# Introduction to Engineering Management

# ENGINEERING AND MANAGEMENT

#### **Textbook**

Managing Engineering and Technology, Daniel L. Babcock and Lucy C. Morse

Publisher: Prentice Hall India Pvt. Ltd.

#### **Reference Books:**

- Engineering Management- Gupta-S. Chand publications
- Industrial engineering and Organization Management- Dr. S.K. Sharma, Savita Sharma
- A new American TQM- Four Practical in Management Shoji Shiba
- Management , J.A.F Stoner, R.E. Freeman & D. R. Gilbert, 1995, prentice Hall
- Management A global perspective, International edition, 1994, McGraw-Hill

12/13/2022

# **Origins of Engineering**

The words *engineer* and *ingenious* both stem from the Latin *ingenium*, which meant a **talent**, **natural capacity**, or **clever** invention.

Early applications of "clever inventions" often were military ones, and *ingeniarius* became one of several words applied to builders of such "ingenious" military machines.

Talent, natural capacity, or clever invention.

# **Engineering as a Profession**

the profession of the engineer as defined in the charter that Telford obtained [in 1818 for the Institute of Civil Engineers] for himself and his associates from [King] George the Fourth—"the art of directing the great sources of power in nature, for the use and convenience of man."

Engineer's Council for Professional Development (ECPD), 1979 the precursor of ABET, the Accrediting Board of Engineering and Technology defined *engineering* as

the profession in which a knowledge of the mathematica and natural sciences gained by study, experience, an practice is applied with judgment to develop ways utilize, economically, the materials and forces of the nature for the benefit of mankind.

### **What Engineers Do**

engineering

engineering

/ɛndʒɪˈnɪərɪŋ/

See definitions in:

All Civil Engineering Biology

#### noun

noun: engineering

- the branch of science and technology concerned with the design, building, and use of engines, machines, and structures.
  - a field of study or activity concerned with modification or development in a particular area.
     "software engineering"
- the action of working artfully to bring something about."if not for his shrewd engineering, the election would have been lost"



/endzi'niə/

#### verb

gerund or present participle: engineering

- design and build (a machine or structure).
   "the men who engineered the tunnel"
  - modify (an organism) by manipulating its genetic material.
     "it is now possible to engineer tobacco plants that are resistant to the virus"
- skilfully arrange for (something) to occur."she engineered another meeting with him"

12/13/2022 5

An engineer is a practitioner of engineering, concerned with applying scientific knowledge, mathematics, and ingenuity to develop solutions for technical, societal and commercial problems.

Engineers design materials, structures, and systems while considering the limitations imposed by practicality, regulation, safety, and cost.

Engineering has been differentiated from other academic paths by the need for people to logically apply quantifiable principles.

- Academic knowledge, practical training, experience, and work-study are all avenues to becoming an engineer.
- The key attribute for engineers is the direct application of that knowledge and experience.

Many engineering applications require cross-pollination or integration of multiple disciplines.

- The previous focusing on a specialty is not as important as being able to communicate and team with others.
- Flexibility and interpersonal skills will be the hallmark of the new generation of engineering disciplines.

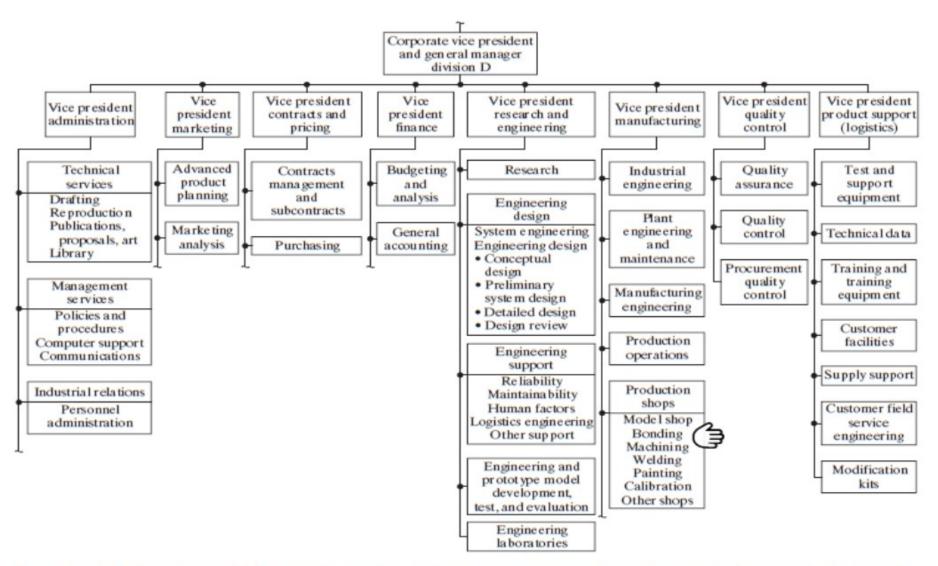


Figure 1-1 Engineering activities within a division of a large corporation. (From Benjamin S. Blanchard, Engineering Organization and Management, © 1976, Figure 10-3, p. 280. Reprinted by permission of Prentice-Hall, Inc., Englewood Cliffs, NJ).

# Management

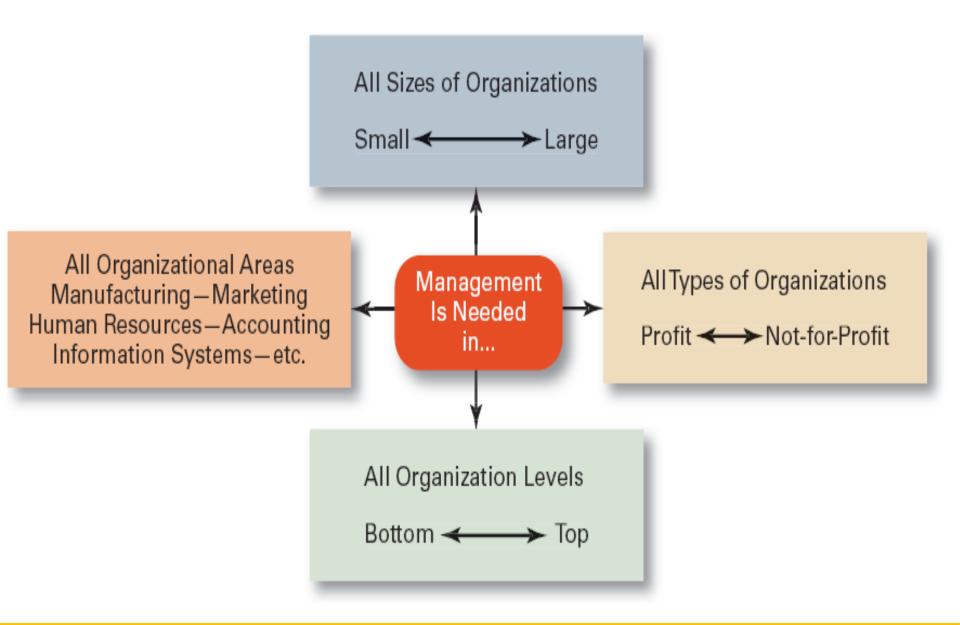
#### **Definitions**

- The work of creating and maintaining environments in which people can accomplish goals
  efficiently and effectively (Albanese)
- The process of achieving desired results through efficient utilization of human and material resources (Bedeian)
- The process of reaching organizational goals by working with and through people and other organizational resources (Certo)
- A set of activities (including planning and decision making, organizing, leading, and controlling) directed at an organization's resources (human, financial, physical, and information) with the aim of achieving organizational goals in an efficient and effective manner (Griffin)
- The process by which managers create, direct, maintain, and operate purposive organizations through coordinated, cooperative human effort (McFarland)
- The process of acquiring and combining human, financial, informational, and physical resources to attain the organization's primary goal of producing a product or service desired by some segment of society (Pringle, Jennings, and Longnecker)

## **Organizations and Management**

Organization is a *deliberate structure* of two or more people to accomplish some specific *purpose* or *goal*.

- All organizations have some programs or method for achieving goals – a plan.
- Organizations must also acquire and allocate *resources* necessary to achieve their goals.



# **Managing Organizations**

#### Management

- The practice of consciously and continuously shaping organizations.
- •The process of planning, organizing, leading, and controlling the work of organization members and of using all available organizational resources to reach stated organizational goals.

#### **Managers**

 People responsible for directing the efforts aimed at helping organizations achieve their goals.

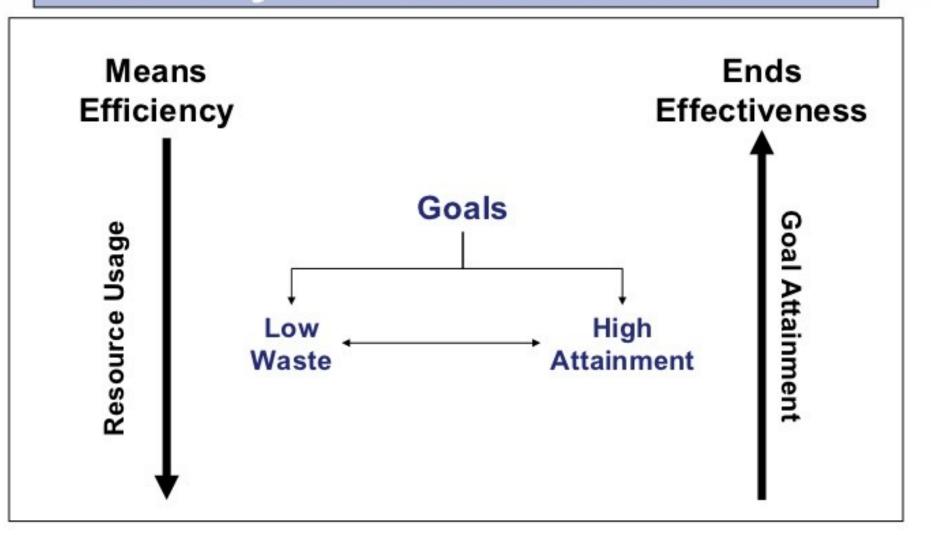
### Managerial performance

The measure of how efficient and effective a manager is (i.e. how well he/she determines and achieves appropriate objectives).

## **Managerial Concerns**

- Efficiency "Doing things right"
   Getting the most output for the least inputs
- •Effectiveness "Doing the right things"
  - Attaining organizational goals

# Efficiency and Effectiveness



# Levels of Managem ent

Top
Management
President, CEO,
Executive
Vice Presidents

#### Middle Management

Plant Managers, Division Managers, Department Managers

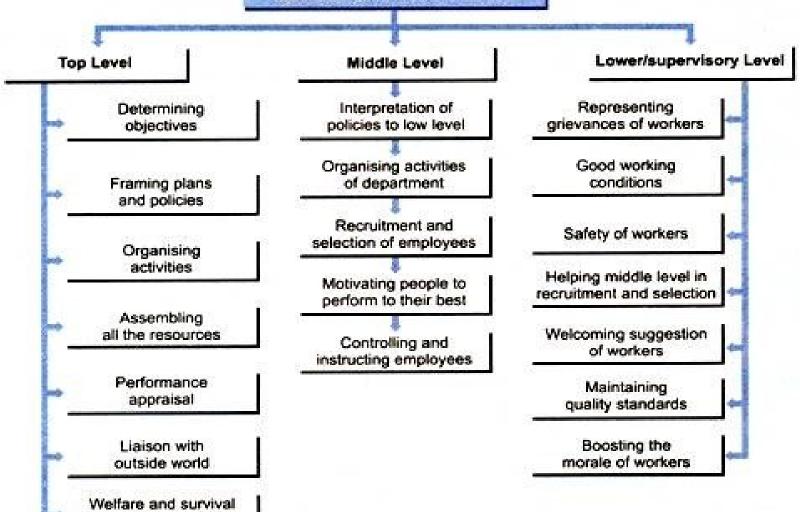
#### **First-Line Management**

Foreman, Supervisors, Office Managers

Non- Managerial Employees

Level Type of Job			
	Directly supervise non-managers.		
	Carry out the plans and objectives of higher management using		
	the personnel and other resources assigned to them.		
First-line Managers	Short-range operating plans governing what will be done		
	omorrow or next week, assign tasks to their workers, supervise		
	he work that is done, and evaluate the performance of individual workers.		
	Manage through other managers.		
	lake plans of intermediate range to achieve the long-range goals		
Middle Managemen	et by top management, establish departmental policies, and		
	evaluate the performance of subordinate work units and their		
	managers.		
	Provide and integrating and coordinating function so that the		
	short-range decisions and activities of first-line supervisory		
	roups can be orchestrated toward achievement of the long-range		
	goals of the enterprise.		
	Responsible for defining the character, mission, and objectives of		
Top Management	the enterprise.		
	Es <del>t</del> ablish criteria for and review long-range plans.		
	valuate the performance of major departments, and they evaluate		
	eading management personnel to gauge their readiness for		
	promotion to key executive positions.		

#### LEVELS OF MANAGEMENT



of organisation

#### Top Managers

- Set objectives
- Scan environment
- Plan and make decisions

#### Middle Managers

- Allocate resources
- Oversee first-line managers
- Report to top management
- Develop and implement activities

#### **First-line Managers**

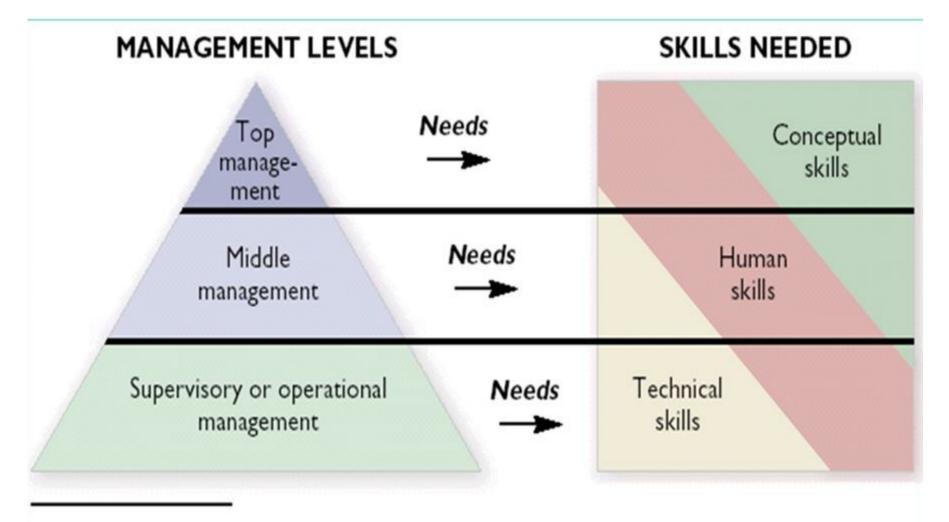
- Coordinate activities
- Supervise employees
- Report to middle managers
- Involved in day-to-day operations

# **Managerial Skills**

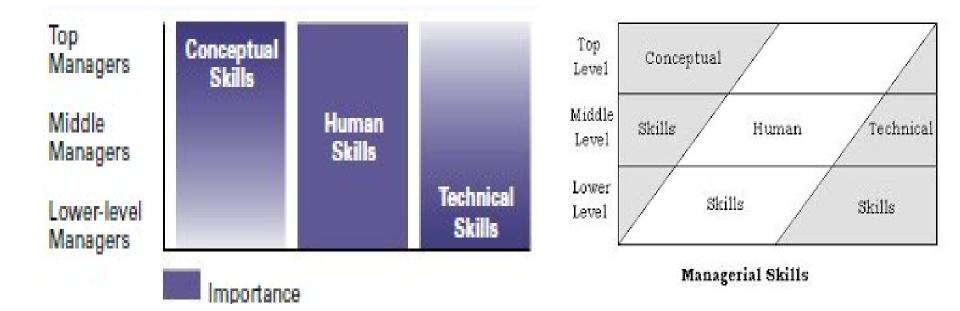
are the knowledge and ability of the individuals in a managerial position to fulfill some specific management activities or tasks.

According to American social and organizational psychologist Robert Katz, the three basic types of management skills include technical, interpersonal, and conceptual.

- Conceptual Skills
  - Used to analyze and diagnose complex situations
- Interpersonal Skills
  - Used to work with, understand, and motivate individuals and groups
- Technical Skills
  - Involve job-specific knowledge and techniques required to perform tasks



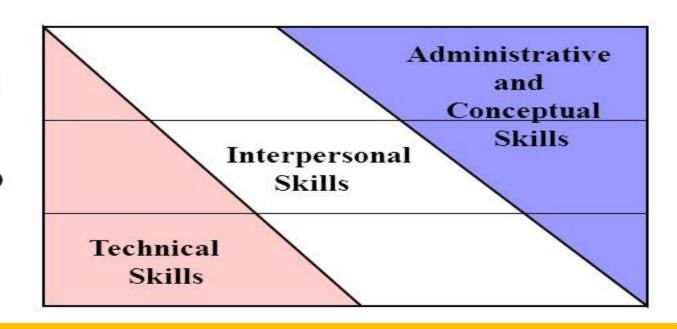
As a manager moves from the supervisory to the top-management level, conceptual skills become more important than technical skills, but human skills remain equally important

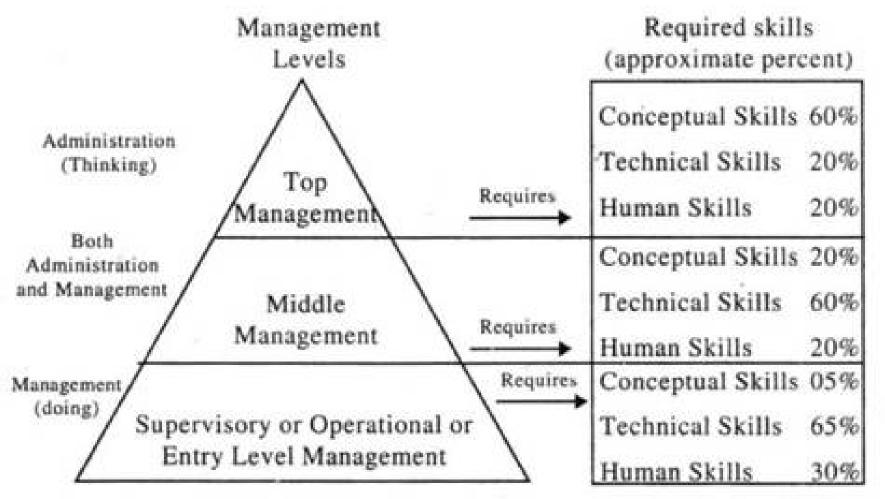


3<sup>rd</sup> Level (Senior Managers)

2<sup>nd</sup> Level (Middle Managers)

> 1<sup>st</sup> Level (Supervisors)





The management function may be divided into two categories: (1) administrative management and (2) operative management. The upper level of management is usually called administrative management and the lower level is known as operative management.

# **Managerial Roles**

# Mintzberg's ten managerial roles

#### Interpersonal roles

How a manager interacts with other people

- Figurehead
- Leader
- Liaison

#### Informational roles

How a manager exchanges and processes information

- Monitor
- Disseminator
- Spokesperson

#### Decisional roles

How a manager uses information in decision making

- Entrepreneur
- Disturbance handler
- Resource allocator
- Negotiator

	Figurehead	Performs ceremonial and symbolic duties such as greeting visitors, signing legal documents			
INTERPERSONAL	Leader	Direct and motivate subordinates, training, counseling and communicating with subordinates			
	Liaison	Maintain information links both inside and outside organization; use mail phone calls, meetings			
Informational	Recipient	Seek and receive information links both inside and outside organization; use mail, phone calls and meetings			
	Disseminator	Forward information to other organization members; send memos and reports and make phone calls			
	Spokesperson	Transmit information to outsiders through speeches, reports and memos			
DECISIONAL	Entrepreneur	Initiate improvement projects, identify new ideas, delegate idea responsibility to others			
	Disturbance Handler	Take corrective action during disputes or crises; resolve conflicts among subordinates; adapt to environmental crises			
	Resource Allocator	Decide who gets resources, scheduling, budgeting, setting priorities			
	Negotiato r	Represent department during negotiation of union contracts, sales, purchases, budgets; represent department interests			

Role	Description	Examples of Identifiable Activities		
Interpersonal				
Figurehead	Symbolic head; obliged to perform a number of routine duties of a legal or social nature	Greeting visitors; signing legal documents		
Leader	Responsible for the motivation of subordinates; responsible for staffing, training, and associated duties	Performing virtually all activities that involve subordinates		
Liaison	Maintains self-developed network of outside contacts and informers who provide favours and information	Acknowledging mail; doing external board work; performing other activities that involve outsiders		
Informational				
Monitor	Seeks and receives a wide variety of internal and external information to develop a thorough understanding of organization and environment	Reading periodicals and reports; maintaining personal contacts		
Disseminator	Transmits information received from outsiders or from subordinates to members of the organization	Holding informational meetings; making phone calls to relay information		
Spokesperson	Transmits information to outsiders on organization's plans, policies, actions, results, etc.	Holding board meetings; giving information to the media		
Decisional				
Entrepreneur	Searches organization and its environment for opportunities and initiates "improvement projects" to bring about changes	Organizing strategy and review sessions to develop new programs		
Disturbance handler	Responsible for corrective action when organization faces important, unexpected disturbances	Organizing strategy and review sessions that involve disturbances and crises		
Resource allocator	Responsible for the allocation of organizational resources of all kinds—making or approving all significant organizational decisions	Scheduling; requesting authorization; performing any activity that involves budgeting and the programming of subordinates' work		
Negotiator	Responsible for representing the organization at major negotiations	Participating in union contract negotiations		

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# **Functions of Managers**

Planning

Planning is the process of setting goals, and charting the best way of action for achieving the goals. This function also includes, considering the various steps to be taken to encourage the necessary levels of change and innovation.

Organizing

Organizing is the process of allocating and arranging work, authority and resources, to the members of the organization so that they can successfully execute the plans.

Staffing

A: Staffing is the process of filling the positions in the organization and keeping them filled.

B: Staffing is the process of recruiting and selecting the right person for the right job at the right time in the right place.

Leading

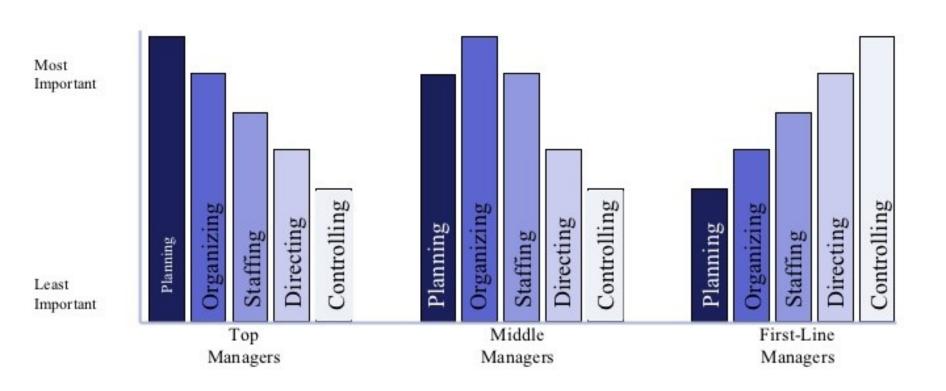
Leading involves directing, influencing and motivating employees to perform essential tasks. This function involves display of leadership qualities, different leadership styles, different influencing powers, with excellent abilities of communication and motivation.

5 Controlling

Controlling is the process of devising various checks to ensure that planned performance is actually achieved. It involves ensuring that actual activities conform to the planned activities. Monitoring the financial statements, checking the cash registers to avoid overdraft etc., form part of this process.



# Importance of management functions to managers in each level



#### Management Functions

Planning	Organizing	Leading	Controlling	 Lead to
Defining goals, establishing strategy, and developing subplans to coordinate activities	Determining what needs to be done, how it will be done, and who is to do it	Directing and motivating all involved parties and resolving conflicts	Monitoring activities to ensure that they are accomplished as planned	Achieving the organization's stated purpose

12/13/2022

# Management: Science or Art?

- ☐ Science of Management
  - □ Assumes that problems can be approached using rational, logical, objective, and systematic ways.
  - □ Requires the use of technical, diagnostic, and decisionmaking skills and techniques to solve problems.
- ☐ Art of Management
  - Decisions are made and problems solved using a blend of intuition, experience, instinct, and personal insights.
  - □ Requires the use of conceptual, communication, interpersonal, and time-management skills to successfully accomplish the tasks associated with managerial activities.

# Management is both art and science.

Management is called an art because managing requires certain skills which are personal possessions of managers. Science provides the knowledge & art deals with the application of knowledge and skills. A manager to be successful in his profession must acquire the

# **Engineering Management**

The direct supervision of engineers or of engineering functions (such as research and design activities).

"Engineering of management" – the application of quantitative methods and techniques to the practice of management (often called "management science").

# **Engineering Management versus "Ordinary" Management**

- The engineering manager is distinguished from other managers because he/she possesses both an ability to apply engineering principles and a skill in organizing and directing people and projects.
- He/she is uniquely qualified for two types of jobs: the management of technical functions (such as design or production) in almost any enterprise, or the management of broader

Engineering management is the art and science of planning, organizing, allocating resources, and directing and controlling activities that have a technological component.

American Society for Engineering Management

Engineering management is designing, operating, and continuously improving purposeful systems of people, machines, money, time, information, and energy by integrating engineering and management knowledge, techniques, and skills to achieve desired goals in technological enterprise through concern for the environment, quality, and ethics.

Omurtag (1988)

Engineering management is the discipline addressed to making and implementing decisions for strategic and operational leadership in current and emerging technologies and their impacts on interrelated systems. IEEE (1990) and Kocaoglu (1991)

Source: Timothy Kotnour and John V. Farr, "Engineering Management: Past, Present, and Future," Engineering Management Journal, vol. 17, no. 1, March 2005.

# Need for Engineers in Management

High-technology enterprises make a business of doing things that have never been done before. Extensive planning needed considering the uncertainties and feasibility of products or outcome.

Recruitment and evaluation of technical personnel.

Better understand the nature and motivation of technical specialist and can gain their respect, confidence, and loyalty.

#### Why Study Engineering Management?

It helps the engineer become a more effective technical specialist and strengthens the ability to lead people and projects. As a specialist, the engineer becomes more effective through understanding how his or her engineering skills can best support the goals of the organization and its customers. And the trained engineering manager becomes uniquely qualified for two types of positions: management of the technical functions (such as research, design, or production), and the management of broader functions (such as marketing or general management) in the high-technology enterprise.

- Really understand the business.
- Understand both the technology that is driving the business today and the technology that will
  change the business in the future.
- Treat research and development as an investment to be nurtured, rather than an expense to be minimized.
- Spend more time on strategic thinking about the future as they rise higher in the corporation.
- Are dedicated to solving a customer's problem or satisfying a need, which is how I would
  define true marketing as opposed to sales.

· Place a premium on innovation.

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