn out to have quite a lot of leadership ability.

Top Ten Characteristics of a Great Manager

1. Time Management
Supervisory positions can be very stressful and overwhelming when specific deadlines need to be met. Leaders need to be able to handle tasks and assignments in a timely manner. Time is similar to finances and both need to be budgeted wisely.

2. Communication Skills
Communication is fundamental in any aspect of life, especially for management teams and among employee relations. Supervisors need to be capable of communicating clearly with fellow managers, employees, other businesses, and customers. Confidence and personality plays a major role in a manager's ability to communicate. Managers should be experienced with speaking both to groups and individuals.

3. Conflict Resolution
Conflict occurs just about everyday in personal and career based environments. Managers need to be able to listen, identify an issue, agree on the issue, discuss solutions, agree on the solution, and follow up. Conflict between employees may cause awkward tension within the office which can result in slacking or bitterness. Employees should feel comfortable approaching managers regarding conflict and confident that a resolution will be found. Managers will also need to be able to resolve conflict with customers when the time arises. Often clients will become frustrated if something goes wrong and managers need to be able to handle the situation appropriately. It's also important for a follow up check to ensure there are no further problems.

4. Personal Traits
The business industry expects a lot from managers and personality traits are a major aspect. Managers need to be creative, adaptable, charismatic, understanding, confident, mentally stable, tolerate stress well, great listener, and willingness to learn. Management positions are not easy to fill because of all the key qualities necessary and not everyone will possess all of them. I firmly believe certain personality traits are one of the most important aspects required to run a successful organization.

5. Experience
Let's face it, not every manager has previous supervisory experience. Generally each manager wasn't immediately promoted to their position and had to climb their way up the totem pole. Many companies overlook potential managers because they don't have previous leadership experience. Experience should be based off their knowledge of their job title, how many years they have worked in their field, and performance appraisals. Experience is something every employer looks at regardless of what position and it's important for people to realize sometimes they have to start lower than expected in order to earn their position.

6. Goal Setting
Goal setting goes hand-in-hand with time management. Managers need to manage their time wisely and focus on specific goals. Managers also need to be able to assign certain tasks to employees by giving them a goal as well.

7. Responsibility
Being responsible in the workplace is very important. Managers need to ensure assignments, tasks, and deadlines are met. It's also the responsibility of a manager to hire appropriate people for specific positions. Managers are expected to be able to handle a lot and being responsible about every situation will be beneficial in the end.

8. Organization
Managers need to be well organized for many different reasons and in many different areas. Keeping a clean and well organized office will impress others and also make it easier to work. Managers need to encourage employees to also keep their personal space clean and neat. Organizing projects, assignments, and documents is a great way to find them quickly and with ease.

9. Leadership Skills

Managers are leaders in the workplace and need to possess the basic skills. Generally managers were once leaders in other aspects of their life. They might have led youth groups, school projects, plays, and other groups. Being able to handle a group of people and lead them in the right direction is very important.

10. Objective Views

Managers need to remain objective towards their employees, fellow managers, customers, and their own personal work. A manager should not be bias towards a certain group or person. He/she should always remain non-judgmental and give everyone a chance to prove themselves. Having a "favorite" employee should not happen because it's not fair to other employees. Managers should also be able to remember that you should view staff members and customers in a professional manner rather than as a close personal friend.

Seven personal qualities found in a good leader

A good leader has an exemplary character. It is of utmost importance that a leader is trustworthy to lead others. A leader needs to be trusted and be known to live their life with honestly and integrity. A good leader “walks the talk” and in doing so earns the right to have responsibility for others. True authority is born from respect for the good character and trustworthiness of the person who leads.

A good leader is enthusiastic about their work or cause and also about their role as leader. People will respond more openly to a person of passion and dedication. Leaders need to be able to be a source of inspiration, and be a motivator towards the required action or cause. Although the responsibilities and roles of a leader may be different, the leader needs to be seen to be part of the team working towards the goal. This kind of leader will not be afraid to roll up their sleeves and get dirty.

A good leader is confident. In order to lead and set direction a leader needs to appear confident as a person and in the leadership role. Such a person inspires confidence in others and draws out the trust and best efforts of the team to complete the task well. A leader who conveys confidence towards the proposed objective inspires the best effort from team members

A leader also needs to function in an orderly and purposeful manner in situations of uncertainty. People look to the leader during times of uncertainty and unfamiliarity and find reassurance and security when the leader portrays confidence and a positive demeanor.

Good leaders are tolerant of ambiguity and remain calm, composed and steadfast to the main purpose. Storms, emotions, and crises come and go and a good leader takes these as part of the journey and keeps a cool head

A good leader, as well as keeping the main goal in focus, is able to think analytically. Not only does a good leader view a situation as a whole, but is able to break it down into sub parts for closer inspection. While keeping the goal in view, a good leader can break it down into manageable steps and make progress towards it

A good leader is committed to excellence. Second best does not lead to success. The good leader not only maintains high standards, but also is proactive in raising the bar in order to achieve excellence in all areas.

These seven personal characteristics are foundational to good leadership. Some characteristics may be more naturally present in the personality of a leader. However, each of these characteristics can also be developed and strengthened. A good leader whether they naturally possess these qualities or not, will be diligent to consistently develop and strengthen them in their leadership role

42.2 Transformational Leadership

Views of school leadership are changing largely because of current restructuring initiatives and the demands of the 90s. Advocates for school reform also usually advocate altering power relationships.

The problem, explain Douglas Mitchell and Sharon Tucker (1992), is that we have tended to think of leadership as the capacity to take charge and get things done. This view keeps us from focusing on the importance of teamwork and comprehensive school improvement. Perhaps it is time, they say, to stop thinking of leadership as aggressive action and more as a way of thinking--about ourselves, our jobs, and the nature of the educational process. Thus, "instructional leadership" is "out" and "transformational leadership" is "in."

How has the term "transformational leadership" evolved and what does it mean?
The idea of transformational leadership was first developed by James McGregor Burns in 1978 and later extended by Bernard Bass as well as others. Neither Burns nor Bass studied schools but rather based their work on political leaders, Army officers, or business executives.

For example, there has been a shift in businesses away from Type A to Type Z organizations. Type Z organizations reduce differences in status between workers and managers, emphasize participative decision-making, and are based on a form of "consensual" or "facilitative" power that is manifested through other people instead of over other people (Kenneth Leithwood 1992).

Although there have been few studies of such leadership in schools and the definition of transformational leadership is still vague, evidence shows that there are similarities in transformational leadership whether it is in a school setting or a business environment (Nancy Hoover and others 1991, Kenneth Leithwood and Doris Jantzi 1990, Leithwood). "The issue is more than simply who makes which decisions," says Richard Sagor (1992). "Rather it is finding a way to be successful in collaboratively defining the essential purpose of teaching and learning and then empowering the entire school community to become energized and focused. In schools where such a focus has been achieved, we found that teaching and learning became transformative for everyone."

How does this differ from other school leadership styles?

Instructional leadership
Instructional leadership encompasses hierarchies and top-down leadership, where the leader is supposed to know the best form of instruction and closely monitors teachers' and students' work. One of the problems with this, says Mary Poplin (1992), is that great administrators aren't always great classroom leaders and vice versa. Another difficulty is that this form of leadership concentrates on the growth of students but rarely looks at the growth of teachers. Since she believes that education now calls on administrators to be "the servants of collective vision," as well as "editors, cheerleaders, problem solvers, and resource finders," instructional leadership, she declares, has outlived its usefulness.

Transactional leadership
Transactional leadership is sometimes called bartering. It is based on an exchange of services (from a teacher, for instance) for various kinds of rewards (such as a salary) that the leader controls, at least in part.
Transactional leadership is often viewed as being complementary with transformational leadership. Thomas Sergiovanni (1990) considers transformational leadership a first stage and central to getting day-to-day routines carried out. However, Leithwood says it doesn't stimulate improvement. Mitchell and Tucker add that transactional leadership works only when both leaders and followers understand and are in agreement about which tasks are important.

What are the goals of transformational leadership?
Leithwood finds that transformational leaders pursue three fundamental goals:
Helping staff develop and maintain a collaborative, professional school culture: This means staff members often talk, observe, critique, and plan together. Norms of collective responsibility and continuous improvement encourage them to teach each other how to teach better. Transformational leaders involve staff in collaborative goal setting, reduce teacher isolation, use bureaucratic mechanisms to support cultural changes, share leadership with others by delegating power, and actively communicate the school's norms and beliefs.

Fostering teacher development

One of Leithwood's studies suggests that teachers' motivation for development is enhanced when they internalize goals for professional growth. This process, Leithwood found, is facilitated when they are strongly committed to a school mission. When leaders give staff a role in solving nonroutine school improvement problems, they should make sure goals are explicit and ambitious but not unrealistic.

Helping teachers solve problems more effectively

Transformational leadership is valued by some, says Leithwood, because it stimulates teachers to engage in new activities and put forth that "extra effort" (see also Hoover and others, Sergiovanni, Sagor). Leithwood found that transformational leaders use practices primarily to help staff members work smarter, not harder. "These leaders shared a genuine belief that their staff members as a group could develop better solutions than the principal could alone," concludes Leithwood.

What strategies do transformational leaders use?

Here are specific ideas, culled from several sources on transformational leadership (Sagor, Leithwood, Leithwood and Jantzi, Poplin):

- Visit each classroom every day; assist in classrooms; encourage teachers to visit one another's classes.
- Involve the whole staff in deliberating on school goals, beliefs, and visions at the beginning of the year.
- Help teachers work smarter by actively seeking different interpretations and checking out assumptions; place individual problems in the larger perspective of the whole school; avoid commitment to preconceived solutions; clarify and summarize at key points during meetings; and keep the group on task but do not impose your own perspective.
- Use action research teams or school improvement teams as a way of sharing power. Give everyone responsibilities and involve staff in governance functions. For those not participating, ask them to be in charge of a committee.
- Find the good things that are happening and publicly recognize the work of staff and students who have contributed to school improvement. Write private notes to teachers expressing appreciation for special efforts.
- Survey the staff often about their wants and needs. Be receptive to teachers' attitudes and philosophies. Use active listening and show people you truly care about them.
- Let teachers experiment with new ideas. Share and discuss research with them. Propose questions for people to think about.
- Bring workshops to your school where it's comfortable for staff to participate. Get teachers to share their talents with one another. Give a workshop yourself and share information with staff on conferences that you attend.
- When hiring new staff, let them know you want them actively involved in school decision-making; hire teachers with a commitment to collaboration. Give teachers the option to transfer if they can't wholly commit themselves to the school's purposes.
- Have high expectations for teachers and students, but don't expect 100 percent if you aren't also willing to give the same. Tell teachers you want them to be the best teachers they possibly can be.
- Use bureaucratic mechanisms to support teachers, such as finding money for a project or providing time for collaborative planning during the workday. Protect teachers from the problems of limited time, excessive paperwork, and demands from other agencies.
- Let teachers know they are responsible for all students, not just their own classes.

What are the results of this kind of leadership?

Evidence of the effects of transformational leadership, according to Leithwood, is "uniformly positive." He cites two findings from his own studies:

- Transformational leadership practices have a sizable influence on teacher collaboration, and
- Significant relationships exist between aspects of transformational leadership and teachers' own reports of changes in both attitudes toward school improvement and altered instructional behavior.

Sergiovanni suggests that student achievement can be "remarkably improved" by such leadership. Finally, Sagor found that schools where teachers and students reported a culture conducive to school success had a transformational leader as its principal.

However, Mitchell and Tucker conclude that transformational leadership should be seen as only one part of a balanced approach to creating high performance in schools. Leithwood agrees: "While most schools rely on both top-down and facilitative forms of power, finding the right balance is the problem. For schools that are restructuring, moving closer to the facilitative end of the power continuum will usually solve the problem."

42.3 VISION

A good Vision serves three important purposes.

- Clarifying "General direction for Change"
- Motivates People to take action in right direction, even if initial steps are personally painful.
- Helps coordinate action of different people, even thousand & thousands of individuals, in a remarkably fast & efficient way.

Characteristics of Effective Vision

Imaginable: It conveys a picture of what the future could look like. The vision must be ambitious enough to force people out of their comfort zones. The God we serve created the universe; He can do great things!

Desirable: It appeals to the long-term interests of most of the organization's stakeholders. In contrast, poor visions tend to ignore the legitimate interests of some groups, or to exploit other groups.

Realistic: Good visions are not "pie-in-the-sky" fantasies with no chance of realization. Christian leaders must be careful not to let a cavalier "all things are possible with God" attitude to substitute for a legitimate vision that is, at once, faith-filled yet realistic. Moreover, good visions will take advantage of fundamental trends. Finally, to be realistic, the vision should be linked to the core competencies of the organization.

Focused: Good visions are clear enough to motivate action. They should not be vague or ambiguous.

Flexible: Good visions must be flexible enough to allow initiative. Bad visions are sometimes too specific or do not allow for modification. As the change proceeds, the vision itself will often change! So it must be flexible to begin with.

Communicable: An effective vision can be explained successfully within five minutes. Unintelligible visions are ineffective. The trumpet must sound a clear and compelling call. Vision articulates what is important, unique & exciting about what organization do. It guides for decision rules employees make about behavior.

Vision Statement

Vision Statement Encompasses the desired future for your company. A Vision Statement provides a basis on which you & your team members can focus & work towards. Some vision statements look ahead only a year or two, while other vision statements may look ahead ten years. Whatever time frame, a vision statement is essential for giving drives to every employee in your company. A good vision should draw up a 'picture' of what an individual or a group has in mind & cause those that read it to 'see' the intended outcome.

42.4 The Leadership Grid & the Managerial Grid

Leadership model that focuses on task (production) & employee (people) orientations of Managers as well as combinations of concerns between two extremes. Developed by Robert R. Blake and Jane S. Mouton, The Leadership Grid provides a framework for understanding types of leadership. The grid consists of two behavioral dimensions:

- Concern for production
- Concern for people

Blake and Mouton characterize five different leadership styles according to the varying emphasis on each of these two dimensions (with a range of 1 to 9 on each continuum), as illustrated in the table below. They suggest that most effective leadership is characterized by the combination of high concern for production with high concern for people.

Developed by the founders of our company, Drs. Robert R. Blake and Jane S. Mouton, **The Managerial Grid** graphic below is a very simple framework that elegantly defines seven basic styles that characterize workplace behavior and the resulting relationships. The seven managerial Grid styles are based on how two fundamental concerns (concern for people and concern for results) are manifested at varying levels whenever people interact.

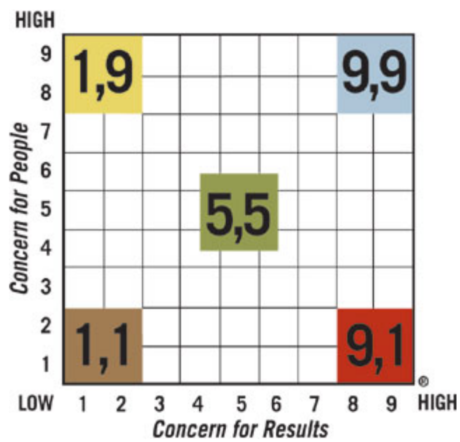

Figure 42.1: Managerial Grid

The Seven Managerial Grid Styles:

9,1 Controlling (Direct & Dominate)
I expect results and take control by clearly stating a course of action. I enforce rules that sustain high results and do not permit deviation.

1,9 Accommodating (Yield & Comply)
I support results that establish and reinforce harmony. I generate enthusiasm by focusing on positive and pleasing aspects of work.

5,5 Status Quo (Balance & Compromise)
I endorse results that are popular but caution against taking unnecessary risk. I test my opinions with others involved to assure ongoing acceptability.

1,1 Indifferent (Evade & Elude)
I distance myself from taking active responsibility for results to avoid getting entangled in problems. If forced, I take a passive or supportive position.

PAT Paternalistic (Prescribe and Guide)
I provide leadership by defining initiatives for myself and others. I offer praise and appreciation for support, and discourage challenges to my thinking.

OPP Opportunistic (Exploit & Manipulate)
I persuade others to support results that offer me private benefit. If they also benefit, that's even better in gaining support. I rely on whatever approach is needed to secure an advantage

9,9 Sound (Contribute and Commit)
I initiate team action in a way that invites involvement and commitment. I explore all facts and alternative views to reach a shared understanding of the best solution

Grid Relationship Skills
The Grid theory translates into practical use through Grid style relationship skills that people experience day in and day out when they work together. These relationship skills depict the typical and vital behaviors for each style that make relationships effective or ineffective. Some behaviors strengthen and motivate teams while others obstruct progress.
Critique - Learning from experience by anticipating and examining how behavior and actions affect results
Initiative - Taking action to exercise shared effort, drive, and support for specific activities
Inquiry - Questioning, seeking information, and testing for understanding
Advocacy - Expressing attitudes, opinions, ideas, and convictions
Decision-Making - Evaluating resources, criteria, and consequences to reach a decision
Conflict Resolution - Confronting and working through disagreements with others toward resolution
Resilience - Reacting to problems, setbacks, and failure, and understanding how these factors influence the ability to move forward

Grid theory makes behaviors as tangible and objective as any other corporate commodity. By studying each of the seven Leadership Grid styles and the resulting relationship skill behaviors, teams can examine, in objective terms, how behaviors help or hurt them. They can explore types of critique that work best for them and why. They can openly discuss how to improve decision-making and conflict resolution skills. These and other subjects usually considered "off limits" in terms of productivity are the very subjects that usually impede productivity. The Grid approach makes these subjects not only "discussable" but measurable in objective terms that generate empathy, motivation to improve, and creativity.

Leaders may be concerned for their people and they also must also have some concern for the work to be done. The question is, how much attention to they pay to one or the other? This is a model defined by

Concern for People	*High*	Country Club management		Team management
	Medium		Middle of the road management	
	Low	Impoverished management		Authority-compliance
		Low	*Medium*	*High*
		Concern for Production (Task)		

Blake and Mouton in the early 1960s.

Figure 42.2: Leadership Grid

Impoverished management
Minimum effort to get the work done. A basically lazy approach that avoids as much work as possible.

Authority-compliance
Strong focus on task, but with little concern for people. Focus on efficiency, including the elimination of people wherever possible.

Country Club management
Care and concern for the people, with a comfortable and friendly environment and collegial style. But a low focus on task may give questionable results.

Middle of the road management
A weak balance of focus on both people and the work. Doing enough to get things done, but not pushing the boundaries of what may be possible.

Team management
Firing on all cylinders: people are committed to task and leader is committed to people (as well as task).

LESSON 43

COMMUNICATION IN THE PROJECT MANAGEMENT

BROAD CONTENTS

Communication
Interpersonal Communication
Barriers in Interpersonal Communication and Importance of Barrier Removal
Writing Skills
Letter Writing
Active Listening
Presentations
Conducting Project Meetings

43.1 Communication

The purpose of communication is to get your message across to others clearly and unambiguously. Doing this involves effort from both the sender of the message and the receiver. And it's a process that can be fraught with error, with messages often misinterpreted by the recipient. When this isn't detected, it can cause tremendous confusion, wasted effort and missed opportunity. In fact, communication is only successful when both the sender and the receiver understand the same information as a result of the communication. By successfully getting your message across, you convey your thoughts and ideas effectively. When not successful, the thoughts and ideas that you send do not necessarily reflect your own, causing a communications breakdown and creating roadblocks that stand in the way of your goals – both personally and professionally.

In a recent survey of recruiters from companies with more than 50,000 employees, communication skills were cited as the single more important decisive factor in choosing managers. The survey, conducted by the University of Pittsburgh's Katz Business School, points out that communication skills, including written and oral presentations, as well as an ability to work with others, are the main factor contributing to job success.

In spite of the increasing importance placed on communication skills, many individuals continue to struggle, unable to communicate their thoughts and ideas effectively – whether in verbal or written format. This inability makes it nearly impossible for them to compete effectively in the workplace, and stands in the way of career progression.
Getting your message across is paramount to progressing. To do this, you must understand what your message is, what audience you are sending it to, and how it will be perceived. You must also weigh-in the circumstances surrounding your communications, such as situational and cultural context.
Communication In the context of Project Manager

Project Communication Management provides a critical link between "people, ideas, & information" at all stages in Project Life Cycle. Communication in Project Management is a formal process aid in "decision making" & help to achieve a successful project. Approximately 70-90% of a typical Project Manager's time is spent in Communication according to the following proportion:

- Approximately 45% - Listening.
- Another ~30%- Talking.
- PM's spend ~ 50% of time in meetings.

Communication Management Plan defines how & when various stakeholder receive information & communicate with each other. Memos, emails etc. are non-formal communication types. Total number of communication channels between stakeholders is given by the following relationship.
N(N - 1)/2 (where N is the number of stakeholders)

It means that if there are 10 stakeholder in a project, that project will have 45 channels of communication.

Cost of Correspondence

One page business letter that took 10 min to dictate cost between $13.60 & $20.52 in 1996. one can imagine its cost today. poor writing costs even more since it wastes time, wastes effort and jeopardizes goodwill.

Characteristics of Effective Communication

Following are some of the characteristics of effective communication.

- Fostering an “Open Communication Climate.
- Committing to “Ethical Communication.
- Understanding–”Dynamics of Intercultural Communication”.
- Becoming Proficient in Communication Technology.
- Using an “Audience Centered Approach”.
- Creating & Processing Messages Efficiently”.

In series of transmission form one person to next, message becomes less & less accurate. Poor retention of information is another serious problem. It necessitates repeating message & using several channels. It will obviously require use more than one channel to Communication same message.

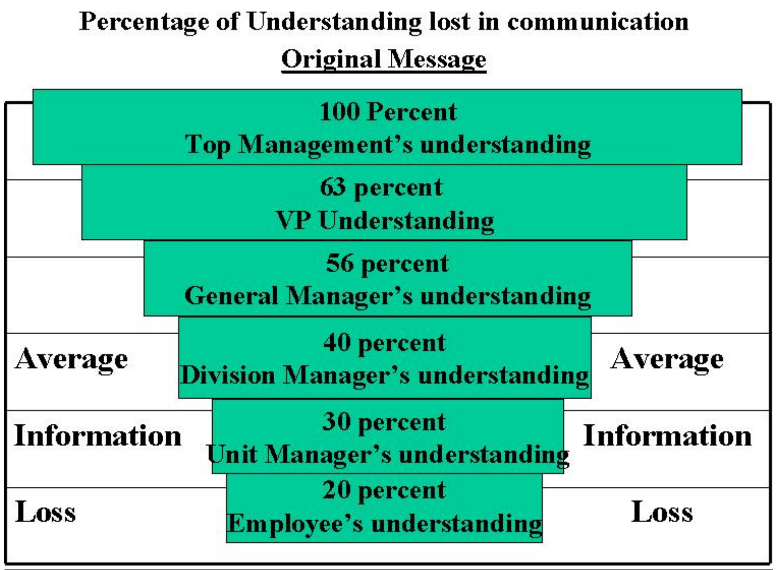

Figure 43.1: Percentage of Understanding Lost in Communication

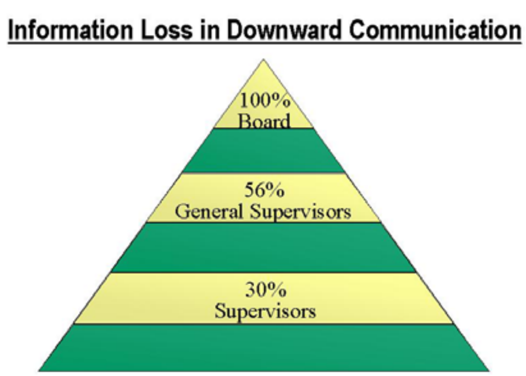

Figure 43.2: Information Loss in Downward Communication

Techniques to Improve Organization Communication

Following are some of the techniques, or process improvements that can improve the communication in any organization.

- Emphasis on Teamwork
- Improve Reporting System
- Focus on Employees Participation & Involvement
- Improve Management System
- Change Organizational Culture
- Flatter Hierarchy
- Cross Functional Teams
- Fewer Control

The function of communication is to provide form in which ideas & purposes can be expressed as Message. Vocabulary, language, & knowledge play important role in sender's ability to encode.

43.2 Interpersonal Communication

Interpersonal communication is the process of sending and receiving information between two or more people. Communication is interpersonal when the people involved are contacting each other as persons, on a personal level.

Effective Communication is much more than simply transmitting information to employees. It requires face-to-face contact in environment of "Openness & Trust". Several aspects of Interpersonal communication include Talking, Listening, Reading, Writing and the more formalized aspects such as conducting meetings, interviews etc. and so on.

Elements of Good Talking

- Voice Quality
- Talking Style
- Word Choice and Vocabulary

Three Broad Types of Interpersonal Communication:

- Oral
- Written
- Nonverbal

Oral Communication consists of all forms of spoken Information & Most preferred type of Communication used by Managers. Managers prefer face-to-face & Tele Communication to written Communication because it permits immediate feedback.

Written Communication Letters, memos, policy manuals, reports, forms, & other documents are used to share Information in Organization.

Types of Nonverbal Communication

- Body Language
- Space
- Time
- Para language
- Color
- Layout and Design

43.3 Barriers against Effective Interpersonal Communication

<u>Emotions</u> Sometimes when people communicate an idea or matter across, the receiver can feel how the sender perceives the subject matter. Often messages are interpreted differently for different people. Extreme emotions are most likely to hinder effective communication because the idea or message

maybe misinterpreted. It's always best to avoid responding or reacting to the subject matter when you're upset or angry because most of the time, you'll not be able to think in a clear manner.

Filtering This is where the sender manipulates the information that he communicates to the receiver. The purpose of this is because sometimes people would shape and reform the message so that it appears and sounds favorable to the receiver. Filtering information may mislead the receiver into thinking into something favorable and the let down may be upsetting if it's found out that information has been filtered.

Overloaded with Information Too much information about the same subject matter may be confusing. For example, you have 50 e-mails on the same subject matter, each e-mail contains a little part of the subject matter. It would be better to have one e-mail from the sender which includes all the information in clear and simple form with only the information you want that you asked for. Normally, the human brain can only take in so much information to process, overloading it with information will exceed our human processing capacity, and the receiver would often misunderstand or not understand at all what the sender is telling them.

Defensiveness Humans tend to refuse for a mutual understanding when they feel that they are being threatened or are put in a position which they are at a disadvantage. Defensiveness normally consists of attacking what the sender tells you, putting out sarcastic remarks, questioning their motives or being overly judgmental about the subject matter.

Cultural Difference Sometimes our culture may be a huge hindrance for effective interpersonal communication. When two people with different cultures communicate, they often do not understand each other's cultures and may misunderstand the true meaning of what each other's trying to convey through such a sense. For example, Japanese people would say 'ha-i' and Americans may misunderstand that they are saying "hi". This makes the intentions unclear between both people.
Jargon Not everyone understands each other's jargon words. Jargon should be avoided when talking to someone who isn't familiar with you personally or within your organization.

43.3.1 The importance of removing barriers

Problems with communication can pop-up at every stage of the communication process (which consists of **sender**, **encoding**, **channel**, **decoding, receiver**, **feedback** and **context** - see the diagram below) and have the potential to create misunderstanding and confusion.

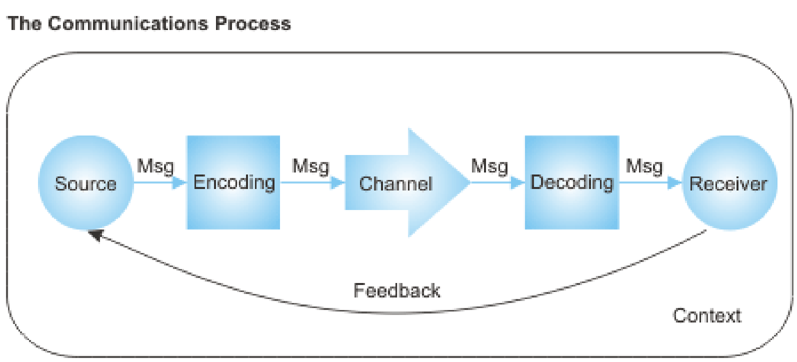

Figure 43.3: The Communication Process

To be an effective communicator and to get your point across without misunderstanding and confusion, your goal should be to lessen the frequency of these problems at each stage of this process with clear, concise, accurate, well-planned communications. We follow the process through below:

SOURCE
As the source of the message, you need to be clear about why you're communicating, and what you want to communicate. You also need to be confident that the information you're communicating is useful and accurate.

MESSAGE
The message is the information that you want to communicate.

ENCODING
This is the process of transferring the information you want to communicate into a form that can be sent and correctly decoded at the other end. Your success in encoding depends partly on your ability to convey information clearly and simply, but also on your ability to anticipate and eliminate sources of confusion (for example, cultural issues, mistaken assumptions, and missing information.) A key part of this is knowing your audience: Failure to understand who you are communicating with will result in delivering messages that are misunderstood.

CHANNEL
Messages are conveyed through channels, with verbal including face-to-face meetings, telephone and videoconferencing; and written including letters, emails, memos and reports.
Different channels have different strengths and weaknesses. For example, it's not particularly effective to give a long list of directions verbally, while you'll quickly cause problems if you criticize someone strongly by email.

DECODING
Just as successful encoding is a skill, so is successful decoding (involving, for example, taking the time to read a message carefully, or listen actively to it.) Just as confusion can arise from errors in encoding, it can also arise from decoding errors. This is particularly the case if the decoder doesn't have enough knowledge to understand the message.

RECEIVER
Your message is delivered to individual members of your audience. No doubt, you have in mind the actions or reactions you hope your message will get from this audience. Keep in mind, though, that each of these individuals enters into the communication process with ideas and feelings that will undoubtedly influence their understanding of your message, and their response. To be a successful communicator, you should consider these before delivering your message, and act appropriately.

FEEDBACK
Your audience will provide you with feedback, verbal and nonverbal reactions to your communicated message. Pay close attention to this feedback as it is the only thing that allows you to be confident that your audience has understood your message. If you find that there has been a misunderstanding, at least you have the opportunity to send the message a second time.

CONTEXT
The situation in which your message is delivered is the context. This may include the surrounding environment or broader culture (i.e. corporate culture, international cultures, etc.).

43.4 WRITING SKILLS

Many people are intimidated by writing. Even so, there are times when writing is the best way to communicate, and often the only way to get your message across.

Write With Necessary Caution
When writing, remember that once something is in written form, it cannot be taken back. Communicating this way is concrete than verbal communications, with less room for error and even less

room for mistakes. This presents written communicators with additional challenges, including spelling, grammar, punctuation, even writing style and actual wording.
Thankfully, today's technology makes memo, letter and proposal writing much easier by providing reliable tools that check and even correct misspelled words and incorrect grammar use. Unfortunately, these tools are not foolproof and will require your support, making your knowledge in this area important.

The Importance of "Style"
Some of the most basic tips to remember when writing include:
- Avoid slang words
- Try not to use abbreviations (unless appropriately defined)
- Steer away from the symbols (such as ampersands [&])
- Clichés should be avoided, or at the very least, used with caution
- Brackets are used to play down words or phrases
- Dashes are generally used for emphasis
- Great care should ALWAYS be taken to spell the names of people and companies correctly
- Numbers should be expressed as words when the number is less than 10 or is used to start a sentence (example: Ten years ago, my brother and I…). The number 10, or anything greater than 10, should be expressed as a figure (example: My brother has 13 Matchbox cars.)
- Quotation marks should be placed around any directly quoted speech or text and around titles of publications
- Keep sentences short

While these tips cover the most common mistakes made when writing letters, memos and reports, they in no way cover everything you need to know to ensure your written communications are accurate and understood.

While this takes some practice, there are many sources available to assist with writing style, including "The Elements of Style", by Strunk and White. One glance in any newsroom or on the desk of even the most accomplished writers and you are sure to find this small, easy-to-understand, no-nonsense guide to writing. It is clear, concise and perhaps the best book of its kind. If you plan on writing a great deal of letters or even proposals, it is strongly recommended that you pick up this nifty guide, which by the way, will fit in your shirt pocket.

43.5 Letter Writing
When writing letters, it is best to address the letter to an individual. And, when beginning the letter with a personal name, be sure to end it with an appropriate closing, such as 'Sincerely yours'. If you cannot obtain an individual's name, consider ending it with a more generic (less personal) closing, such as 'With kindest regards'.
For normal business letters, your letter should start with an overall summary, showing in the first paragraph why the letter is relevant to the reader. It's not a good practice to make the reader go past the first paragraph to find out why the letter was sent to them.
The body of the letter needs to explain the reason for the correspondence, including any relevant background and current information. Make sure the information flows logically, ensuring you are making your points effectively.
The closing of the letter is the final impression you leave with the reader. End with an action point, such as 'I will call you later this week to discuss this further'.

The Importance of Careful Proofing
Perhaps the most important thing to remember when writing a letter is to check it thoroughly when it is completed. Even when you think it is exactly what you want, read it one more time. This "unwritten" rule holds true for everything you write – memos, letters, proposals, etc.
Use both the grammar and spell check on your computer, paying very, very close attention to every word highlighted. Do not place total faith on your computer here. Instead, you should have both a dictionary and thesaurus (printed or online) to hand to double-check everything your computer's editing tools highlight, as these tools are certainly not always reliable, for a variety of reasons.

When checking your written communications, make sure the document is clear and concise. Is there anything in the written communication that could be misinterpreted? Does it raise unanswered questions or fail to make the point you need to get across?
Can you cut down on the number of words used? For instance, don't use 20 words when you can use 10. While you do not want to be curt or abrupt, you do not want to waste the reader's time with unnecessary words or phrases.
Is your written communication well organized? Does each idea proceed logically to the next? Would some additional headings help? Make sure your written communications are easy to read and contain the necessary information, using facts where needed and avoiding information that is not relevant. Again, outline the course of action you expect, such as a return call or visit.
Close appropriately, making sure to include your contact information. While this may seem obvious, it is sometimes overlooked and can make your written communications look amateurish. This can diminish your chances of meeting your written communication's goals.

43.6 Active Listening

It is obvious to say that if you have poor interpersonal communications skills (which include active listening), your productivity will suffer simply because you do not have the tools needed to influence, persuade and negotiate – all necessary for workplace success. Lines of communications must be open between people who rely on one another to get work done.

Considering this, you must be able to listen attentively if you are to perform to expectations, avoid conflicts and misunderstandings, and to succeed - in any arena. Following are a few short tips to help you enhance your communications skills and to ensure you are an active listener:

1. Start by Understanding Your Own Communication Style

Good communication skills require a high level of self-awareness. Understanding your personal style of communicating will go a long way toward helping you to create good and lasting impressions on others. By becoming more aware of how others perceive you, you can adapt more readily to their styles of communicating. This does not mean you have to be a chameleon, changing with every personality you meet. Instead, you can make another person more comfortable with you by selecting and emphasizing certain behaviors that fit within your personality and resonate with another. In doing this, you will prepare yourself to become an active listener.

2. Be an Active Listener

People speak at 100 to 175 words per minute (WPM), but they can listen intelligently at up to 300 words per minute. Since only a part of our mind is paying attention, it is easy to go into mind drift - thinking about other things while listening to someone. The cure for this is active listening - which involves listening with a purpose. It may be to gain information, obtain directions, understand others, solve problems, share interest, see how another person feels, show support, etc.
If you're finding it particularly difficult to concentrate on what someone is saying, try repeating their words mentally as they say it - this will reinforce their message and help you control mind drift.

3. Use Nonverbal Communication

Use nonverbal behaviors to raise the channel of interpersonal communication. Nonverbal communication is facial expressions like smiles, gestures, eye contact, and even your posture. This shows the person you are communicating with that you are indeed listening actively and will prompt further communications while keeping costly, time-consuming misunderstandings at a minimum.

4. Give Feedback

Remember that what someone says and what we hear can be amazingly different! Our personal filters, assumptions, judgments, and beliefs can distort what we hear. Repeat back or summarize to ensure that you understand. Restate what you think you heard and ask, "Have I understood you correctly?" If you find yourself responding emotionally to what someone said, say so, and ask for more information: "I may not understand you correctly, and I find myself taking what you said personally. What I thought you just said is XXX; is that what you meant?"

Feedback is a verbal communications means used to clearly demonstrate you are actively listening and to confirm the communications between you and others. Obviously, this serves to further ensure the communications are understood and is a great tool to use to verify everything you heard while actively listening.

43.7 Presentation Planning Checklist

This presentation checklist will help you deliver successful presentation. This is adapted in part from "Business Communications: A Cultural and Strategic Approach" by Michael J. Rouse and Sandra Rouse.

Presentation:

Does your introduction grab participant's attention and explain your objectives?
Do you follow this by clearly defining the points of the presentation?
Are these main points in logical sequence?
Do these flow well?
Do the main points need support from visual aids?
Does your closing summarize the presentation clearly and concisely?
Is the conclusion strong?
Have your tied the conclusion to the introduction?

Delivery:

Are you knowledgeable about the topic covered in your presentation?
Do you have your notes in order?
Where and how will you present (indoors, outdoors, standing, sitting, etc.)?
Have you visited the presentation site?
Have you checked your visual aids to ensure they are working and you know how to use them?

Appearance:

Make sure you are dressed and groomed appropriately and in keeping with the audience's expectations.
Practice your speech standing (or sitting, if applicable), paying close attention to your body language, even your posture, both of which will be assessed by the audience.

Visual Aids:

Are the visual aids easy to read and easy to understand?
Are they tied into the points you are trying to communicate?
Can they be easily seen from all areas of the room?

43.8 Running Effective Project Meetings

Meetings are wonderful tools for generating ideas, expanding on thoughts and managing group activity. But this face-to-face contact with team members and colleagues can easily fail without adequate preparation and leadership.

The Importance of Preparation

To ensure everyone involved has the opportunity to provide their input, start your meeting off on the right foot by designating a meeting time that allows all participants the time needed to adequately prepare.
Once a meeting time and place has been chosen, make yourself available for questions that may arise as participants prepare for the meeting. If you are the meeting leader, make a meeting agenda, complete with detailed notes.

Managing a Meeting

Choosing the right participants is key to the success of any meeting. Make sure all participants can contribute and choose good decision-makers and problem-solvers. Try to keep the number of participants to a maximum of 12, preferably fewer. Make sure the people with the necessary information for the items listed in the meeting agenda are the ones that are invited.

When an agenda item is resolved or action is agreed upon, make it clear who in the meeting will be responsible for this. In an effort to bypass confusion and misunderstandings, summarize the action to be taken and include this in the meeting's minutes.

Time Keeping

Meetings are notorious for eating up people's time. Here are some ways of ensuring that time is not wasted in meetings:

- Start on time.
- Don't recap what you've covered if someone comes in late: doing so sends the message that it is OK to be late for meetings, and it wastes everyone else's valuable time.
- State a finish time for the meeting and don't over-run.
- To help stick to the stated finish time, arrange your agenda in order of importance so that if you have to omit or rush items at the end to make the finish time, you don't omit or skimp on important items.
- Finish the meeting before the stated finish time if you have achieved everything you need to.

Issuing Minutes

Minutes record the decisions of the meeting and the actions agreed. They provide a record of the meeting and, importantly, they provide a review document for use at the next meeting so that progress can be measured - this makes them a useful disciplining technique as individuals' performance and non-performance of agreed actions is given high visibility.

LESSON 44

PROJECT RISK MANAGEMENT

BROAD CONTENTS

What is Risk?
Primary Components
Tolerance of Risk
Risk Management
Categories of Risk
Risk Planning
Risk Identification
Risk Assessment (identification and analysis)
Risk Handling

In the early days of project management on many commercial programs, the majority of project decisions heavily favored cost and schedule. This favoritism occurred because we knew more about cost and scheduling than we did about technical risks. Technology forecasting was very rarely performed other than by extrapolating past technical knowledge into the present.

Today, the state of the art of technology forecasting is being pushed to the limits. For projects with time duration of less than one year, we normally assume that the environment is known and stable, particularly the technological environment. For projects over a year or so in length, technology forecasting must be considered. Computer technology doubles in performance about every two years. Engineering technology is said to double every three or so years. How can a project manager accurately define and plan the scope of a three- or four-year project without expecting engineering changes resulting from technology improvements?

44.1 What are the Risks?

A Midwest manufacturing company embarked on an eight-year project to design the manufacturing factory of the future. The plant is scheduled to go into the construction phase in the year 2000. How do we design the factory of the future without forecasting the technology? What computer technology will exist? What types of materials will exist and what types of components will our customers require? What production rate will we need and will technology exist to support this production level?

Economists and financial institutions forecast interest rates. The forecasts appear in public newspapers and journals. Yet, every company involved in high tech does some form of technology forecasting, but appears very reluctant to publish the data. Technology forecasting is regarded as company proprietary information and may be part of the company's strategic planning process.

We read in the newspaper about cost overruns and schedule slips on a wide variety of large-scale development projects. Several issues within the control of the buyer, seller, or major stakeholders can lead to cost growth and schedule slippage on development projects. These causes include, but are not limited to:

- Starting a project with a budget and/or schedule that is inadequate for the desired level of performance or scope (e.g., integration complexity).
- Having an overall development process (or key parts of that process) that favors performance (or scope) over cost and schedule.
- Establishing a design that is near the feasible limit of achievable performance or integration complexity at a given point in time.
- Making major project design decisions before the relationships between cost, performance, schedule, and risk are understood.

These four causes will contribute to uncertainty in forecasting technology and the associated design needed to meet performance requirements. And the inability to perfectly forecast technology and the associated design will contribute to a project's technical risk, and can also lead to cost and schedule risk.

Today, the competition for technical achievement has become fierce. Companies have gone through life-cycle phases of centralizing all activities, especially management functions, but are decentralizing technical expertise. By the mid 1980s, many companies recognized the need to integrate technical risks with cost and schedule risks, and other activities (e.g., quality). Risk management processes were developed and implemented where risk information was made available to key decision-makers.

The risk management process, however, should be designed to do more than just identify the risk.

The process must also include: a formal *planning* activity, *analysis* to quantify the likelihood and predict the impact on the project, a *handling* strategy for selected risks, and the ability to *monitor* the progress in reducing these selected risks to the desired level.

A project, by definition, is something that we have not done previously and will not do again in the future. Because of this uniqueness, we have developed a "live with it" attitude on risk and attribute it as part of doing business. If risk management is set up as a continuous, disciplined process of planning, assessment (identification and analysis), handling, and monitoring, then the system will easily supplement other systems as organization, planning and budgeting, and cost control. Surprises that become problems will be diminished because emphasis will now be on proactive rather than reactive management.

Risk management can be justified on almost all projects. The level of implementation can vary from project to project, depending on such factors as size, type of project, who the customer is, relationship to the corporate strategic plan, and corporate culture. Risk management is particularly important when the overall stakes are high and a great deal of uncertainty exists. In the past, we treated risk as a "let's live with it." Today, risk management is a key part of overall project management. It forces us to focus on the future where uncertainty exists and develop suitable plans of action to prevent potential issues from adversely impacting the project.

Risk is a measure of the probability and consequence of not achieving a defined project goal. Most people agree that risk involves the notion of uncertainty. Can the specified aircraft range be achieved? Can the computer be produced within budgeted cost? Can the new product launch date be met? A probability measure can be used for such questions; for example, the probability of not meeting the new product launch date is 0.15. However, when risk is considered, the consequences or damage associated with occurrence must also be considered.

Goal A, with a probability of occurrence of only 0.05, may present a much more serious (risky) situation than goal B, with a probability of occurrence of 0.20, if the consequences of not meeting goal A are, in this case, more than four times more severe than failure to meet goal B. Risk is not always easy to assess, since the probability of occurrence and the consequence of occurrence are usually not directly measurable parameters and must be estimated by statistical or other procedures.

44.2 Components of Risk

Risk has two primary components for a given event:

- A probability of occurrence of that event
- Impact of the event occurring (amount at stake)

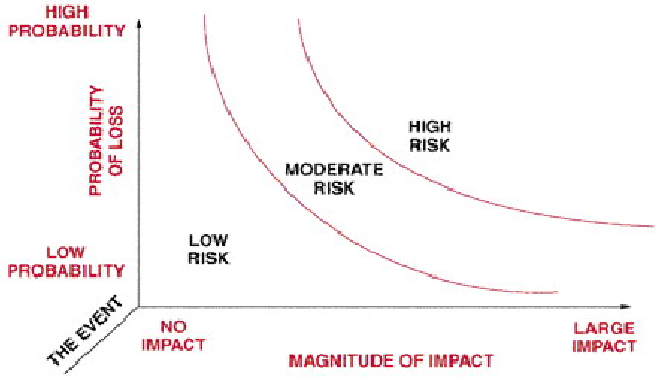

Figure 44.1: Overall risk is a function of its components.

Figure 44.1 shows the components of risk.
Conceptually, risk for each event can be defined as a function of likelihood and impact; that is,

$$\text{Risk} = f(\text{Likelihood, impact})$$

In general, as either the likelihood or impact increases, so does the risk. Both the likelihood and impact must be considered in risk management.

Risk constitutes a lack of knowledge of future events. Typically, future events (or outcomes) that are favorable are called opportunities, whereas unfavorable events are called risks.

Another element of risk is the cause of risk. Something, or the lack of something, can induce a risky situation. We denote this source of danger as the hazard. Certain hazards can be overcome to a great extent by knowing them and taking action to overcome them. For example, a large hole in a road is a much greater danger to a driver who is unaware of it than to one who travels the road frequently and knows enough to slow down and go around the hole. This leads to the second representation of risk:

$$\text{Risk} = f(\text{Hazard, safeguard})$$

Risk increases with hazard but decreases with safeguard. The implication of this equation is that good project management should be structured to identify hazards and to allow safeguards to be developed to overcome them. If enough safeguards are available, then the risk can be reduced to an acceptable level.

44.3 Tolerance of Risk

There is no single textbook answer on how to manage risk. The project manager must rely upon sound judgment and the use of the appropriate tools in dealing with risk. The ultimate decision on how to deal with risk is based in part upon the project manager's tolerance for risk.

The three commonly used classifications of tolerance for risk appear in Figure 44.2. They include the risk averter or avoider, the neutral risk taker, and the risk seeker or lover. The *Y* axis in Figure 44.2 represents "utility," which can be defined as the amount of satisfaction or pleasure that the individual receives from a payoff. (This is also called the project manager's tolerance for risk.) The *X* axis in this case is the amount of money at stake.

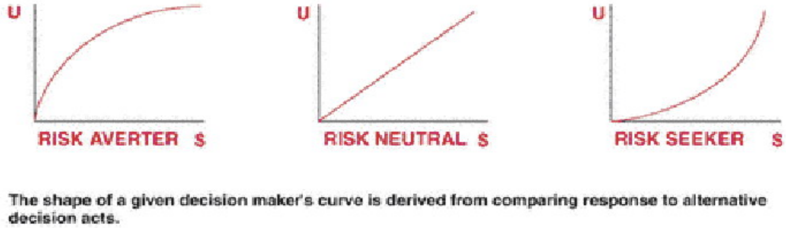

Figure 44.2: Risk preference & utility function

With the risk averter, utility rises at a *decreasing* rate. In other words, when more money is at stake, the project manager's satisfaction or tolerance diminishes. With the risk lover, the project manager's satisfaction increases when more money is at stake (i.e., an increasing slope to the curve). A risk averter prefers a more certain outcome and will demand a premium to accept risk.

A risk lover prefers the more uncertain outcome and may be willing to pay a penalty to take a risk.

44.4 Risk Management

Risk management is the act or practice of dealing with risk. It includes *planning* for risk, *assessing* (*identifying and analyzing*) risk issues, developing *risk handling* options, and *monitoring* risks to determine how risks have changed.
Risk management is not a separate project office activity assigned to a risk management department, but rather is one aspect of sound project management. Risk management should be closely coupled with key project processes, including but not limited to: overall project management, systems engineering, cost, scope, quality, and schedule.

Proper risk management is proactive rather than reactive. As an example, an activity in a network requires that a new technology be developed. The schedule indicates six months for this activity, but project engineers think that nine months is closer to the truth. If the project manager is proactive, he might develop a Risk Handling Plan right *now*. If the project manager is reactive (e.g., a "problem solver"), then he will do nothing until the problem actually occurs. At that time the project manager must react rapidly to the crisis, and may have lost valuable time when contingencies could have been developed. Hence, proper risk management will attempt to reduce the likelihood of an event occurring and/or the magnitude of its impact.

44.5 Categories of Risk

The Project Management Institute **categorizes risks** as follows:
External–unpredictable: Government regulations, natural hazards, and acts of God
External–predictable: Cost of money, borrowing rates, raw material availability
The external risks are outside of the project manager's control but may affect the direction of the project.
Internal (nontechnical): Labor stoppages, cash flow problems, safety issues, health and benefit plans.
The internal risks may be within the control of the project manager and present uncertainty that may affect the project.

Technical: Changes in technology, changes in state of the art, design issues, operations/maintenance issues. Technical risks relate to the utilization of technology and the impact it has on the direction of the project.

Legal: Licenses, patent rights, lawsuits, subcontractor performance, contractual failure
To identify risk issues, evaluators should break down program elements to a level where they can perform valid assessments. The information necessary to do this varies according to the phase of the program. During the early phases, requirement and scope documents, and acquisition plans may be the only program-specific data available. They should be evaluated to identify issues that may have adverse consequences.

Another method of decomposition is to create a Work Breakdown Structure (WBS) as early as possible in a program, and use this in a structured approach to evaluate candidate risk categories against candidate system or lower level designs. To use this approach, each element at level three of the WBS is further broken down to the fourth or fifth level and is subjected to a risk analysis. Items at system, segment or group, or subsystem levels, as well as management items, are assessed using attributes such as maturity and complexity of hardware and software items or the dependency of the item on existing systems, facilities, or contractors to evaluate their risk levels.

Another approach is to evaluate risk associated with some key processes (e.g., design and manufacturing) that will exist on a project. Information on this approach is contained in the government DoD directive 4245.7-M, which provides a standard structure for identifying technical risk areas in the transition from development to production. The structure is geared toward programs that are mid-to-late in the development phase but, with modifications, could be used for other projects. The directive identifies a *template* for each major technical activity. Each template identifies potential areas of risk. Overlaying each template on a project allows identification of mismatched areas, which are then identified as "at risk." Having used all applicable templates, the program manager will have created a "watch list" of production transition risk areas and can prioritize control actions— many of which will be the responsibility of systems engineering. DoD Directive 4245.7-M describes technical methods for reducing the risk in each identified area.

High-risk areas may reflect missing capabilities in the project manager's organization or in supporting organizations. They may also reflect technical difficulties in the design or development process. In either case, "management" of risk involves using project management assets to reduce the identified risks.

The value in each of these approaches to risk identification lies in the methodical nature of the approach, which forces disciplined, consistent treatment of risk. However, using any method in a "cookbook" manner may cause unique risk aspects of the project to be overlooked. Before acting on the outcome of any assessment, the project manager must review the strengths and weaknesses of the approach and identify other factors that may introduce technical, schedule, cost, program, or other risks.

Certainty, Risk, and Uncertainty

Decision-making falls into three categories: certainty, risk, and uncertainty. Decision-making under certainty is the easiest case to work with. With certainty, we assume that all of the necessary information is available to assist us in making the right decision, and we can predict the outcome with a high level of confidence.

Decision-Making under Certainty

Decision-making under certainty implies that we know with 100 percent accuracy what the states of nature will be and what the expected payoffs will be for each state of nature. Mathematically, this can be shown with payoff tables.

To construct a payoff matrix, we must identify (or select) the states of nature over which *we have no control*. We then select our own action to be taken for each of the states of nature. Our actions are called strategies. The elements in the payoff table are the outcomes for each strategy.

A payoff matrix based on decision-making under certainty has two controlling features.

- Regardless of which state of nature exists, there will be one dominant strategy that will produce larger gains or smaller losses than any other strategy for all the states of nature.
- There are no probabilities assigned to each state of nature.

Decision-Making under Risk

In most cases, there usually does not exist one dominant strategy for all states of nature. In a realistic situation, higher profits are usually accompanied by higher risks and therefore higher probable losses. When there does not exist a dominant strategy, a probability must be assigned to the occurrence of each state of nature.

Risk can be viewed as outcomes (i.e., states of nature) that can be described within established confidence limits (i.e., probability distributions). These probability distributions are obtained from well-defined experimental distributions.

Decision-making under Uncertainty

The difference between risk and uncertainty is that under risk there are assigned probabilities, and under uncertainty meaningful assignments of probabilities are not possible. As with decision making under risk, uncertainty also implies that there may exist no single dominant strategy. The decision-maker, however, does have at his disposal four basic criteria from which to make a management decision. The decision about which criterion to use will depend on the type of project as well as the project manager's tolerance to risk.

Risk Management Process

It is important that a risk management strategy is established early in a project and that risk is continually addressed throughout the project life cycle. Risk management includes several related actions involving risk: planning, assessment (identification and analysis), handling, and monitoring:

• ***Risk planning:*** This is the process of developing and documenting an organized, comprehensive, and interactive strategy and methods for identifying and tracking risk issues, developing risk handling plans, performing continuous risk assessments to determine how risks have changed, and assigning adequate resources.

• ***Risk assessment:*** This process involves identifying and analyzing program areas and critical technical process risks to increase the likelihood of meeting cost, performance, and schedule objectives.

•***Risk identification*** is the process of examining the program areas and each critical technical process to identify and document the associated risk. *Risk analysis* is the process of examining each identified risk issue or process to refine the description of the risk, isolate the cause, and determine the effects.

• ***Risk handling:*** This is the process that identifies, evaluates, selects, and implements options in order to set risk at acceptable levels given program constraints and objectives. This includes the specifics on what should be done, when it should be accomplished, who is responsible, and associated cost and schedule. Risk handling options include assumption, avoidance, control (also known as mitigation), and transfer. The most desirable handling option is selected, and a specific approach is then developed for this option.

• ***Risk monitoring:*** This is the process that systematically tracks and evaluates the performance of risk handling actions against established metrics throughout the acquisition process and provides inputs to updating risk handling strategies, as appropriate.

44.6 Risk Planning

Risk planning is the detailed formulation of a program of action for the management of risk. It is the process to:

- Develop and document an organized, comprehensive, and interactive risk management strategy.
- Determine the methods to be used to execute a program's risk management strategy.
- Plan for adequate resources.

Risk planning is iterative and includes the entire risk management process, with activities to assess (identify and analyze), handle, monitor (and document) the risk associated with a program. The result is often the risk management plan (RMP).

Planning begins by developing and documenting a risk management strategy. Early efforts establish the purpose and objective, assign responsibilities for specific areas, identify additional technical expertise needed, describe the assessment process and areas to consider, define a risk rating approach, delineate procedures for consideration of handling options, establish monitoring metrics (where possible), and define the reporting, documentation, and communication needs.

The RMP is the roadmap that tells the project team how to get from where the program is today to where the program manager wants it to be in the future. The key to writing a good RMP is to provide the necessary information so the program team knows the objectives, goals, and the risk management process. Since it is a roadmap, it may be specific in some areas, such as the assignment of responsibilities for project personnel and definitions, and general in other areas to allow users to choose the most efficient way to proceed. For example, a description of techniques that suggests several methods for evaluators to use to assess risk is appropriate, since every technique has advantages and disadvantages depending on the situation.

44.7 Risk Assessment

Risk assessment is the *problem definition* stage of risk management, the stage that identifies, analyzes, and quantifies program issues in terms of probability and consequences, and possibly other considerations (e.g., the time to impact). The results are a key input to many subsequent risk management actions. It is often a difficult and time-consuming part of the risk management process.

There are no quick answers or shortcuts. Tools are available to assist evaluators in assessing risk, but none are totally suitable for any program and are often highly misleading if the user does not understand how to apply them or interpret the results. Despite its complexity, risk assessment is one of the most important phases of the risk management process because the caliber and quality of assessments can have a large impact on program outcomes.

The components of assessment— identification and analysis— are performed sequentially with identification being the first step.

Risk identification begins by compiling the program's risk issues. Project issues should be examined and identified by reducing them to a level of detail that permits an evaluator to understand the significance of any risk and its causes (e.g., risk issues). This is a practical way of addressing the large and diverse number of potential risks that often occur in moderate- to large-scale programs.

For example, a WBS level 4 or 5 element may be made up of several risk issues associated with a specification or function.

Risk analysis is a technical and systematic process to examine identified risks, isolate causes, determine the relationship to other risks, and express the impact in terms of probability and consequence of occurrence.

44.8 Risk Identification

The second step in risk management is to identify all potential risk issues. This may include a survey of the program, customer, and users for concerns and problems.

Some degree of risk always exists in project, technical, test, logistics, production, and engineering areas. Project risks include cost, funding, schedule, contract relationships, and political risks. (Cost and schedule risks are often so fundamental to a project that they may be treated as stand-alone risk categories.) Technical risks, such as related to engineering and technology, may involve the risk of meeting a performance requirement, but may also involve risks in the feasibility of a design concept or the risks associated with using state-of-the-art equipment or software. Production risk includes concerns over packaging, manufacturing, lead times, and material availability. Support risks include maintainability, operability, and trainability concerns. The understanding of risks in these and other areas evolves over time.

Consequently, risk identification must continue through all project phases.
The methods for identifying risk are numerous. Common practice is to classify project risk according to its source. Most sources are either objective or subjective.

Objective sources: Recorded experience from past projects and the current project as it proceeds

- Lessons learned files
- Program documentation evaluations
- Current performance data

Subjective sources: Experiences based upon knowledgeable experts

- Interviews and other data from subject matter experts

Risks can also be identified according to life-cycle phases, as shown in Figure 44.3. In the early life-cycle phases, the total project risk is high because of lack of information. In the later life-cycle phases, the financial risk is the greatest.

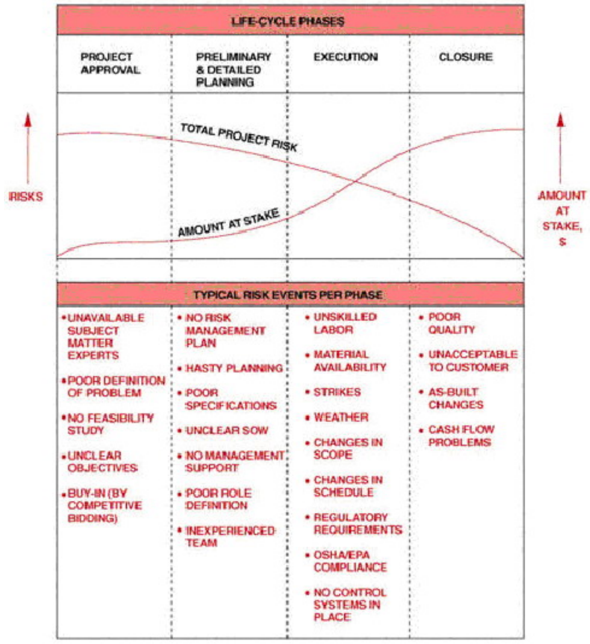

Figure 44.3: Life-cycle risk analysis

Any source of information that allows recognition of a potential problem can be used for risk identification. These include:

- Systems engineering documentation
- Life-cycle cost analysis
- Plan/WBS decomposition
- Schedule analysis
- Baseline cost estimates
- Requirements documents
- Lessons learned files
- Assumption analysis
- Trade studies/analyses
- Technical performance measurement (TPM) planning/analysis
- Models (influence diagrams)
- Decision drivers
- Brainstorming
- Expert judgment

Expert judgment techniques are applicable not only for risk identification, but also for forecasting and decision-making. Two expert judgment techniques are the Delphi method and the nominal group technique. The Delphi method has the following general steps:

Step 1: A panel of experts is selected from both inside and outside the organization. The experts do not interact on a face-to-face basis and may not even know who else sits on the panel.

Step 2: Each expert is asked to make an anonymous prediction on a particular subject.

Step 3: Each expert receives a composite feedback of the entire panel's answers and is asked to make new predictions based upon the feedback. The process is then repeated as necessary.

Closely related to the Delphi method is the nominal group technique, which allows for face-to-face contact and direct communication. The steps in the nominal group technique are as follows:

Step 1: A panel is convened and asked to generate ideas in writing.

Step 2: The ideas are listed on a board or a flip chart. Each idea is discussed among the panelists.

Step 3: Each panelist prioritizes the ideas, which are then ranked mathematically. Steps 2 and 3 may be repeated as necessary.

Expert judgment techniques have the potential for bias in risk identification and analysis. Factors affecting the bias include:

- Overconfidence in one's ability
- Insensitivity to the problem or risk
- Proximity to project
- Motivation
- Recent event recall
- Availability of time
- Relationship with other experts

There exist numerous ways to classify risks. In a simple business context, risk can be defined as:

- Business risk
- Insurable risk

Business risks provide us with opportunities of profit and loss. Examples of business risk would be competitor activities, bad weather, inflation, recession, customer response, and availability of resources. Insurable risks provide us with only a chance for a loss. Insurable risks include such elements as:
Direct property damage: This includes insurance for assets such as fire insurance, collision insurance, and insurance for project materials, equipment, and properties.
Indirect consequential loss: This includes protection for contractors for indirect losses due to third party actions, such as equipment replacement and debris removal.
Legal liability: This is protection for legal liability resulting from poor product design, design errors, product liability, and project performance failure. This does not include protection from loss of goodwill.
Personnel: This provides protection resulting from employee bodily injury (worker's compensation), loss of key employees, replacement cost of key employees, and several other types of business losses due to employee actions.

On construction projects, the owner/customer usually provides "wrap-up" or "bundle" insurance, which bundles the owner, contractor, and subcontractors into one insurable package. The contractor may be given the responsibility to provide the bundled package, but it is still paid for by the owner/customer.

44.9 Risk Handling

Risk handling includes specific methods and techniques to deal with known risks, identifies who is responsible for the risk issue, and provides an estimate of the cost and schedule associated with reducing the risk, if any. It involves planning and execution with the objective of reducing risks to an acceptable level. The evaluators who assess risk should begin the process by identifying risks and developing handling options and approaches to propose to the program manager, who selects the appropriate one(s) for implementation. There are several factors that can influence our response to a risk, including but not limited to:

- Amount and quality of information on the actual hazards that caused the risk (descriptive uncertainty)
- Amount and quality of information on the magnitude of the damage (measurement uncertainty)
- Amount and quality of information on probability of occurrence
- Personal benefit to project manager for accepting the risk (voluntary risk)
- Risk forced upon project manager (involuntary risk)
- Confusion and avoidability of the risk
- The existence of cost-effective alternatives (equitable risks)
- The existence of high-cost alternatives or possibly lack of options (inequitable risks)
- Length of exposure to the risk

Risk handling must be compatible with the RMP and any additional guidance the program manager provides. A critical part of risk handling involves refining and selecting the most appropriate handling option(s) and specific approach (es) for selected risk issues (often those with medium or higher risk levels).

Personnel who evaluate candidate risk handling options may use the following criteria as starting points for evaluation:

- Can the option be feasibly implemented and still meet the user's needs?
- What is the expected effectiveness of the handling option in reducing program risk to an acceptable level?
- Is the option affordable in terms of dollars and other resources (e.g., use of critical materials, and test facilities)?
- Is time available to develop and implement the option, and what effect does that have on the overall program schedule?
- What effect does the option have on the system's technical performance?

Risk handling options include: risk assumption, risk avoidance, risk control, and risk transfer.
Although the control option (often called mitigation) is commonly used in many high technology programs, it should not automatically be chosen. All four options should be evaluated, and the best one chosen for each risk issue.

The options for handling risk fall into the following categories:
Risk assumption (i.e., retention): The project manager says, "I know the risk exists and am aware of the possible consequences. I am willing to wait and see what happens. I accept the risk and its impact should it occur."
Risk avoidance: The project manager says, "I will not accept this option because of the potentially unfavorable results."
Risk control (i.e., prevention or mitigation): The project manager says, "I will take the necessary measures required to control this risk by continuously reevaluating it and developing contingency plans or fall-back positions. I will do what is expected."
Risk transfer: The project manager says, "I will share this risk with others through insurance or a warranty, or transfer the entire risk to them. Perhaps I can convert the risk into an opportunity."

LESSON 45

PROJECT PROCUREMENT, CONTRACT MANAGEMENT, AND ETHICS IN PROJECT MANAGEMENT

BROAD CONTENTS

Procurement
Procurement Cycles
Type of contract
Categories of Contract
Ethics in Project Management

45.1. Procurement

Procurement can be defined as the acquisition of goods or services. Procurement (and contracting) is a process that involves two parties with different objectives who interact in a given market segment. Good procurement practices can increase corporate profitability by taking advantage of quantity discounts, minimizing cash flow problems, and seeking out quality suppliers. Because procurement contributes to profitability, procurement is often centralized, which results in standardized practices and lower paperwork costs.

All procurement strategies are frameworks by which an organization attains its objectives. There are two basic procurement strategies:

Corporate procurement strategy: the relationship of specific procurement actions to the corporate strategy

Project procurement strategy: the relationship of specific procurement actions to the operating environment of the project

Project procurement strategies can differ from corporate procurement strategies because of constraints, availability of critical resources, and specific customer requirements. Corporate strategies might promote purchasing small quantities from several qualified vendors, whereas project strategies may dictate sole source procurement.

Procurement planning usually involves the selection of one of the following as the primary objective:

- Procure all goods/services from a single source.
- Procure all goods/services from multiple sources.
- Procure only a small portion of the goods/services.
- Procure none.

Another critical factor is the environment in which procurement must take place. There are two environments: macro and micro. The macro environment includes the general external variables that can influence how and when we do procurement. These include recessions, inflation, cost of borrowing money, and unemployment. As an example, a foreign corporation had undertaken a large project that involved the hiring of several contractors. Because of the country's high unemployment rate, the decision was made to use only domestic suppliers/contractors and to give first preference to contractors in cities where unemployment was the greatest, even though there were other more qualified suppliers/contractors.

The microenvironment is the internal environment of the firm, especially the policies and procedures imposed by the firm, project, or client in the way that procurement will take place.

This includes the procurement/contracting system, which contains five cycles:
Requirement cycle: definition of the boundaries of the project
Requisition cycle: analysis of sources
Solicitation cycle: the bidding process
Award cycle: contractor selection and contract award
Contract administration cycle: managing the subcontractor until completion of the contract

There are several activities that are part of the procurement process and that overlap several of the cycles. These cycles can be conducted in parallel, especially requisition and solicitation.

45.2. Procurement Cycles

The first step in the procurement process is the definition of project, specifically the requirement. This is referred to as the requirement cycle and includes the following:
Defining the need for the project
Development of the statement of work, specifications, and work breakdown structure
Performing a make or buy analysis
Laying out the major milestones and the timing/schedule
Cost estimating, including life-cycle costing
Obtaining authorization and approval to proceed

The SOW is a narrative description of the work to be accomplished and/or the resources to be supplied. The identification of resources to be supplied has taken on paramount importance during the last ten years or so. During the 1970s and 1980s, small companies were bidding on mega jobs only to subcontract out more than 99% of all of the work. Lawsuits were abundant and the solution was to put clauses in the SOW requiring that the contractor identify the names and resumes of the talented internal resources that would be committed to the project, including the percentage of their time on the project. Specifications are written, pictorial, or graphic information that describe, define, or specify the services or items to be procured. There are three types of specifications:

Design specifications: These detail what is to be done in terms of physical characteristics. The risk of performance is on the buyer.
Performance specifications: These specify measurable capabilities the end product must achieve in terms of operational characteristics. The risk of performance is on the contractor.
Functional specifications: This is when the seller describes the end use of the item to stimulate competition among commercial items, at a lower overall cost. This is a subset of the performance specification, and the risk of performance is on the contractor.

There are always options in the way the end item can be obtained. Feasible procurement alternatives include make or buy, lease or buy, buy or rent, and lease or rent. Buying domestic or international is also of critical importance, especially to the United Auto Workers Union. Factors involving the make or buy analysis is shown below:

- The make decision
- Less costly (but not always!!)
- Easy integration of operations
- Utilize existing capacity that is idle
- Maintain direct control
- Maintain design/production secrecy
- Avoid unreliable supplier base
- Stabilize existing workforce
- The buy decision

- Less costly (but not always!!)
- Utilize skills of suppliers
- Small volume requirement (not cost effective to produce)
- Having limited capacity or capability
- Augment existing labor force
- Maintain multiple sources (qualified vendor list)
- Indirect control

The lease or rent decision is usually a financial endeavor. Leases are usually longer term than renting. Consider the following example. A company is willing to rent you a piece of equipment at a cost of $100 per day. You can lease the equipment for $60 per day plus a one-time cost of $5000. What is the breakeven point, in days, where leasing and renting are the same?

Let X be the number of days.

$$\underbrace{\$100X}_{\text{renting}} = \underbrace{\$5000 + \$60X}_{\text{leasing}}$$

Solving, X = 125 days

Therefore, if the firm wishes to use this equipment for more than 125 days, it would be more cost effective to sign a lease agreement rather than a rental agreement.

Requisition Cycle

Once the requirements are identified, a requisition form is sent to procurement to begin the requisition process. The requisition cycle includes:
Evaluating/confirming specifications (are they current?)
Confirming sources
Reviewing past performance of sources
Producing solicitation package

The solicitation package is prepared during the requisition cycle but utilized during the solicitation cycle. In most situations, the same solicitation package must be sent to each possible supplier so that the playing field is level. A typical solicitation package would include:
Bid documents (usually standardized)
Listing of qualified vendors (expected to bid)
Proposal evaluation criteria
Bidder conferences
How change requests will be managed
Supplier payment plan

Standardized bid documents usually include standard forms for compliance with EEO, affirmative action, OSHA/EPA, minority hiring, etc. A listing of qualified vendors appears in order to drive down the cost. Quite often, one vendor will not bid on the job because it knows that it cannot submit a lower bid than one of the other vendors. The cost of bidding on a job is an expensive process.

Bidder conferences are used so that no single bidder has more knowledge than others. If a potential bidder has a question concerning the solicitation package, then it must wait for the bidders' conference to ask the question so that all bidders will be privileged to the same information. This is particularly important in government contracting. There may be several bidders' conferences between solicitation and award. Project management may or may not be involved in the bidders' conferences, either from the customer's side or the contractor's side.

Solicitation Cycle

Selection of the acquisition method is the critical element in the solicitation cycle. There are three common methods for acquisition:

- Advertising
- Negotiation
- Small purchases (i.e., office supplies)

Advertising is when a company goes out for sealed bids. There are no negotiations. Competitive market forces determine the price and the award goes to the lowest bidder.

Negotiation is when the price is determined through a bargaining process. In such a situation, the customer may go out for a:

- Request for information (RFI)
- Request for quotation (RFQ)
- Request for proposal (RFP)

The RFP is the most costly endeavor for the vendor. Large proposals contain separate volumes for cost, technical performance, management history, quality, facilities, subcontractor management, and others. The negotiation process can be competitive or noncompetitive. Noncompetitive processes are called sole-source procurement.

On large contracts, the negotiation process goes well beyond negotiation of the bottom line.
Separate negotiations can be made on price, quantity, quality, and timing. Vendor relations are critical during contract negotiations. The integrity of the relationship and previous history can shorten the negotiation process. The three major factors of negotiations are:

- Compromise ability
- Adaptability
- Good faith

Negotiations should be planned for. A typical list of activities would include:

- Develop objectives (i.e., min-max positions)
- Evaluate your opponent
- Define your strategy and tactics
- Gather the facts
- Perform a complete price/cost analysis
- Arrange "hygiene" factors

If you are the buyer, what is the maximum you will be willing to pay? If you are the seller, what is the minimum you are willing to accept? You must determine what motivates your opponent. Is your opponent interested in profitability, keeping people employed, developing a new technology, or using your name as a reference? This knowledge could certainly affect your strategy and tactics.

Hygiene factors include where the negotiations will take place. In a restaurant? Hotel? Office? Square table or round tables? Morning or afternoon? Who faces the windows and who faces the walls? There should be a postnegotiation critique in order to review what was learned. The first type of postnegotiation critique is internal to your firm. The second type of postnegotiation critique is with all of the losing bidders to explain why they did not win the contract. Losing bidders may submit a "bid protest" where the customer may have to prepare a detailed report as to why this bidder did not win the contract. Bid protests are most common on government contracts.

Award Cycle

The award cycle results in a signed contract. Unfortunately, there are several types of contracts. The negotiation process also includes the selection of the type of contract.
There are certain basic elements of most contracts.
Mutual agreement: There must be an offer and acceptance.
Consideration: There must be a down payment.
Contract capability: The contract is binding only if the contractor has the capability to perform the work.

The objective of the award cycle is to negotiate a contract type and price that will result in reasonable contractor risk and provide the contractor with the greatest incentive for efficient and economic performance.
Legal purpose: The contract must be for a legal purpose.
Form provided by law: The contract must reflect the contractor's legal obligation, or lack of obligation, to deliver end products.
The two most common contract forms are completion contracts and term contracts.
Completion contract: The contractor is required to deliver a definitive end product. Upon delivery and formal acceptance by the customer, the contract is considered complete, and final payment can be made.
Term contract: The contract is required to deliver a specific "level of effort," not an end product.

The effort is expressed in woman/man-days (months or years) over a specific period of time using specified personnel skill levels and facilities. When the contracted effort is performed, the contractor is under no further obligation. Final payment is made, irrespective of what is actually accomplished technically.

The final contract is usually referred to as a definitive contract, which follows normal contracting procedures such as the negotiation of all contractual terms, conditions, cost, and schedule prior to initiation of performance. Unfortunately, negotiating the contract and preparing it for signatures may require months of preparation. If the customer needs the work to begin immediately or if long-lead procurement is necessary, then the customer may provide the contractor with a letter contract or letter of intent. The letter contract is a preliminary written instrument authorizing the contractor to begin immediately the manufacture of supplies or the performance of services. The final contract price may be negotiated after performance begins, but the contractor may not exceed the "not to exceed" face value of the contract. The definitive contract must still be negotiated.

- The type of contract selected is based upon the following:
- Overall degree of cost and schedule risk
- Type and complexity of requirement (technical risk)
- Extent of price competition
- Cost/price analysis
- Urgency of the requirements
- Performance period
- Contractor's responsibility (and risk)
- Contractor's accounting system (is it capable of earned value reporting?)
- Concurrent contracts (will my contract take a back seat to existing work?)
- Extent of subcontracting (how much work will the contractor outsource?)

45.3. **Types of Contracts**

Before analyzing the various types of contracts, one should be familiar with the terminology found in them.
The target cost or estimated cost is the level of cost that the contractor will most likely obtain under normal performance conditions. The target cost serves as a basis for measuring the true cost at the end of production or development. The target cost may vary for different types of contracts even though the contract objectives are the same. The target cost is the most important variable affecting research and development.
Target or expected profit is the profit value that is negotiated for, and set forth, in the contract. The expected profit is usually the largest portion of the total profit.
Profit ceiling and profit floor are the maximum and minimum values, respectively, of the total profit. These quantities are often included in contract negotiations.

Price ceiling or ceiling price is the amount of money for which the government is responsible. It is usually measured as a given percentage of the target cost, and is generally greater than the target cost.
Maximum and minimum fees are percentages of the target cost and establish the outside limits of the contractor's profit.
The sharing arrangement or formula gives the cost responsibility of the customer to the cost responsibility of the contractor for each dollar spent. Whether that dollar is an overrun or an under-run dollar, the sharing arrangement has the same impact on the contractor. This sharing arrangement may vary depending on whether the contractor is operating above or below target costs.

The production point is usually that level of production above which the sharing arrangement commences.
Point of total assumption is the point (cost or price) where the contractor assumes all liability for additional costs.

At one end of the range is the cost-plus, a fixed-fee type of contract where the company's profit, rather than price, is fixed and the company's responsibility, except for its own negligence, is minimal. At the other end of the range is the lump sum or turnkey type of contract under which the company has assumed full responsibility, in the form of profit or losses, for timely performance and for all costs under or over the fixed contract price. In between are various types of contracts, such as the guaranteed maximum, incentive types of contracts, and the bonus-penalty type of contract.

These contracts provide for varying degrees of cost responsibility and profit depending on the level of performance. Contracts that cover the furnishing of consulting services are generally on a per diem basis at one end of the range and on a fixed-price basis at the other end of the range.

Because no single form of contract agreement fits every situation or project, companies normally perform work in the United States under a wide variety of contractual arrangements, such as:

- Cost-plus percentage fee
- Cost-plus fixed fee
- Cost-plus guaranteed maximum
- Cost-plus guaranteed maximum and shared savings
- Cost-plus incentive (award fee)
- Cost and cost sharing
- Fixed price or lump sum
- Fixed price with re-determination
- Fixed price incentive fee
- Fixed price with economic price adjustment
- Fixed price incentive with successive targets
- Fixed price for services, material, and labor at cost (purchase orders, blanket agreements)
- Time and material/labor hours only
- Bonus-penalty
- Combinations
- Joint venture

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There are generally five types of contracts to consider:

- Fixed-Price (FP),
- Cost -Plus-Fixed-Fee (CPFF), Or Cost-Plus-Percentage-Fee (CPPF),
- Guaranteed Maximum-Shared Savings (GMSS),
- Fixed-Price-Incentive-Fee (FPIF), And
- Cost-Plus-Incentive-Fee (CPIF) Contracts.

Each type is discussed separately.

Fixed-Price (FP)

Under a fixed-price or lump-sum contract, the contractor must carefully estimate the target cost. The contractor is required to perform the work at the negotiated contract value. If the estimated target cost was low, the total profit is reduced and may even vanish. The contractor may not be able to underbid the competitors if the expected cost is overestimated. Thus, the contractor assumes a large risk.

This contract provides maximum protection to the owner for the ultimate cost of the project, but has the disadvantage of requiring a long period for preparation and adjudications of bids. Also, there is the possibility that because of a lack of knowledge of local conditions, all contractors may necessarily include an excessive amount of contingency. This form of contract should never be considered by the owner unless, at the time bid invitations are issued, the building requirements are known exactly. Changes requested by the owner after award of a contract on a lump sum basis lead to troublesome and sometimes costly extras.

Cost -Plus-Fixed-Fee (CPFF), Or Cost-Plus-Percentage-Fee (CPPF)

Traditionally, the cost-plus-fixed-fee contract has been employed when it was believed that accurate pricing could not be achieved any other way. In the CPFF contract, the cost may vary but the fee remains firm. Because, in a cost-plus contract, the contractor agrees only to use his best efforts to perform the work, good performance and poor performance are, in effect, rewarded equally. The total dollar profit tends to produce low rates of return, reflecting the small amount of risk that the contractor assumes. The fixed fee is usually a small percentage of the total or true cost.

The cost-plus contract requires that the company books be audited. With this form of contract the engineering-construction contractor bids a fixed dollar fee or profit for the services to be supplied by the contractor, with engineering, materials, and field labor costs to be reimbursed at actual cost. This form of bid can be prepared quickly at a minimal expense to contractor and is a simple bid for the owner to evaluate. Additionally, it has the advantage of establishing incentive to the contractor for quick completion of the job.

If it is a cost-plus-percentage -fee contract, it provides maximum flexibility to the owner and permits owner and contractor to work together cooperatively on all technical, commercial, and financial problems. However, it does not provide financial assurance of ultimate cost. Higher building cost may result, although not necessarily so, because of lack of financial incentive to the contractor compared with other forms. The only meaningful incentive that is evident today is the increased competition and prospects for follow-on contracts.

Guaranteed Maximum-Shared Savings (GMSS)

Under the guaranteed maximum-share savings contract, the contractor is paid a fixed fee for his profit and reimbursed for the actual cost of engineering, materials, construction labor, and all other job costs, but only up to the ceiling figure established as the "guaranteed maximum." Savings below the guaranteed maximum are shared between owner and contractor, whereas contractor assumes the responsibility for any overrun beyond the guaranteed maximum price.

This contract form essentially combines the advantages as well as a few of the disadvantages of both lump sum and cost-plus contracts. This is the best form for a negotiated contract because it establishes a maximum price at the earliest possible date and protects the owner against being overcharged, even though the contract is awarded without competitive tenders. The guaranteed maximum-share savings contract is unique in that the owner and contractor share the financial risk and both have a real incentive to complete the project at lowest possible cost.

Fixed-Price-Incentive-Fee (FPIF)

Fixed-price-incentive-fee contracts are the same as fixed-price contracts except that they have a provision for adjustment of the total profit by a formula that depends on the final total cost at completion of the project and that has been agreed to in advance by both the owner and the contractor. To use this type of contract, the project or contract requirements must be firmly established. This contract provides an incentive to the contractor to reduce costs and therefore increase profit. Both the owner and contractor share in the risk and savings.

Cost-Plus-Incentive-Fee (CPIF) Contracts

Cost-plus-incentive-fee contracts are the same as cost plus contracts except that they have a provision for adjustment of the fee as determined by a formula that compares the total project costs to the target cost. This formula is agreed to in advance by both the owner and contractor. This contract is usually used for long-duration or R&D type projects. The company places more risk on the contractor and forces him to plan ahead carefully and strive to keep costs down.

Contract Type	Advantages	Disadvantages
Cost-plus-fee	• Provides maximum flexibility to owner	• No assurance of actual final cost
	• Minimizes contractor profits	• No financial incentive to minimize time and cost
	• Minimizes negotiations and preliminary specification costs	• Permits specification of high-cost features by owner's staff
	• Permits quicker start, earlier completion	• Permits excessive design changes by owner's staff increasing time and costs
	• Permits choice of best-qualified, not lowest-bidding, contractor	
	• Permits use of same contractor from consultation to completion, usually increasing quality and efficiency	
Guaranteed maximum-share savings	• Provides firm assurance of ultimate cost at earliest possible date	• Requires complete auditing by owner's staff
	• Insures prompt advice to owner of delays and extra costs resulting from changes	• Requires completion of definitive engineering before negotiation of contract
	• Provides incentive for quickest completion	
	• Owner and contractor share financial risk and have mutual incentive for possible savings	
	• Ideal contract to establish owner–contractor cooperation throughout execution of project	
Fixed price/lump sum	• Provides firm assurance of ultimate cost	• Requires exact knowledge if what is wanted before contract award
	• Insures prompt advice to owner of delays and extra costs resulting from changes	• Requires substantial time and cost to develop inquiry specs, solicit, and evaluate bids. Delays completion 3–4 months
	• Requires minimum owner follow-up on work	• High bidding costs and risks may reduce qualified bidders
	• Provides maximum incentive for quickest completion at lowest costs	• Cost may be increased by excessive contingencies in bids to cover high-risk work
	• Involves minimal auditing by owner's staff	

Contract Type	Advantages	Disadvantages
Fixed price for services, material and labor	• Essentially same as cost-plus-fee contract • Fixes slightly higher percentage of total cost	• May encourage reduction of economic studies and detailing of drawing: produce higher costs for operation, construction, maintenance
	• Eliminates checking and verifying contractor's services	• Other same disadvantages as cost-plus-fee contract
Fixed price for imported goods and services, local costs reimbursable	• Maximum price assured for high percentage of plant costs	• Same extended time required for inquiry specs, quotations, and evaluation as fixed lump -sum for complete project
	• Avoids excessive contingencies in bids for unpredictable and highly variable local costs	• Requires careful definition of items supplied locally to insure comparable bids
	• Permits selection of local suppliers and subcontractors by owner	• No financial incentive to minimize field and local costs

45.4. ETHICS

Ethical Origins

Societal Ethics: Standards of Members of Society use when dealing with each other Based on "Values & standards"
Societal Ethics: Found in Society's Legal Rules, Norm, & Mores. Codified in the "Form of Law" & Society Customer.

Norms dictate how people should behave. Societal ethics vary based on a given Society. Strong beliefs in one country differ elsewhere.

Professional Ethics: Professional Ethics are the Values & standards used by Group of Managers in workplace. They are applied when decision not "Clear-Cut Ethically". Some examples are the practices of Physicians/Lawyers Professional Associates (PMA, Bar Council)

Values: are an individual's basic convictions of what is "Right & Wrong". They are the basic beliefs about what one should or should not do? & what is & is not important?

Individual Ethics: are the values of an individual resulting from their family & upbringing.

Ethics codes & policies provide sign of top management's desires in project based organizational culture. Project manager should behave ethically to avoid harming others. Managers responsible for "protecting & nurturing resources" in their charge. Leadership, Culture and Incentive Compensation Plans help Shape "Individual Ethical behavior" in project management promoting ethics. There is strong evidence showing that ethical managers benefit in the longer run. Firms increasingly seek to make good ethics part of norm & organizational culture. Ethical decisions involve normative judgment implies "something is good or bad, right or wrong, better or worse." Some examples are:
Should you pay compensation pay to lay off workers?
Should you buy goods from overseas firms that hire children? (If you don't Children may not earn enough money to eat)

Views of Ethical Decision-Making

Figure 45.1: Views of Ethical Decision Making

Code of Ethics:

Professional organizations such as the Project Management Institute are taking a serious look at developing the requirements for a professional project manager. In a paper by Ireland, Pike, and Schrock, this subject was described by an ethics obligation matrix and a code of ethics.

OBLIGATIONS	TO WHOM OWNED						
	EMPLOYER	CLIENT/ CUSTOMER	TEAM MEMBERS	STUDENT APPRENTICE	PROFESSIONAL SOCIETY	PUBLIC IN GENERAL	GOVERNMENT
1. Support Code of Ethics					X		
2. Support Professional Society					X		
3. Guard Privileged Information	X	X					
4. Accept Responsibility for Actions	X	X	X	X	X	X	X
5. Proper Use of Authority	X		X	X			
6. Maintain Expertise in State-of-Art	X	X	X	X	X		
7. Build and Maintain Public Confidence					X		
8. Support, Respect and Abide by Laws						X	X
9. Avoid Gift Exchange	X	X					
10. Conservation of Resources (Productivity)	X	X				X	
11. Avoid Conflict of Interest	X	X					
12. Equal Opportunity Employment						X	
13. Health and Safety			X			X	
14. Promote Project Management Profession					X		
15. Honesty in Dealing With Employer and Client	X	X					
16. Professional Interface	X	X	X	X	X	X	

Figure 45.2: Ethics Obligation Matrix

Code of Ethics for Project Managers

Project Managers, in the pursuit of their profession, affect the quality of life for all people in our society. Therefore, it is vital that Project Managers conduct their work in an ethical manner to earn and maintain the confidence of team members, colleagues, employees, clients and the public.

Article I: Project Managers shall

- Maintain high standards of personal and professional conduct.
- Accept responsibility for their actions.
- Undertake projects and accept responsibility only if qualified by training or experience, or after full disclosure to their employers or clients of pertinent qualifications.
- Maintain their professional skills at the state -of-the-art and recognize the importance of continued personal development and education.
- Advance the integrity and prestige of the profession by practicing in a dignified manner.
- Support this code and encourage colleagues and co-workers to act in accordance with this code.
- Support the professional society by actively participating and encouraging colleagues and

coworkers to participate.
- Obey the laws of the country in which work is being performed.

Article II: ***Project Managers shall, in their work:***
- Provide the necessary project leadership to promote maximum productivity while striving to minimize costs.
- Apply state-of-the-art management tools and techniques to ensure schedules are met and the project is appropriately planned and coordinated.
- Treat fairly all project team members, colleagues and co-workers, regardless of race, religion, sex, age or national origin.
- Protect project team members from physical and mental harm.
- Provide suitable working conditions and opportunities for project team members.
- Seek, accept and offer honest criticism of work, and properly credit the contribution of others.
- Assist project team members, colleagues and co-workers in their professional development.
-

Article III: ***Project Managers shall, in their relations with employers and clients:***

- Act as faithful agents or trustees for their employers or clients in professional or business matters.
- Keep information on the business affairs or technical processes of an employer or client in confidence while employed, and later, until such information is properly released.
- Inform their employers, clients, professional societies or public agencies of which they are members or to which they may make any presentations, of any circumstances that could lead to a conflict of interest.
- Neither give nor accept, directly or indirectly, any gift, payment or service of more than nominal value to or from those having business relationships with their employers or clients.
- Be honest and realistic in reporting project cost, schedule and performance.
-

ARTICLE IV: ***Project Managers shall, in fulfilling their responsibilities to the community:***

- Protect the safety, health and welfare of the public and speak out against abuses in those areas affecting the public interest.
- Seek to extend public knowledge and appreciation of the project management profession and its achievements.
-

How Firms Can Improve Their Social Responsiveness (Ethical Performance)

- Establish and publish their own Code of Ethics
- Ombudsmen - (committee, task force) to review the corporate past behavior
- Protect whistle-blowing - when an employee discloses an illegal, immoral, or unethical action committed by a member of the organization
- Training programs - ethical sensitivity training
- Controlling compliance - corporate social audit (or ethics audit)
- Leadership - demonstrate commitment from leaders
- Involve personnel at all levels