f171fd5797fa582d666aed25c7e620be
ebrary

2

Organizing and the Human Element

f171fd5797fa582d666aed25c7e620be
ebrary

2.1 Introduction

Industrial organizations have been increasing in size, number, and the size of their operations from the days of the Industrial Revolution. Today's organizations have to operate in more demanding and competitive environments than the environments of the past. For example, 50 years ago companies could survive with only one or perhaps two product lines, but in today's environments their survival depends on factors such as multiple product lines (i.e., diversification) and vigorous integration of technology into the existing setups [1]. Factors such as these have been instrumental in organizing the operations of industrial organizations in such a manner that they operate most efficiently and at the minimum cost. The term *organizing* may simply be described as the process of developing a structure for the organization or company to help its manpower to operate systematically to satisfy the organizational goals in an effective manner [2].

The human element plays a pivotal part in the success or failure of an engineering company. For example, a company may have an excellent engineering product, but poor human management within the organization may make it an unprofitable product. Human resources are probably the most important resource of an organization because they are a major element of cost in most enterprises (e.g., in the petroleum and chemical industries, the labor cost varies between 25% and 30% of the total operating cost) and they influence an organization's productivity [3].

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

This chapter presents important aspects of the organizing and human element considered useful for engineering management professionals.

2.2 The Components of Organizing and Guidelines for Planning an Organization

The basic goal of organizing is to divide the work into reasonably manageable units. Irrespective of the permanency of such units, organizing involves many elementary components that require careful consideration during the design of any organizational system. Some of these components are as follows [1]:

f171fd5797fa582d666aed25c7e620be
ebrary

- *Definition of work.* This calls for management to have a good understanding of the type, scope, and magnitude of work to be carried out in the future.
- *Division of work.* This is the process of subdividing the work under consideration into manageable units.
- *Division of labor and specialization.* This is concerned with allocating the subdivided work to groups and individuals specialized in carrying out the task/function.
- *Unity of command and direction.* One of the fundamentals of organization calls for an individual to receive orders from one superior authority only [4]. However, in modern organizational systems such as the matrix, dual accountability and power sharing could be unavoidable. Under such circumstances, each employee must be very clear concerning for which specific items he or she is responsible and to whom. The unity of direction calls for clearly directing each set of activities toward specified goals, unified by one accepted plan and one leader. In a modern organization, task direction and leadership channels are rather intricate, thus they must be carefully considered.
- *Responsibility and authority.* Each organizational unit and each individual must have clearly delineated authority defining the scope and type of work to be executed and how to work in harmony, which includes the authority to pass orders and use resources.
- *Chain of command and span of control.* A chain of command may be described as an unbroken line of authority that links all concerned individuals to successively higher authority levels. In establishing an organizational structure the aim is to provide a clear chain of command for each and every command axis of the organization. The

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

span of control is the number of people reporting directly to a supervisor. Usually various factors are considered in establishing span of control at each organizational level.

- *Centralization.* This is concerned with the concentration of authority at the top level of an enterprise or any of its elements. Usually, the degree of centralization varies from one organization to another.

Past experience indicates that the following guidelines are quite useful in planning an organization [5]:

f171fd5797fa582d666aed25c7e620be
ebrary

- Ensure that the individual delegating responsibility is accountable.
- Keep a position's functional and managing duties separate.
- Ensure that an individual receives orders from only one authority.
- Keep the management levels to a minimum.
- Keep the delegation of authority and responsibility close to the point of action as much as possible.
- Keep the line of responsibility and authority from the top to the bottom of the organization as clear as possible.
- Design each organizational element such that it satisfies its own objectives effectively in addition to that of its parent enterprise.

2.3 Organizational Charts and Basic Relationships in Organizational Structures

f171fd5797fa582d666aed25c7e620be
ebrary

In an organization, there are probably only a handful of documents that get treated with more respect and emotion and carry more authority than organizational charts. Reasons for having organizational charts include the assignment of responsibilities to individuals, the outlining of basic authority, the identification of weak or strong control, and the outlining of basic relationships. In addition, organizational charts improve communication channels, simplify management functions, provide a sense of security, serve as a basis for directives, serve as reference documents, and serve as a framework for budgeting and scheduling [6].

Some of the limitations of the organizational charts include [1]:

- An inability to show work flow;
- An inability to show informal organization;

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- An inability to display factors such as dual accountability, resource sharing, and power sharing;
- Inflexibility;
- A state of being too static;
- An inability to show how the work is being performed and integrated;
- An overemphasis on status and position.

There are three basic relationships in the organizational structures of many companies as shown in Figure 2.1: line, group, and staff. In the case of line, authority flows from superior A to subordinate B, and then through B to subordinate C. This way a line is formed from the top management level to the lowest organizational level. That is why it is known as the *line authority*. The group is also known as *multiple reporting* and in this case a group of individuals report to a single superior. Usually, more people report to a superior at the bottom organizational level than at the top level. In the case of the staff relationship, a group of individuals perform the role of helping the line management carry out the organizational goals in an effective manner. The staff relationship is not something new—in ancient times, Alexander the Great's (355–323 B.C.) armies practiced this concept [2]. Usually, the staff function or relationship exists more at the top end of the organizational ladder than at the bottom end.

f171fd5797fa582d666aed25c7e620be
ebrary

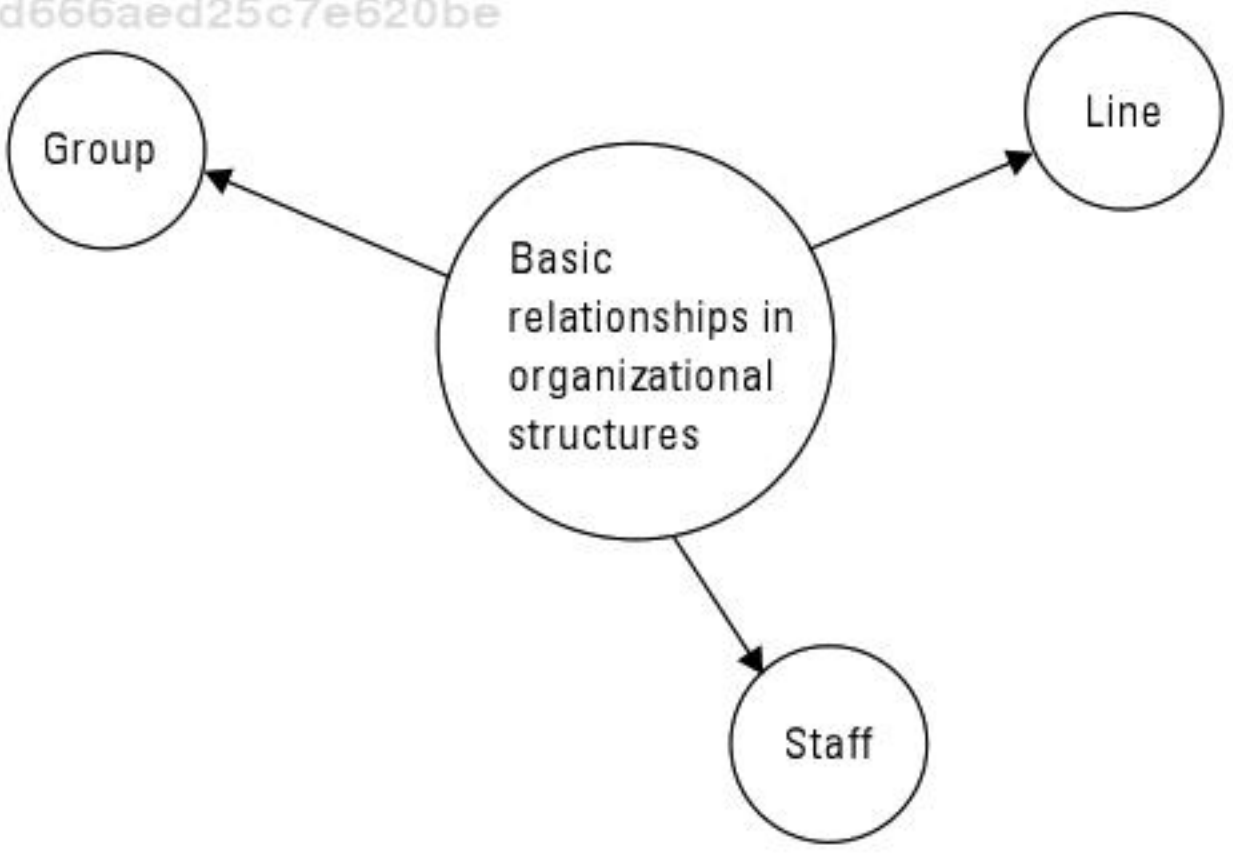

Figure 2.1 Three basic relationships in organizational structures.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

2.4 Centralization and Decentralization of Organizations, Span of Control, and Delegation

Centralization and decentralization are important issues in establishing the organizational structures of engineering companies. In the case of centralization, the upper management has the authority to make the important or critical decisions. By contrast, in the case of decentralization, the authority is distributed among lower levels of the organization. Nonetheless, for an effective performance, a proper balance between the two is necessary.

Past experience indicates that an organization leans more toward centralization if the following conditions exist [1]:

f171fd5797fa582d666aed25c7e620be
ebrary

- It is a capital-intensive operation.
- There are clear channels of supply and distribution.
- There is a need for close coordination of activities.
- There is a need for confidentiality of top-level decisions.
- There is a need for top-level strategy and direction.
- Available resources can be pooled and shared.
- There is a need for advanced technology and skill developments.

Some of the benefits of centralization are the elimination of work duplication, a reduction in the number of undesirable decisions by less experienced executives, an improvement in control over specialized functions, closer communication between the important decision makers (thus simplifying the coordination of their efforts), the causing of centralized staff expertise to be more efficient and simpler to use, a reduction in the need for experienced subordinate managers, and a reduction in staffing costs because fewer competent managers can handle the jobs and the needs of the staff [2, 5].

Under the conditions listed next, an organization that leans toward decentralization has the following characteristics [1]:

- It is a labor-intensive operation.
- There is noncritical resource sharing.
- Separable operations and profit accountability exist.
- It is a large organization in diversified businesses.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- There is a need for quick reaction time in relation to the external business environment.
- There is a need from operating-level management for entrepreneurial drive, initiative, and commitment.
- It is a project- or multiproduct-oriented operation.

Nonetheless, as per [7], the factors such as those listed next shape the degree of decentralization of authority:

- The business's dynamic nature;
- Management's thinking philosophy;
- Company size;
- Company history;
- Desire for independence by individuals and groups;
- Availability of properly trained managers to make decentralized decisions;
- Cost of decisions;
- Influences from external forces (e.g., government controls, income tax policies, and unions);
- Availability of control techniques for monitoring decisions made at the lower management levels.

f171fd5797fa582d666aed25c7e620be
ebrary

Some of the benefits of decentralization are useful for making the overall organization stronger by facilitating the personal development of individuals, which is useful to stimulate initiative and identification with the firm, useful for creating better feelings of satisfaction among competent individuals, and useful for ensuring that the decisions are made by management individuals with the best experience of local conditions [2, 5].

Span of control may simply be described as the number of individuals directly reporting to a manager. Although it is impossible to calculate the actual number of individuals in an ideal span of control, over the years various experts have proposed various numbers of people to be supervised by a superior. For example, an ideal number of individuals to be supervised by a superior at the upper levels of management is between four and eight and at the lower levels between eight and fifteen. However, a survey of 100 large American firms conducted by the American Management Association

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

revealed that executives reporting to company presidents varied from one to 24, and there were only 26 presidents supervising six or less people [7].

Factors such as those listed next help define the limits of individuals which can be supervised by a superior [1, 7].

- The superior's capacity to comprehend quickly;
- The complexity of the supervised task or function;
- The physical proximity of the subordinate's functions;
- The requirement for personal involvement by superior;
- The team or group characteristics of subordinate manpower;
- The overhead function's responsibilities, such as staffing, organizing, planning, and reporting;
- The integration needs among subfunctions;
- The similarity of the supervised task or function;
- The amount of personnel administration versus task leadership only.

After extensive research, the model Lockheed Missile and Space Company developed a span of control mode that takes into consideration the following factors [7–9]:

- The degree of coordination required;
- The organizational help available to superiors;
- The locations of individuals reporting to a superior;
- The degree of direction and control required by subordinate individuals;
- The type of department or unit management;
- The nature of work performed;
- The importance of planning and functions of superiors or organizational units, their complexity and time requirements;
- The similarity of functions carried out by subordinate individuals.

Each of the above variables is assigned a weight in determining the optimum span of control.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

In the past, some attempts have been made to develop mathematical span of control models. For example, [10] defines the total number of leaders in a company as follows:

$$TL = \frac{WF\left(M^{n} - 1\right)}{M^{n}\left(M - 1\right)} \tag{2.1}$$

where

TL	is the total number of leaders in a company.
n	is the total number of hierarchy levels in a company.
WF	is the company work force excluding supervisory personnel.
M	is the number of persons to be supervised by a superior or leader.

Since a company has only one president, we write

$$\frac{WF}{M^{n}} = 1 \tag{2.2}$$

Substituting (2.2) into (2.1) yields

$$TL = \frac{\left(M^{n} - 1\right)}{\left(M - 1\right)} \tag{2.3}$$

f171fd5797fa582d666aed25c7e620be
ebrary

Using (2.2), we get

$$n = \frac{\log WF}{\log M} \tag{2.4}$$

and

$$M = \left(WF\right)^{\frac{1}{n}} \tag{2.5}$$

This mathematical model is subject to observations such as the organizational levels decrease with the increase in span of control, uniform span

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

of control at all hierarchy levels, and n is inversely proportional to log M because of constant WF. All in all, mathematical models such as this could be useful in making decisions concerning the span of control.

Delegation is concerned with assigning responsibility and authority to subordinate individuals by a superior, and it is absolutely necessary because superiors work through others. The task of delegation is not easy, and it suffers from various managerial and subordinate obstacles. The managerial obstacles include poor confidence in subordinates, poor directing capability, overwariness of risk in tasks performed by subordinates, false beliefs that the superiors can do a better job than the subordinates, and poor control mechanisms to make management aware of impending difficulty [11].

By contrast, some of the subordinates' obstacles to delegation are poor self-confidence, poor incentives for additional responsibilities, heavy current workloads, poor facilities for accomplishing the job properly, fear of mistakes, and reluctance to sort out the problem themselves because they find it easier to obtain the help of superiors [11].

Over the years, various people have presented interesting approaches for delegating authority. Some of the useful guidelines for managers in delegating authority are as follows [8]:

- Choose only those individuals whose qualifications and experiences match the tasks in question.
- Divide the job under consideration into various separate tasks.
- Aim for the total understanding of subordinate individuals with respect to factors such as orders being delegated, his or her authority, the subsequent review procedure to be used, and subsequent reward (if any).
- Monitor progress periodically.
- Provide sufficient authority to subordinates.
- Describe the responsibility standards for each task to be performed.

2.5 Methods of Organization

Many different methods are used to develop organizational structures. The application of these methods depends on factors such as location, company policy, skills of manpower, and product. This section presents five methods of organization [2, 5–7].

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

2.5.1 Organization by Product

Some companies use this approach to develop their organizational structure. The approach calls for dividing the company into divisions and then assigning each division the responsibility for one particular product. Figure 2.2 shows a simplified chart of an organization by product.

Some of the benefits of this approach are as follows:

- It develops better coordination of functional activities.
- It places better attention on the product.
- It develops teamwork more easily.
- It places profit responsibility at the divisional level.
- It serves as a measurable training ground for general managers.

By contrast, the major disadvantages of this method are an increase in need for general managers, the limitation of contact among individuals of the same specialty, and the difficulty in maintaining cost effectiveness of central services.

2.5.2 Organization by Function

This is a widely used method in organizing company activities, and it calls for dividing work according to discipline or subject in addition to performing all similar work under one unit. This method is often favored by large research

f171fd5797fa582d666aed25c7e620be
ebrary

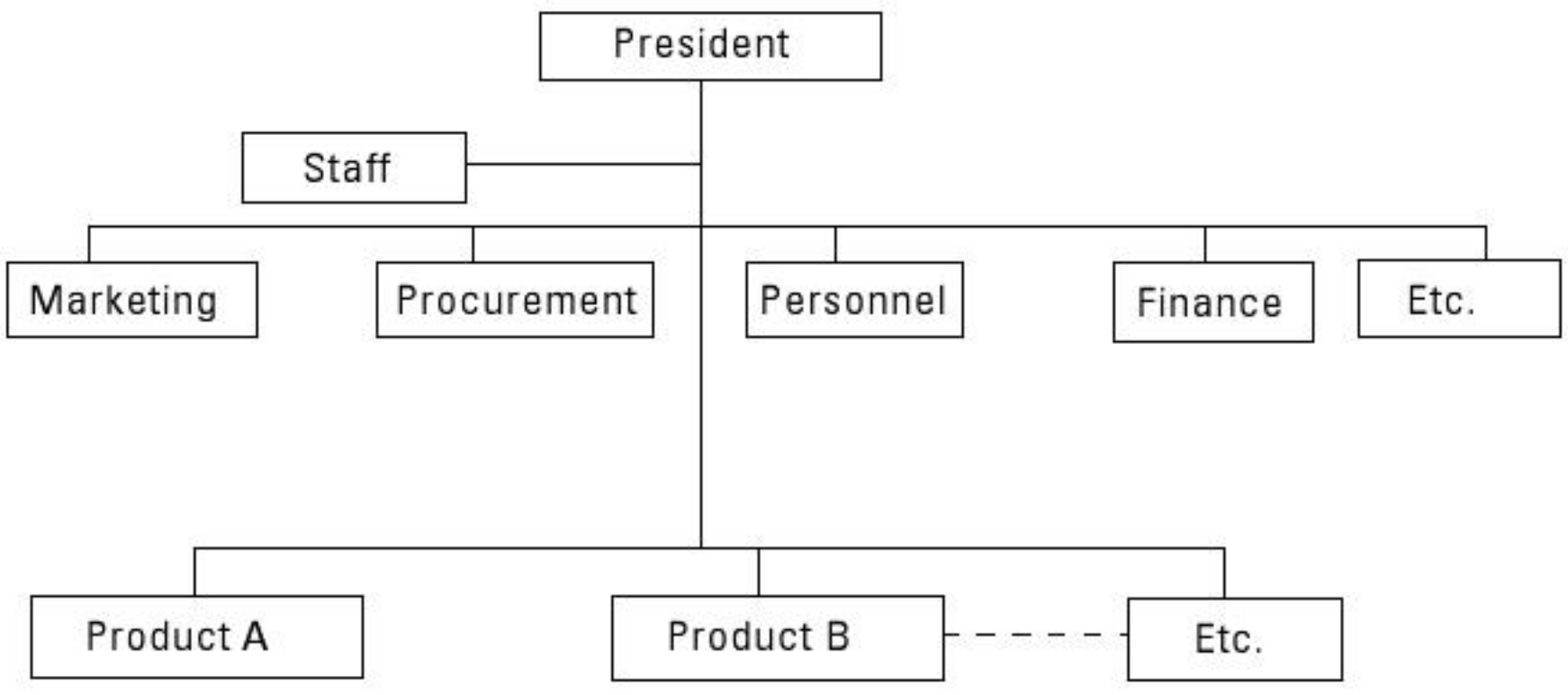

Figure 2.2 Organization by product.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

groups and enterprises as well as organizations with long-term projects [6, 9]. Figure 2.3 presents a simplified chart of a functional organization.

Some of the advantages of this method are as follows:

- More uniform products;
- Consistent policy;
- Even distribution of work;
- Elimination of duplicate facilities;
- Room for technical specialization;
- Group homogeneity, thus it is easy to supervise a group.

f171fd5797fa582d666aed25c7e620be
ebrary

The method also has several drawbacks, including slow work flow, difficulty when shifting personnel, and poor effectiveness in cross-discipline developmental work.

2.5.3 Organization by Project

In this case, appropriate individuals are grouped together to carry out a complex project within prescribed limits. Thus, the project organization may simply be described as a nonpermanent structure formed to meet a specific objective. More specifically, after the completion of the project the individuals associated with the project are either sent back to their permanent department or transferred to a new project.

Past experience indicates that small and medium-sized enterprises and companies with various short-term jobs favor the organization by project approach [6]. A simplified organizational structure of a project-based

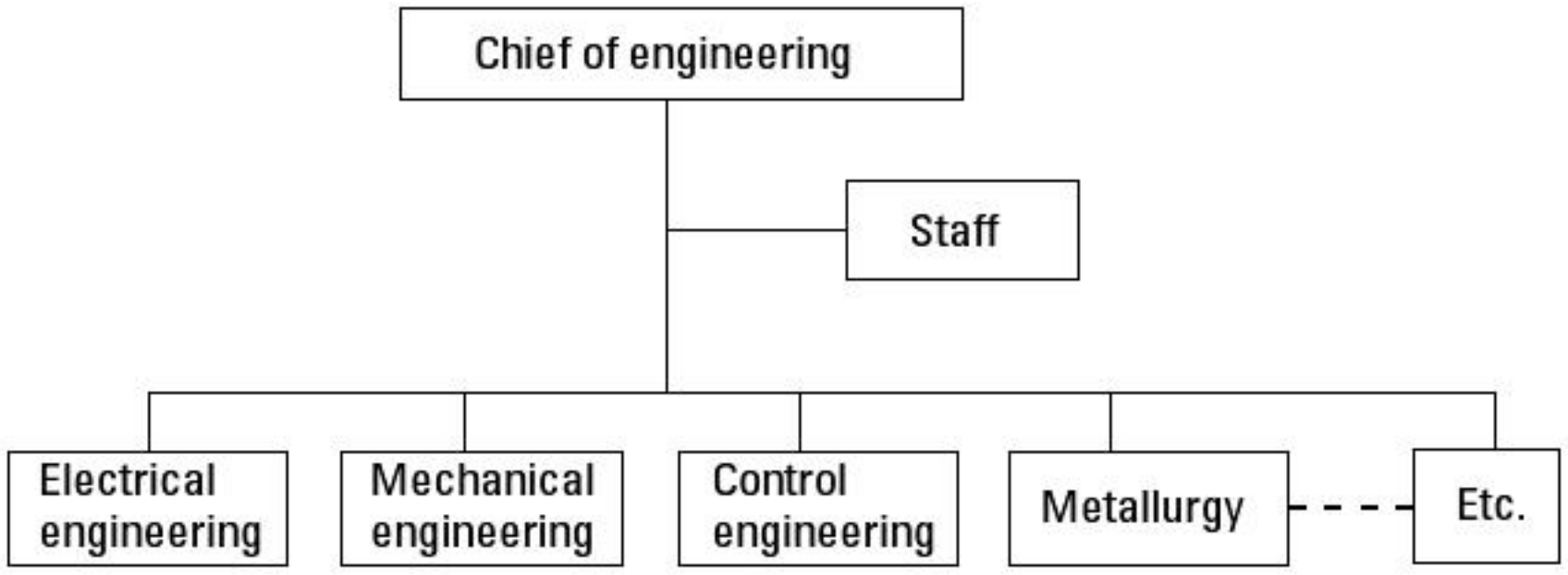

Figure 2.3 A functional organization.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

organization is shown in Figure 2.4. Some of the benefits of the organization by project approach are as follows [1, 5, 6]:

- It focuses attention on a single project.
- It improves efficiency of work flow.
- It is a useful framework for team effort.
- It allows improved coordination of large projects.
- It is a useful tool for specialization by product.
- It is useful to make more specific the accountability and responsibility of the project.

f171fd5797fa582d666aed25c7e620be
ebrary

By contrast, the disadvantages of this approach include less uniform products, duplication of work facilities, and inconsistent policy [9].

2.5.4 Organization by Territory

This approach is used in a situation where a company is physically dispersed [7, 9]. Under this approach, all activities in a given territory are grouped and then a manager is appointed to head the group. There are various reasons for having "departmentation" by territory, including poor communication facilities, a need to take prompt action, and the encouragement of local participation in decision making. Figure 2.5 presents a simplified diagram of organization by territory.

Some of the advantages of organization by territory are the emphasis placed on local conditions, usefulness in upgrading regional coordination, and the advantage taken of local conditions' economy. By contrast, the method's two main disadvantages are the difficulty in maintaining economical central services and the increased need for general managers.

f171fd5797fa582d666aed25c7e620be
ebrary

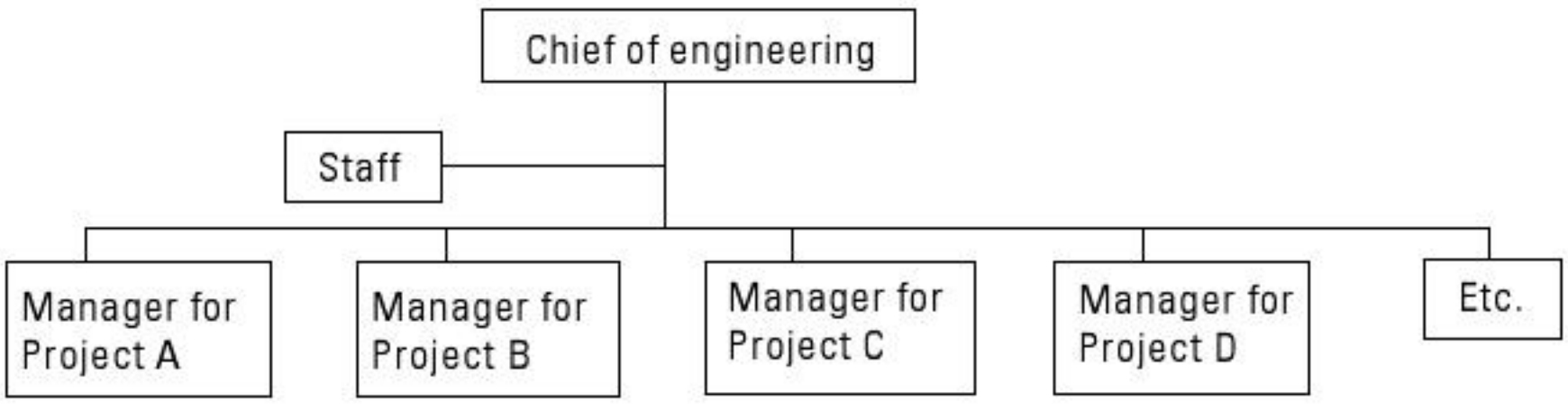

Figure 2.4 A simplified chart of a project-based organization.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

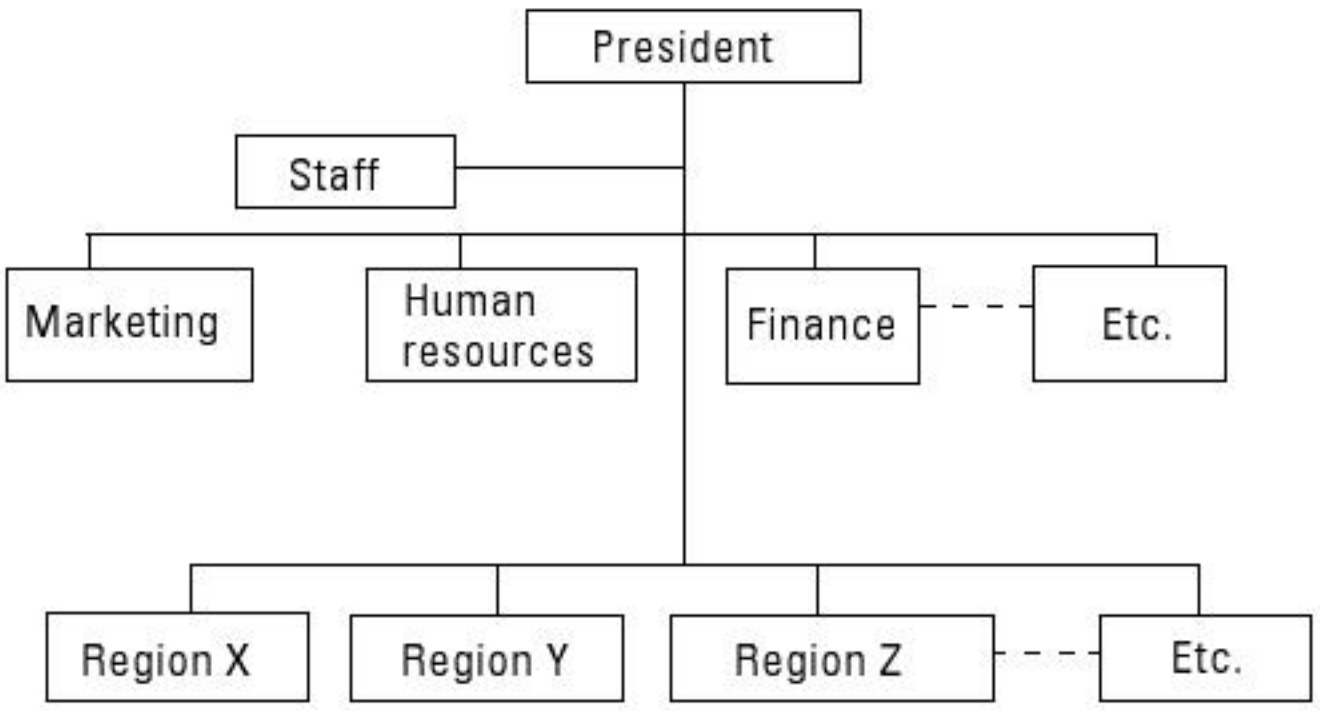

Figure 2.5 A simplified chart of organization by territory.

f171fd5797fa582d666aed25c7e620be
ebrary

2.5.5 Matrix Organization

Broadly speaking, this is the result of combining the functional and project methods together. This way most advantages of both the approaches are achieved. The matrix organization method was first practiced by medium-sized aerospace companies in the 1950s because these organizations were not large enough to take full advantage of the organization by project approach. In the matrix organization, the project manpower is loaned to the project manager, and it reports to both the project manager and the chiefs of the functional or "home" departments. More specifically, the functional departments are the ones to which this manpower is permanently assigned.

Some of the benefits of the matrix organization are efficient decision making, which provides a better control and increases the role of middle management [12]. Similarly, two of its drawbacks are the possibility of producing surplus skills in the event of smaller projects and the application of such skills to projects that do not require it.

2.6 Functions of an Engineering Department and Guidelines for Organizing a New Engineering Department

A typical engineering department performs various types of functions, and they may be grouped under five distinct categories as shown in Figure 2.6 [6].

The administrative category includes functions such as those listed here:

- Formulating polices and planning;
- Hiring, firing, and promotion;

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

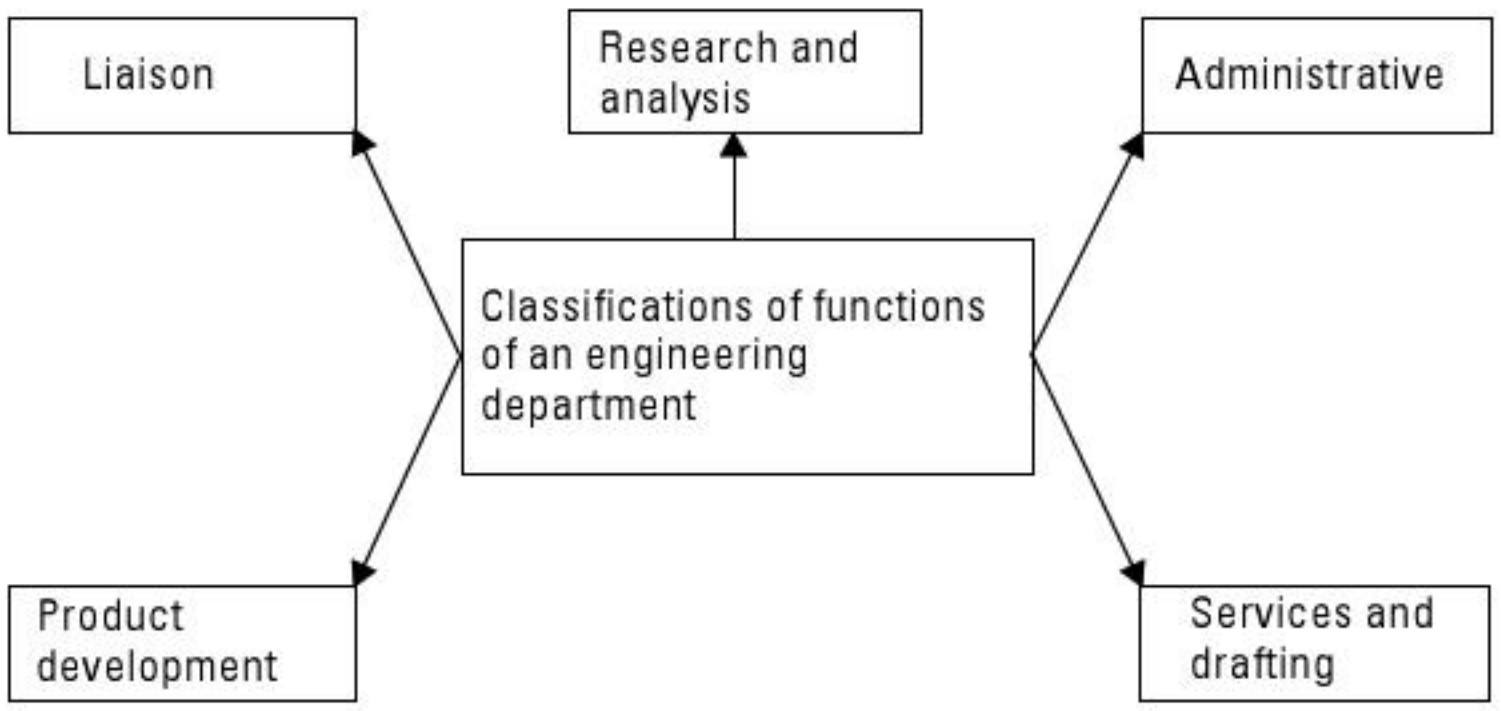

Figure 2.6 Categories of functions of a typical engineering department.

f171fd5797fa582d666aed25c7e620be
ebrary

- Budgeting;
- Pricing;
- Assigning duties and controlling work;
- Procurement;
- Progress reporting;
- Training;
- Salary review.

The following functions belong to the research and analysis category:

f171fd5797fa582d666aed25c7e620be
ebrary

- Searching for new ideas;
- Performing patent and literature searches;
- Testing and evaluating;
- Finding solutions to basic problems;
- Providing analytical services;
- Performing calculation and computing.

Some of the functions belonging to the product development classification are as follows:

- Preparing and analyzing proposals;
- Redesigning;

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Searching for new products;
- Standardizing parts and materials;
- Designing new products.

The functions such as those listed next belong to the services and drafting category:

- Releasing drawings and prints;
- Drafting;
- Constructing models;
- Publications.

f171fd5797fa582d666aed25c7e620be
ebrary

Some examples of the functions belonging to the liaison category are as follows:

- Liaising with customers;
- Liaising with other departments;
- Liaising with outside agencies.

Over the years professionals working in the engineering management field have developed various guidelines for organizing a new engineering department. Some of these guidelines are as follows [1]:

f171fd5797fa582d666aed25c7e620be
ebrary

- Develop the overall mission for the department by including factors such as technical objectives, global business objectives, timing, and responsibilities.
- Define the type of tasks to be carried out by the department.
- Define the functional capabilities that the new department should include versus the ones that can be contracted out to other departments or organizations. Ensure that the senior management agrees with the organizational scope prior to taking the next step.
- Define with care the main functional units of the department, along with its reporting structure.
- Define factors such as the specific reporting relations, controls, and responsibilities that will make the department operational.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Delineate and summarize in the organizational plan in a step-by-step fashion the specific staffing levels and facility and equipment requirements.
- Develop job descriptions for all individuals who will report directly to the department manager.
- Advertise positions in the department to be filled, within and outside the company.

2.7 Characteristics and Needs of an Engineer, Routes for an Engineer to Obtain Management Positions, and Transition of an Engineer to a Managerial Position

An engineer possesses certain characteristics and some of the important ones include liking new and different things, being independent, being recognized, exercising technical knowledge and skills, building relationships with other engineering professionals, and directly attacking problems [13].

The many needs of an engineer include job security, acceptable work facilities, economic advancement, opportunities for self-development, work variety, appropriate technical assistance, stimulating and challenging work, adequate supporting staff, independence to attack a work problem, participation in decisions that will affect him or her, proper work assignment, competent bosses, employment with a reputable company, opportunity for his or her ideas to be practiced, having clearly defined responsibility and authority within an organization, and proper recognition for his or her efforts from the management [5, 9, 13]. There are many different routes for an engineer to obtain management positions as shown in Figure 2.7 [5].

The promotion is concerned with changing the current job after obtaining necessary experience, say, 2 or 3 years at one place, in the early stage of an engineer's career because in many organizations the chances of getting a promotion are rather low. Reasonable good service with a firm and leadership in professional activities is another route for a management position, although it is lengthy. The leadership in professional activities is obtained through actions such as writing articles or books and securing positions in professional societies. This allows an engineer a "high visibility" with the company management. A high degree of technical competence and ability to organize is one of the best routes to obtain management positions, particularly for persons doing extremely well in their professional specialties. The sponsor-protégé arrangement is another route for managerial positions. In this case, a manager finds dependable and likeable people and when such a

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

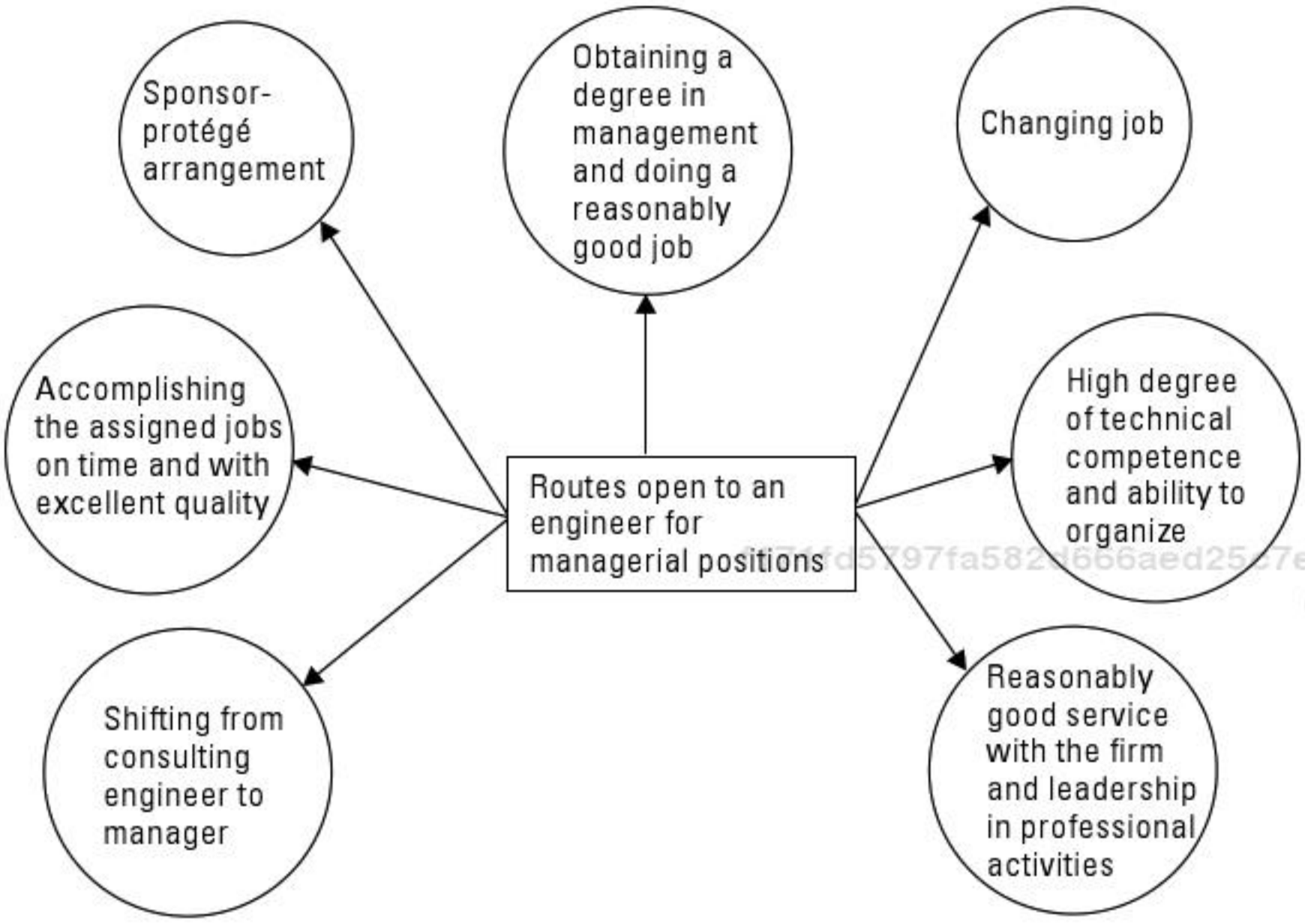

Figure 2.7 Routes for an engineer to obtain managerial positions.

manager gets a promotion, he or she tries to get promotions for his or her closest people, so that they can work for him or her in the new environment.

Accomplishing the assigned jobs on time and with excellent quality is another way of obtaining managerial positions. Obtaining an advanced degree in management and doing a reasonably good job in the field has become a fairly popular route for obtaining management positions. For example, a survey of technical professionals revealed that engineers and scientists who obtained a master's degree in management within 1 to 3 years of their college graduation earn around 17% higher than the ones with a master's degree in engineering [5, 9]. Engineers who develop their specialties by becoming consulting engineers can also move to managerial ranks. Usually, this route works quite well for consulting engineers who do not become too specialized.

Whenever an engineer makes a switch from a technical position to a management position, he or she finds certain changes in areas such as responsibilities and personnel habits. Therefore, such an individual must be prepared for these changes; otherwise, he or she may find it difficult to perform his or her job effectively. Some of these changes are listed next [6].

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- *Dealing with generalities.* This simply means the engineering professional has to work with generalities such as supervision, delegation, sales, and negotiation instead of specifics such as force, pressure, weight, and length in engineering.

- *Reading habits.* The engineer now not only has to read technical magazines but also the management ones. However, due to lack of available time, the individual will look for results rather than working to understand each and every step of an approach or process described in these documents.

- *Human relations.* Now the engineer not only has to look after his or her own interests but also those of the people he or she supervises. He or she will be concerned with maximizing productivity from people with minimum friction and effort.

- *Delivering speeches.* Because management solves many of its problems in meetings, a supervising engineer or manager is expected to propose, explain, and defend his or her ideas in such gatherings. From time to time, a manager may also make speeches to public audiences. All in all, a person in a managerial position has to learn to think and talk on his or her feet in order to advance further in his or her career.

- *Delegating.* As no manager can carry out all the tasks required from his or her department or group, such tasks must be delegated to others within the department. Thus, a person new to a management position has to learn the secrets of delegating tasks pleasantly and effectively.

- *Changing ways of thinking.* An engineer's thinking is usually confined to only one technical project, but in managing his or her thinking will be broader. For example, he or she must now be concerned with his or her department's performance and profit or loss to the overall company. Moreover, he or she will think in terms of selling to others, will think ahead about problems, will think of many alternatives, and will think while listening to others.

- *Training people.* Training others will be important to the newly appointed engineer-manager due to rapid changes in current modern technology. The people under his or her direction must be able to perform their jobs effectively.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

2.8 An Engineering Manager's Qualities and Activities

Over the years, many professionals working in the management field have studied the qualities of engineering managers. After a careful analysis, they have developed a list of typical qualities of a good engineering manager as presented in Table 2.1 [6].

Usually, a manager performs the following basic activities [6, 9, 13]:

- Planning;
- Organizing;
- Staffing;
- Communicating;
- Personnel development;

f171fd5797fa582d666aed25c7e620be
ebrary

Table 2.1
Typical Qualities of a Good Engineering Manager

Number	Quality
1	Tolerance
2	Flexibility
3	Fairness
4	Empathy
5	Ability to reason
6	Good emotional control
7	Good humor
8	Self-confidence
9	Good listening ability
10	Quickness to praise and criticize
11	Tact
12	Technical competence
13	Quickness to see good in others
14	Ability to recognize different points of view
15	Ability to self-appraise
16	Freedom from suspicion and prejudice
17	Good communication skills

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Counseling;
- Training;
- Standards.

Each of these activities is described in [6].

2.9 Motivating Others and Analyzing Team Characteristics

One way to increase the productivity of a department is to motivate its manpower effectively. Some past studies indicate that self-motivated individuals are two to ten times more productive than their non-self-motivated counterparts. Although many different motivational tools have been cited in published literature, as per [6], the following six motivators have proven to be very useful for managers to motivate people in the past:

- Involve employees in the goal-setting act.
- Set performance measuring standards high but within achievable limits of employees.
- Ensure that the employees clearly understand goals and policies.
- Challenge self-defeating attitudes of employees.
- Consult employees on matters that are usually above their level from time to time.
- Uncover motivational tools that work best for an individual employee.

Nonetheless, as per [3], some of the high motivators for engineers are making a direct attack on problems, performing a job successfully, being independent, associating with competent coworkers, doing new and different things, utilizing professional information to solve problems, using technical knowledge and skills in making contributions to the advancement of science, and being recognized for accomplishments by peers and colleagues.

Similarly, the important motivators for managers are having a challenging job, threat of competition, the job as a status symbol, urge for leadership, monetary gain, fear of losing job, and making mistakes [7].

Table 2.2 presents a list of useful questions for engineering managers to use to analyze team characteristics [13].

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

Table 2.2
Useful Questions for Analyzing Team Characteristics

Number	Question
1	What things do the team members do well?
2	What are the major drawbacks of the team?
3	How well do the team members organize their work?
4	How does the team interact with or relate to other groups in work or social situations?
5	Is there any warmth and friendliness among team members?
6	What interpersonal relationships exist among team members?
7	Do team members clearly understand such factors as their responsibilities, plans, and roles?
8	What is the attitude of the team members toward dominant requirements, and what are they doing to meet them? Is there anything that turns them off?
9	What is the team's past experience?
10	Are there any initiators among team members who try to get other members to join in doing things?
11	Are there any distinct motivational patterns of the team members?
12	What is the main goal of the team, and is it clearly understood by the team?
13	What personal goals and values are important to team members?
14	What is really going on for the team?

f171fd5797fa582d666aed25c7e620be
ebrary

2.10 Committees and Staff Meetings

In government and private sectors, committees are widely used to make various types of decisions. A committee is made up of individuals to whom, as a team, specific matter is committed [7].

There are various reasons for having committees: to gain group judgment, to reduce the power of a single individual, to represent different concerned groups, to share and transmit information, to coordinate activities among various groups of an organization, to encourage motivation through participation, to delay decisions on a problem, and so on [7, 9].

Some of the major functions of a committee are as follows [9]:

- Evaluating policies;
- Reviewing performance;

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Producing alternatives;
- Recommending solutions;
- Implementing solutions.

Just like anything else, committees too have various disadvantages, including being subject to minority tyranny, dividing responsibility, being costly in monetary terms, and taking considerable time to reach group decisions. Often various voices against committees are raised, but a survey published in the *Harvard Business Review* found that only 8% of the respondents would eliminate committees if they were ever given power to do so [14].

Staff meetings consume a significant amount of managers' time, and many important decisions are made in these meetings. A competent manager attends these meetings not only to discuss and find solutions to work problems, but also to discover and develop the management potential of his or her subordinates so that at a time of need, the organization will find little difficulty in looking for people with management talent. From the manager's perspective, some of the benefits associated with the staff meetings are as follows [6]:

- They are useful in identifying the fast thinkers.
- The manager will not overlook the potentially gifted executives.
- The manager can monitor his or her entire staff in action.
- Staff meetings are useful testing grounds for discovering the management capabilities of an individual. For example, a person's performance during the staff meetings will give a fair idea about that person's management potential.
- Staff meetings are useful for monitoring the attitudes of staff members.

The staff meetings can only be useful if they are held effectively. Some useful guidelines for holding effective staff meetings are as follows [6, 8, 9]:

- Control the meeting by not allowing irrelevant topics to dominate, leaving the meeting's objective unaccomplished.
- Stimulate the interest of staff members in meetings so that they do not consider them a waste of time.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Do not permit any disruptions during meetings.
- Encourage the participation of all persons present at the meeting through actions such as circulating the meeting agenda well in advance.
- At the start of the meeting, examine the actions taken on decisions of the previous meeting.
- Promote the use of visual aids, particularly when presenting facts and figures.
- Tactfully, assign seats to participants, particularly to a potential troublemaker, whenever the manager (i.e., the chairperson) has an opportunity. As per the behavioral scientists [8], the potential troublemaker should be assigned seat "T" as shown in Figure 2.8. As per the statistics, the manager chairing the meeting is usually a right-eyed dominant person, thus he or she can tactfully ignore the troublemaker seated at position "T." However, when a person wishes to challenge the chairperson, he or she should sit on seat "C" as shown in Figure 2.8. This allows the challenger to confront the person chairing the meeting with eye-to-eye contact, and it could be quite disconcerting to the chairperson if the challenger keeps his or her hand up to participate in the discussion. All in all, a manager or others chairing a meeting should avoid such a seating arrangement.

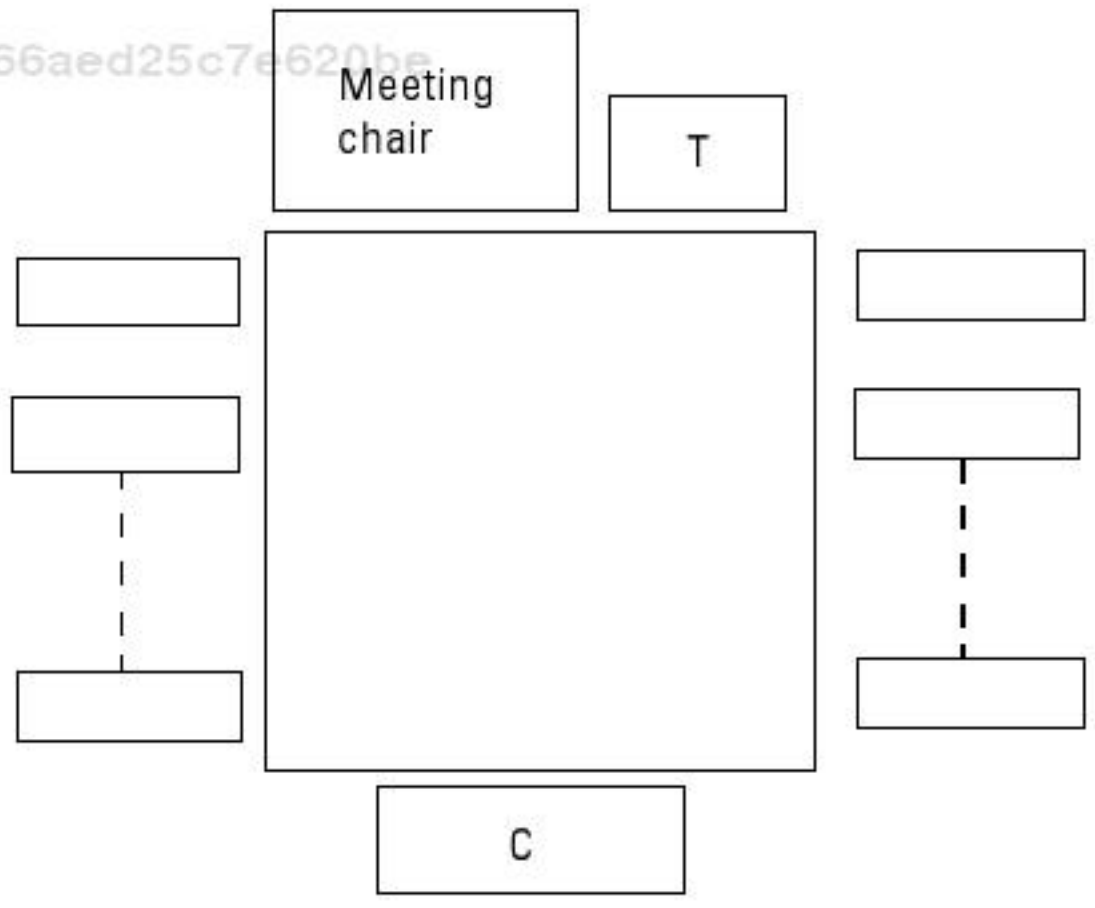

Figure 2.8 Seating layout for a meeting.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

2.11 Displacing Managers and an Organization Size-Efficiency Model

From time to time, management finds itself in a situation of displacing managers due to various factors including poor performance. Displacing a manager from his or her position is not simple or straightforward—it requires careful execution. Otherwise, the company image in the eyes of its employees, customers, and the public could be severely damaged. Past experience indicates that senior management practices various ways of displacing managers. Figure 2.9 presents five basic ways [15]. Each of these ways is discussed separately next.

f171fd5797fa582d666aed25c7e620be
ebrary

Center

In this case, the concerned manager's title and office are retained but his or her group is removed or shifted to another department. Usually, this move is practiced in a situation where it is necessary to conceal from the public the removal of the manager. However, this move has several drawbacks: the concerned individual's salary may be maintained at the same level and the morale of the shifted group members may decrease along with a decrease in productivity.

East

In this case, the affected manager is moved laterally to a position such as a special or staff assistant with the same salary. If the conditions change, the involved individual may return to his or her original position. Some of the benefits of this move are as follows:

f171fd5797fa582d666aed25c7e620be
ebrary

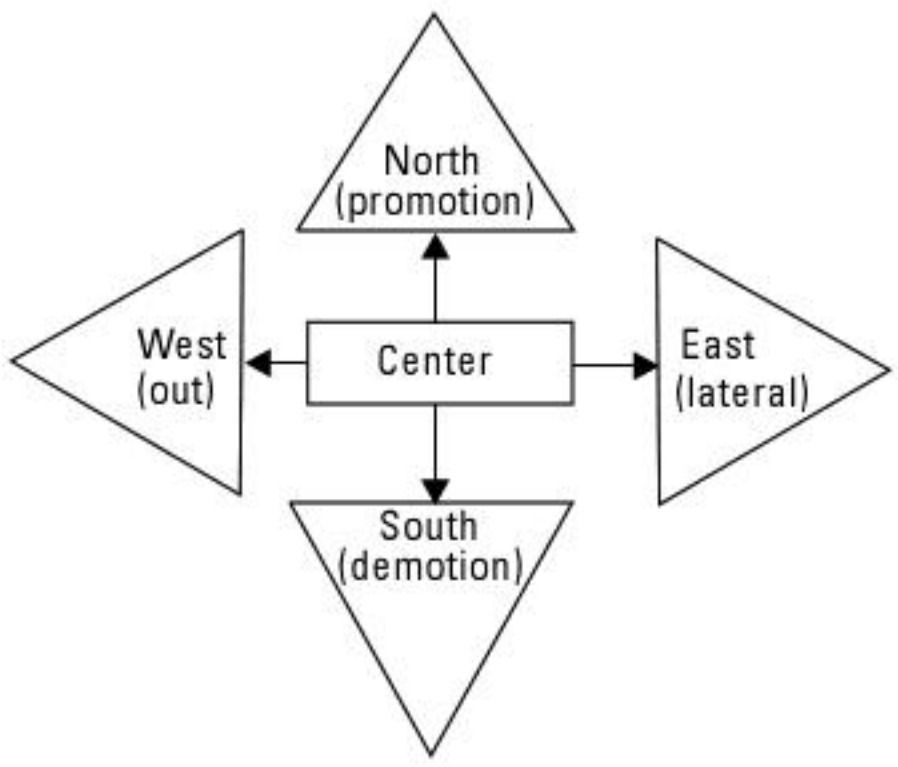

Figure 2.9 Five basic ways to displace a manager.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

- Often, the affected individual is receptive to the move.
- The move is relatively easy to execute.
- Chances for publicity are minimal.
- The morale and loyalty of the involved manager to the firm may not be affected, if the lateral position will be of real value to the individual in question.

North

This is probably the easiest move to remove a manager from his or her current position, and it involves giving such an individual a promotion. Usually, this move is practiced in situations where the manager has become powerful by having strong links with the public, customers, and so on. There is a good chance that the affected manager may not even become aware of the hidden motive and may take it as a genuine promotion.

Two important advantages of the move are that the morale of the individual and the group reporting to him or her remains intact and that it is easy to get the approval of the involved person because of a more prestigious title and probably higher financial benefits.

By contrast, the following two principal drawbacks are associated with this move:

- It is costly because the salary is higher or the same.
- The affected manager may interfere with the functioning of the old group because of the group's loyalty toward him or her.

South

In this case, the concerned individual is demoted from his or her current position. Usually, this move is practiced with an individual who will take it well or is old or sick. Past experience indicates that young individuals do not usually take such humiliation easily and remain loyal to the company. Two principal advantages of this move are probable savings in the payment of salary and the removal of the individual from his or her position. Similarly, the move's disadvantages include probable reduction in an individual's productivity, a lesser degree of loyalty toward the organization, and a possible poor effect on the morale of other members of the company.

West

In this case, the manager is asked to leave the company. Normally, this move is practiced in situations when the other moves fail. From time to time, the moves such as those discussed earlier are practiced first with the hope that the

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

concerned individual leaves the organization at his or her will. Also, sometimes this move is softened with an offer of early retirement or disability leave (if applicable).

Some of the disadvantages of the move are increased chances of adverse publicity, the possibility of a poor effect on the morale of certain members of the organization, and the possibility of an adverse effect on customers and investors because they may interpret this as the existence of unstable forces in the company.

2.11.1 An Organization Size-Efficiency Model

f171fd5797fa582d666aed25c7e620be
ebrary

This model directly or indirectly studies both the organizational and human element aspects. More specifically, the model is basically concerned with determining the relationship between organization size and employees' output. The model is based on the assumption that the organization is involved in paper study oriented tasks such as doing research. More specifically, a professional employee reads other people's works or reports during work hours and writes his or her reports. The following expression was developed to determine the number of publications or reports produced by an organization or department annually [16]:

$$N = \frac{WDM}{\left(AT_w + AT_r M\theta\right)} \tag{2.6}$$

where

f171fd5797fa582d666aed25c7e620be
ebrary

N is the total number of publications or reports produced by an organization or a department per year.

AT_r is the average time taken to read one report by a professional employee, expressed in days.

AT_w is the average time taken to write one report by a professional employee, expressed in days. This time incorporates the time spent on items such as investigation, analysis, writing, and review.

θ is the fraction of all reports or publications received by a professional employee, more specifically, the documents the employee is expected to read.

WD is the assumed number of working days in a year. Thus, in this model, $WD = 240$ days.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

M is the total number of professional employees in the organization or department.

By inserting the value of WD into (2.6), we get

$$N = \frac{240\,M}{\left(AT_w + AT_r M\theta\right)} \tag{2.7}$$

As M becomes very large, (2.7) yields

$$N' = \frac{240}{AT_r\,\theta} \tag{2.8}$$

f171fd5797fa582d666aed25c7e620be
ebrary

where N' is the upper limit of N.

The efficiency of the organization or department is expressed by

$$\gamma = \frac{N}{N_O} = \left[1 + \left(\theta MAT_r\right) / AT_w\right]^{-1} \tag{2.9}$$

where N_o is the total number of reports that can be produced if no time was spent in reading any of the reports written by others.

From (2.9), it can be easily noted that as M becomes large, the value of γ approaches zero, γ being inversely proportional to M.

Example 2.1

Assume that a research organization employs 400 professional employees, and each employee works for 7 hours a day throughout 240 workdays annually. Each employee is involved in a research activity in which he or she reads other people's works in order to write his or her own reports. Past experience indicates that on the average, the employee spends 5 days reading a report prepared by others and 30 days writing his or her report. The time spent for writing includes tasks such as investigation, analysis, and actual writing. If each professional employee reads only 25% of the total reports received annually, calculate the following:

- The total number of reports expected to be produced by the organization per year.
- The total number of reports expected to be produced by the organization annually if the total number of employees in the organization increases to 800 and 1,600.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

For M = 400, 800, and 1,600, substituting the other given data into (2.7) yields the following results, respectively:

$$N = \frac{240(400)}{30 + 5(400)(0.25)} = 181.13 \text{ reports/year}$$

$$N = \frac{240(800)}{30 + 5(800)(0.25)} = 186.41 \text{ reports/year}$$

f171fd5797fa582d666aed25c7e620be
ebrary

and

$$N = \frac{240(1{,}600)}{30 + 5(1{,}600)(0.25)} = 189.16 \text{ reports/year}$$

By substituting the specified data values into (2.8), we get

$$N' = \frac{240}{5(0.25)} = 192 \text{ reports/year}$$

f171fd5797fa582d666aed25c7e620be
ebrary

The above results clearly demonstrate that doubling the company manpower (i.e., 800 and 1,600) did not double the output. In fact, it went from 181.13 to 186.41 and then to 189.16 reports per year. The above results also show that the outputs are increasing towards the upper limit of 192 reports per year.

2.12 Problems

1. List and discuss the important components of organizing that require a careful consideration during the design of any organizational system.
2. What are the advantages of having organizational charts?
3. Discuss the factors under which an organization should be considered for decentralization.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

4. What are the important factors that should be considered in determining the number of people to be supervised by an individual?
5. Discuss the following methods of organization:
   - Organization by function;
   - Organization by project.
6. What are the functions of a typical engineering department?
7. What are the characteristics and needs of an engineer?
8. What are the qualities of a good engineering manager?
9. What are the functions of a typical engineering manager?
10. Write down at least 10 useful questions for analyzing team characteristics.
11. Discuss at least five important guidelines for holding staff meetings effectively.
12. What are the important reasons for having committees?

References

[1] Thamhain, H. J., *Engineering Management,* New York: John Wiley and Sons, 1992.

[2] Mescon, M. H., M. Albert, and K. Khedouri, *Management: Individual and Organizational Effectiveness,* New York: Harper and Row Publishers, 1981.

[3] Glueck, W. F., *Personnel: A Diagnostic Approach,* Plano, TX: Business Publications, 1982.

[4] Fayol, H., *Industrial and General Management,* London: Pitman and Sons, 1949.

[5] Karger, D. W., and R. G. Murdick, *Managing: Engineering and Research,* New York: Industrial Press, 1969.

[6] Chironis, N. P. (ed.), *Management Guide for Engineers and Technical Administrators,* New York: McGraw-Hill, 1969.

[7] Koontz, H. C., C. O'Donnell, and H. Weihrich, *Management: A Book of Readings,* 5th ed., New York: McGraw-Hill, 1980.

[8] Kelly, J., *How Managers Manage,* Englewood Cliffs, NJ: Prentice Hall, 1980.

[9] Dhillon, B. S., *Engineering Management,* Lancaster, PA: Technomic Publishing Company, 1987.

[10] Meij, J. L., "Some Fundamental Principles of a General Theory of Management," *The Journal of Industrial Economics,* Vol. 1, October 1955, pp. 16–32.

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.

f171fd5797fa582d666aed25c7e620be
ebrary

[11] Newman, W. H., "Overcoming Obstacles to Effective Delegation," *Management Review,* January 1956, pp. 36–41.

[12] Pywell, H. E., "Engineering Management in a Multiple (Second- and Third-Level) Matrix Organization," *IEEE Trans. on Engineering Management,* Vol. 26, 1979, pp. 51–55.

[13] Amos, J. M., and B. R. Sarchet, *Management for Engineers,* Englewood Cliffs, NJ: Prentice Hall, 1981.

[14] Tillman, R., "Committees on Trials," *Harvard Business Review,* Vol. 38, No. 3, 1960, pp. 162–173.

[15] Bird, F. L., "How to Displace Executives," in *Management Guide for Engineers and Technical Administrators,* N. P. Chironis (ed.), New York: McGraw-Hill, 1969, pp. 63–64.

[16] Adler, F. P., "Relationships Between Organization Size and Efficiency," *Management Science,* Vol. 7, No. 1, 1960, pp. 80–84.

f171fd5797fa582d666aed25c7e620be
ebrary

f171fd5797fa582d666aed25c7e620be
ebrary

Dhillon, B.S.. Engineering and Technology Management Tools and Applications. Norwood, US: Artech House Books, 2002. ProQuest ebrary. Web. 13 September 2016.
Copyright © 2002. Artech House Books. All rights reserved.