MANAGEMENT CAPSULE

A CONCISE MANAGEMENT MANUAL

FOR STUDENTS, ENTREPRENEURS, AND BUSINESS LEADERS

By

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1) BLAME IT ON ME: A real life black comedy (Kafkaesque), Published by Frog Books, an imprint of Leadstart Publishing Pvt Ltd, Mumbai; (ISBN = 978-93-80154-21-3)

2) WORD BANK - Memoria Technica: Learn and recall abstruse English words through Stories, Anecdotes, News, Narrations, Etymology, and Quotes; (ISBN=978-93-5067-886-2)

3) WORD BANK Series - Know Thyself, Friends and Foes - Memoria Technica: Learn and recall selective abstruse English words; (ISBN= 978-93-5104-854-1)

4) WORD BANK Series - Confusables - Memoria Technica: Learn and recall selective abstruse English words; (ISBN = 978-93-5137-498-5)

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Management Capsule: Table of Contents (Main Chapters)

Table of Contents

Management Capsule: Table of Contents (Total List)

This table comprises detailed list of contents of all the main chapters.

The applicable contents are reproduced at the beginning of each chapter for ready reference.

The index at the rear end of the book lists all the contents in alphabetical order for cross reference.

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Management Capsule:
Prologue

Get the BIG picture of BUSINESS MANAGEMENT in just 21 days!

Prologue

Formal education will make you a living; self education will make you fortune.

… Jim Rohan

The aphorism of the title of this book **"MANAGEMENT CAPSULE"** is very apt; as the contents are designed to cover most of the management subjects in an encapsulated and condensed format, keeping in view the requirement of Entrepreneurs and Business Leaders.

The verb *'manage'* comes from the Italian *maneggiare* (to handle, especially tools), which derives from the Latin word *manus* (hand). The French word *mesnagement* (later *ménagement*) influenced the development of the English word *management* in the 17th and 18th centuries.

At the outset let us debate on the role of MBAs in today's business world.

Is an MBA still necessary?

Earlier, corporations used to recruit MBA graduates from Business Schools in large numbers, to be deployed as Managers. They were perceived as the *'Viz-Kids'* of product innovation, marketing, finance and the like, who implemented *"new styles of leadership"*. They were a symbol of modern management culture. Today, the influence of MBA is not so effective or even reassuring! MBA programs have failed to create the type of leaders who can deal with globalization and the rapid technological advancements. Some skeptics say that the MBA programs do not produce any business leaders at all; and the MBA graduates are, at best, theoretical functionaries laying excessive stress on profits and share values at the expense of ethics and sustainability. Social responsibility is of least priority in their mindset. Share market owes are attributed to the approaches of Ivy League graduates. The eight Ivy League institutions are Brown University, Columbia University, Cornell University, Dartmouth College, Harvard University, Princeton University, the University of Pennsylvania, and Yale University. The term *Ivy League* has connotations of academic excellence, selectivity in admissions, and social elitism. When it comes to entrepreneurship, the question of whether to invest in an MBA degree becomes highly debatable. Can the necessary skills for successful entrepreneurship be taught at the Universities? The answer is 'yes', but not in the present format. All is not gloom and doom with the MBAs. The success of their performance lies in the practical application of their knowledge in the field of business. The problem is that the present crop of MBAs seems to have lost touch with the real business world; laying too much emphasis on theory and research activities. They do not appear to be '***doers'***; but they seem to be adept at planning for ***others*** / ***'doers'*** for performance and accomplishment. They tend to tell the ***doers*** what to do and how to do things; never mind

that the ***doers*** do not seek or even need their advice. MBAs are skilled at measuring the performance of the ***doers*** using various tools and techniques such a metrics and graphics.

I am a great believer in Business Management Science; but wish to inspire a serious debate as to by who, why, where, and when to learn this subject. If I were to design the system, I would recommend integration of professional courses with embedded MBA curriculum. I am certain that the course content of 'MBA' would be cake-walk for the students, in engineering and many other disciplines. I am taking the liberty of saying so from my personal experience, as I am an engineering graduate from IIT, Madras with postgraduate qualifications in management studies from the University of Mumbai. This management education indeed helped me hone my performance in the field of manufacturing and marketing; and this happened to be one of the major reasons for my reaching the apex position of a CEO in the corporate world.

Entrepreneurship is the process of starting and running a business or other organization. The entrepreneur chooses and develops a business model, acquires the human and other required resources, and is fully responsible for its success or failure. Successful entrepreneurs have the ability to lead a business in a positive direction by proper planning and innovation while adapting to changes in environments viz. technical, social, political, or economic in nature.

Now let us focus on the contents of this book. Much of MBA course content is embedded in this book, albeit in an abridged form. This knowledge would be of immense help to entrepreneurs and business leaders in pursuing their missions. It may not be worth the time and effort for the potential entrepreneurs and business leaders to go back to Business School to acquire an MBA degree, in pursuit of excellence. It is also not essential to master all the topics in management studies for the practically inclined. Having the big picture of Management Science, albeit with limited details, would suffice. It is always possible to have access to details as and when need arises, what with the information explosion backed by internet in these days.

This book is specially designed keeping in view the requirement of entrepreneurs and business leaders, who do not wish to invest much time or effort to acquire detailed knowledge of Management Science by way of formal education at a Business School. The outcome of such an effort in acquiring MBA qualification is uncertain in any case and much less reassuring.

I do hope that this book would be of immense help to any entrepreneur or business leader in more than one way, to accomplish his/her mission.

This book enables you to get the big picture of Business Management in just 21 days. Read just one chapter a day.

Chapter 02
Initiation to Management

02 Initiation to Management

The best executive is the one who has sense enough to pick good men to do what he wants done, and self-restraint enough to keep from meddling with them while they do it… Theodore Roosevelt

Table of Contents

02.01.00 Definition of Management

Management is the art and science of getting the work done by a group of persons for the attainment of an organization's goals and objectives – generally to convert certain inputs into desired outputs by means of a process, be it a physical product or a service – using requisite tools and techniques through the management processes comprising planning, organizing, staffing, directing, and controlling functions.

An important aspect of management's function is the allocation of finite resources. There are several different resource types available to management viz. human, financial, Technological, and Natural resources.

The general principles of management are enumerated in a subsequent chapter titled "Principles of Management".

02.02.00 Resources - Multiple 'M's of Management

Many inputs and management processes need to be harmonized or orchestrated together for the best possible outcome in business operations. Words pertaining to these inputs start with the alphabet **'M'**. We shall now classify these **M**'s of **M**anagement. I am not sure as to why these management elements start with the letter **'M'**. Is it a sheer coincidence? Is it an **'M'** syndrome? Pause and ponder! Perhaps, most of the terms pertaining to inputs / processes begin with the character **'M'** incidentally. Maybe, the management *gurus* have contrived to select these terms - starting with the character **'M'-** with the help of a thesaurus / synonyms. Well, it does not matter either way. Business is a "*serious Business*".

What are these multiple **'M's** of ***Management***? The word ***'Management'*** itself starts with the character **'M'**!

- **Money**
- **Mission**
- **Messengers**
- **Messages**
- **Media**
- **Men**
- **Machines**
- **Material**
- **Methods**
- **Moments(Time)**

- **Metrics (Measurements)**

02.02.01 Resources: 2 M's - Triggers of Business Development

To trigger and develop a Business, Entrepreneurs / Business Leaders must have the following 2 M's.

1. ***Money***
2. ***Mission with a vision***

02.02.02 Resources: 5 M's of Production / Manufacturing

Primarily **Man**, the first of these **5 'M's** is the most important resource. The right personnel for the right position is a sure bet for organizational effectiveness and efficiency.

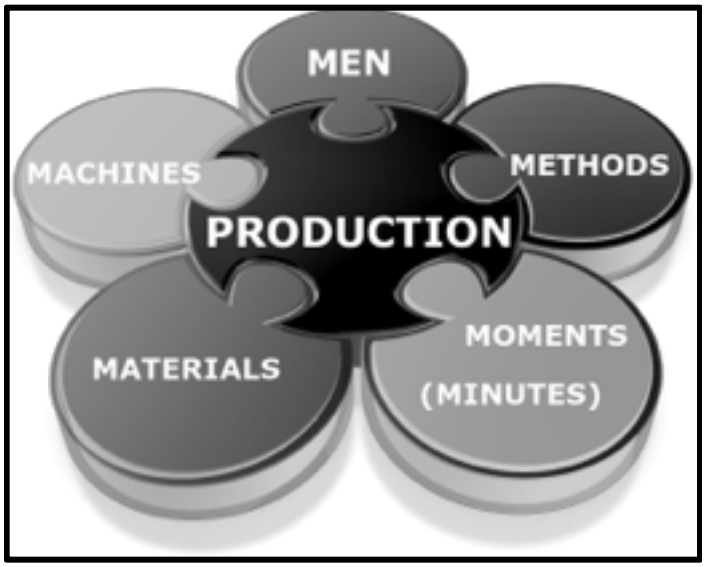
Basically, the major tasks of management are in the areas of Production of goods / services and marketing. The words production and manufacturing are some what used synonymously. The word manufacturing implies creation of physical goods whereas production covers both goods and services.

What are the **5 M's** of production?

These are:

1. **M**en
2. **M**aterials
3. **M**achines
4. **M**ethods
5. **M**oments (**M**inutes)

These **5 M's** of production / Manufacturing are displayed graphically as follow:

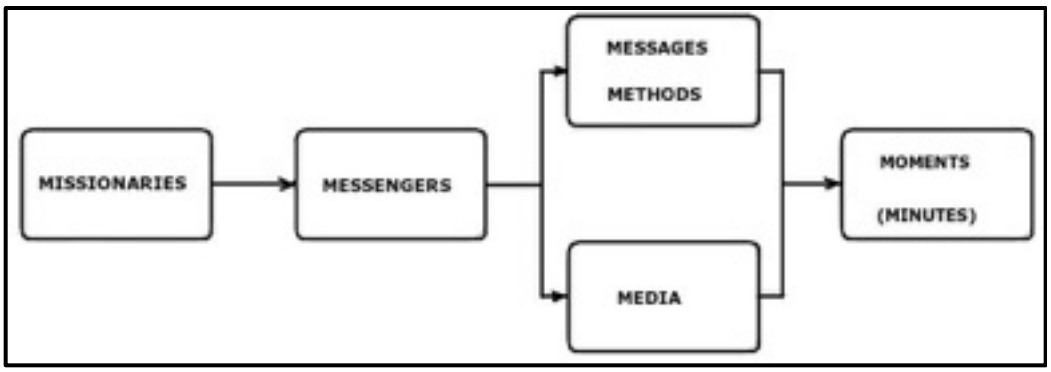


02.02.03 Resources: 5 M's of Marketing / Advertising

Likewise let us look at the **5 M's** of **M**arketing / Advertising. These are:

1. **M**issionaries
2. **M**essengers
3. **M**essages
4. **M**edia
5. **M**oments

These **5 M's** of **M**arketing / Advertising are graphically displayed as follows:



02.03.00 Metrics

Finally, we have to measure the performance (outputs) of management in quantifiable terms such as “production statistics”, “quality parameters of the output”, “planned figures of production / sales volumes vis-a-vis actual figures” etc. We call this “**M**etrics” (“**M**EASUREMENT”) which need to be used for performance review. This is the final test of success or failure of a management process.

Each of these **M’s** is enumerated in the following chapters dedicated for various disciplines in management. Each chapter gives an adequate view of the subject involved. The contents are designed to give the readers, the BIG Picture rather than minute details, keeping in view the requirement of entrepreneurs and business leaders. The idea is to impart total knowledge of management processes in a limited time frame. One can always obtain need-based details, as and when required for practical application. Having the BIG picture gives you the insight required and enables you to look for relevant details.

May I now exhort you to read on and get the big picture of Business Management in just 21 days!

Chapter 03
History of Management

03 History of Management

History is the version of past events that people have decided to agree upon.

... Napoleon Bonaparte

Table of Contents

03.01.00 Brief History of Management

Chronology of management development:

1) 1776: Adam Smith (Scotland) introduced the concept of specialization of labor. He recommended breaking jobs down to sub-tasks and reassigning the specialized tasks. His treatise on "Wealth of Nations" advocated division of Labor.

2) 1900: Frederick W Taylor (US) introduced **Scientific Management.**

- He developed time-study and work-study.
- He classified jobs into 2 categories: those performed by workers and those by supervisors.
- The approach was narrow and the workers were perceived to be mechanistic and motivated only by money and other rewards.

3) 1901: Concept of collective efficiency. Henry L Grant introduced scheduling techniques. Gantt charts introduced by him are used even today extensively.

4) 1914: Operations Research by P M S Blacker (World War II).

5) 1915: F W Harris: Concepts of inventory control and economic batches.

6) 1916: Henri Fayol (A French Metallurgist) suggested 14 general principles of Management. This is a Process School of Management thought / Functional approach to Management.

Some Principles are:

1. Authority and responsibility theory: Authority is the right to give orders. Authority must be commensurate with responsibility. Mangers have to delegate authority before assigning responsibility.

2. Unity of command and span of control concept.

He identified 5 functions in Management process viz. Planning, Organizing, directing, coordinating and controlling.

7) 1935: "Statistical Quality Control" techniques by Dodge and Romig.

8) 1947: Linear Programming by George B. Dantzig and William Orchard.

9) 1955: Computer Era … by IBM.
10) 1960: Organizational behavior; Study of people at work by L. Cummings and L. Porter.

03.02.00 Schools of Management Thought

03.02.01 Classical School of Management

This encompasses "Scientific Management" and "Process Theories".

03.02.01.01 Scientific Management Thoughts (F W Taylor)

- Suggested by Frederick W Taylor, Father of scientific Management.
- Focus is only on economic efficiency.
- Assumes a world of certainty.
- This is a closed system of engineering and economics.
- Assumes men are motivated by money alone.

03.02.01.02 Process School of Management: Functional Approach (Henri Fayol and Ralph C Davis)

This concept was developed by Henri Fayol (France) and Ralph C Davis (US).
Focus is on Functional approach to Management.
Management is viewed as a process involving Planning, organizing, direction and controlling.

03.02.02 Behavioral School

Output is not always dependent upon physical environment.
Workers respond favorably to individual care and attention.
Subordinate – Supervisor relationships directly affect production.
Human relations school recognizes that a person is complex and has multiple needs.
People cannot be treated as machines.
Behavioral scientists, psychologists, sociologists and cultural anthropologists have provided the answer to human relations question.

History of Management

Origin of this thought can be traced to 1930s.
Elton Mayo conducted certain experiments at Hawthorne works of Gen Electric Co. at Chicago in the Telephone relay assembly section.
These famous experiments are known as "**Hawthorne Experiments".**
The aim was to study the effects of changes in physical environment.
Some experiments concerning the effect on production due to changes in lighting triggered this study. When lighting was improved at work place, production went up; and when the lighting was reverted in stages, to earlier level the production did not drop immediately.

Details of the "**Hawthorne Experiments**" are as under:

Location: Relay assembly at Hawthorne works of GE at Chicago, USA.

Participants: 6 girls.

Basic production level at start: 2400 relays per week.

The girls were located in a special room.

A Supervisor discussed the changes with the girls, in advance (consultation).

Chronology of the experiments…

1. Piece rate was given as incentive …. Production was up.
2. 2 breaks of 5 Minutes each were introduced ….. Production was up.
3. 2 breaks of 10 Minutes each was introduced ….. Production was up.
4. 6 breaks of 5 Minutes were introduced …. Production was down. (Assembly girls complained about loss of rhythm.)
5. Back to 2 breaks and a free meal was given….. Production was up.
6. Reduced working hours by 30 Minutes…. Production was up.
7. Reduced working hours by 1 hr …..Total production was same for the week, but hourly production was up.
8. Then all facilities were taken away and situation was reverted back to: 48 hrs work per week, no rest pauses and no free meal.
9. Production was still high at 3000 relays / week; more than before the experiments which was 2,400 relays / week.

Conclusions:

Production level was generally independent of physical changes.
Human relations mattered.
Care for employees, freedom, participation / consultation etc were considered more important to enhance performance.

Thus commenced the behavioral school of management thought and the focus shifted to human relations.

However, Hawthorne experiments were viewed as flawed by many researchers. Nevertheless, a new chapter in Management dawned as a result of these experiments.

03.02.03 Modeling School

The modeling school is concerned with decision-making, systems theory, and mathematical modeling of systems and decision-making processes.

03.02.03.01 Decision Making

- The decision-making orientation considers making decisions to be the central purpose of Management.
- Managers make use of studies dealing with human relations, information processing, assessing risk, and generating decision alternatives to help them make final choices.
- The decision theory can be expanded to include decision process through out the organization.

03.02.03.02 Systems Theory

- Stress is on the importance of “total systems” in the organization.
- All sub systems are inter related. E.g. A policy change in Marketing can affect finance or production.
- According to this school, identifying sub-system relationships, predicting the effects of a change, and implementing a system change appropriately are the part of managing an organization.

03.02.03.03 Mathematical Modeling

- Focus is on mathematical representations of management problems. A formula has certain variables and the result of a decision can be predicted. E.g. Break even analysis, inventory control / Economic batch qty, physical distribution (transportation model) and resource allocation (Operations research) etc…

- This is applicable only to certain management situations amenable to logical analysis.

- Fitting people in mathematical models has not been possible.

- This requires a thorough knowledge of mathematics and conventional mangers might resist this approach. They are more likely to adopt heuristic approach.

- This school can not assure a total approach to Management.

03.03.00 Contingency Approach - An Integrated Approach

- It is not possible to apply any single / particular school of thought in all Management situations.

- Existing ideas must be applied selectively depending upon the circumstances.

- No single idea is universal. As the famous philosopher, Confucius opined, “The Golden Rule is that there is no Golden Rule.”

- The ***contingency approach*** is integrative, focusing on fitting together the ideas of different schools of thought.

- Classical / Process approach is helpful in structuring our Management thinking, since it examines separate activities in detail viz. Planning, Organizing, Direction and Controlling.

- As we plan, organize, direct and control; we must take into account the behavioral implications. The process and behavioral approaches interact in a complex way.

- Many planning, organizing, directing and control activities can be modeled; but behavioral aspects are difficult to integrate.

- Modeling approach is best applied to routinized aspects in an organization.

We need integration of the 3 schools of thought as framework for analysis in management as there can be no universal concept applicable to all situations.

This is known as contingency approach to management.

Chapter 04
Principles of Management

04 Principles of Management

Management by objective works, if you know the objectives. Ninety percent of the time you don't. ...Peter Drucker

Table of Contents

04.01.00 Introduction to Principles of Management

There are many interesting definitions of MANAGEMENT.

"Management is the art of getting things done through others and with formally organized groups."

"Management is a distinct process consisting of planning, organizing, staffing, directing, and controlling; utilizing in each both science and art, and followed in order to accomplish pre-determined objectives."

"Management in business and organizations is the function that coordinates the efforts of people to accomplish goals and objectives using available resources efficiently and effectively. Management comprises planning, organizing, directing, and controlling an organization to accomplish the goal."

In the previous chapter we have gone through the brief history of management. Management Principles developed by Henri Fayol which are of particular interest pertaining to this chapter are enumerated below:

1. Division of Work: Work should be divided among individuals and groups to ensure that effort and attention are focused on special portions of the task. Fayol presented work specialization as the best way to use the human resources of the organization.

2. Authority: The concepts of Authority and responsibility are closely related. Authority was defined by Fayol as the right to give orders and the power to exact obedience. Responsibility involves being accountable, and is therefore naturally associated with authority. Whoever assumes authority also assumes responsibility.

3. Discipline: A successful organization requires the common effort of workers. Penalties should be applied judiciously to encourage this common effort.

4. Unity of Command: Workers should receive orders from only one manager.

5. Unity of Direction: The entire organization should be moving towards a common objective in a common direction.

6. Subordination of Individual Interests to The General Interests: The interests of one person should not take priority over the interests of the organization as a whole.

7. Remuneration: Many variables, such as cost of living, supply of qualified personnel, general business conditions, and success of the business should be considered in determining a worker's rate of pay.

8. Centralization: Fayol defined centralization as lowering the importance of the subordinate role. Decentralization is of increasing importance. The degree to which centralization or decentralization should be adopted depends on the specific organization in which the manager is working.

9. Scalar Chain: Managers in hierarchies are part of a chain like authority scale. Each manager, from the first line supervisor to the president, possesses certain amounts of authority. The President possesses the most authority; the first line supervisor the least. Lower level managers should always keep upper level managers informed of their work activities. The existence of a scalar chain and adherence to it are necessary if the organization is to be successful.

10. Order: For the sake of efficiency and coordination, all materials and people related to a specific kind of work should be treated as equally as possible.

11. Equity: All employees should be treated as equally as possible.

12. Stability of Tenure Of Personnel: Retaining productive employees should always be a high priority of management. Recruitment and Selection Costs, as well as increased product-reject rates are usually associated with hiring new workers.

13. Initiative: Management should take steps to encourage worker initiative, which is defined as new or additional work activity undertaken through self direction.

14. Espirit de corps: Management should encourage harmony and general good feelings among employees.

04.02.00 Input – Output Model

Before we enumerate the management processes in a greater detail, we shall see the specific application of the process in respect of "Production and Operations Management".

Definition: *"*Production and operations management" concerns itself with the conversion of inputs into outputs, using physical resources, so as to provide the desired utilities – of ***form, place, possession or state*** or a combination there of – to the customer while meeting the other organizational objective of effectiveness, efficiency and adoptability.

Change in "***form****":* e.g. Conversion of wood into furniture or ores into metal etc…

Change in "***place***": e.g. Taxi service take us from one place to another.

Change in "***possession***": e.g. Petrol pumps; we take possession of Petrol.

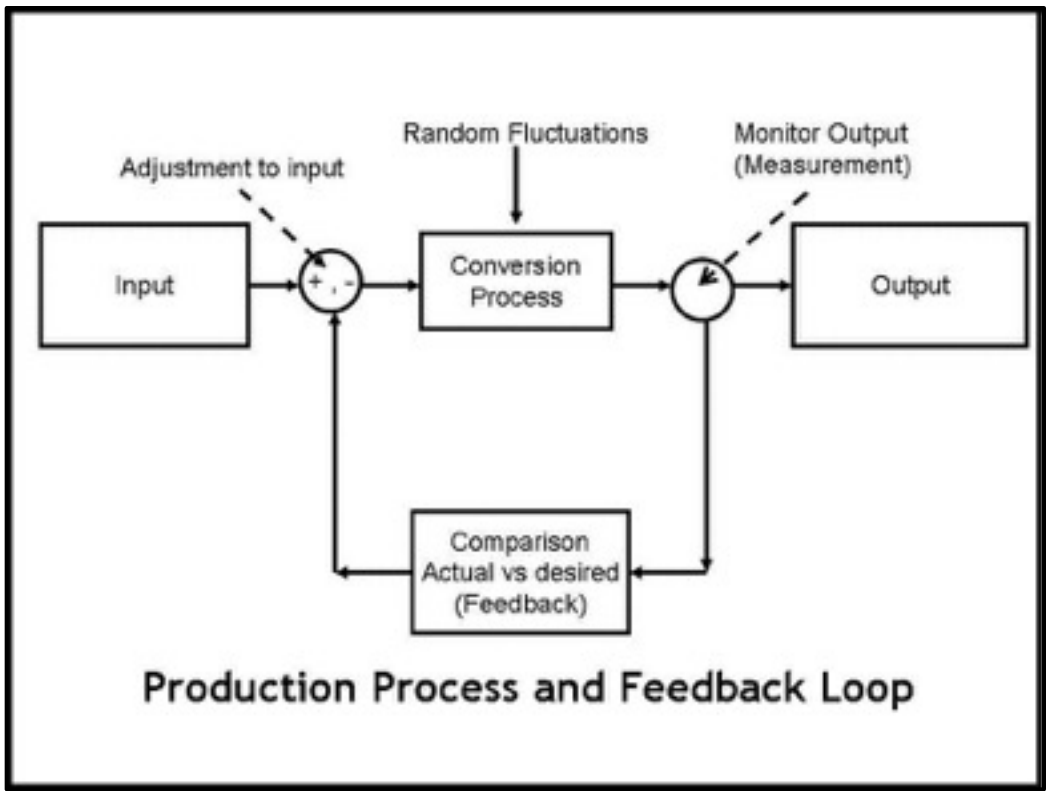
Change in "***state***": e.g. Hospitals change the state of our health.

POM (Production and operations Management) distinguishes itself from the other functions such as personnel, marketing, finance etc by its primary concern for "Conversion by using physical resources".

All management processes are involved in the process of converting some resources (inputs) into utilities (products / services); be it in the area of production, finance, personnel, or marketing.

The following figure (INPUT – OUTPUT MODEL) pertaining to "Production and Operations Management" is self explanatory.

The inputs (resources) in general fall into the categories of ***money, men, machines, material, methods and moments (time);*** described as multiple 'M's of production management.



04.03.00 Framework of Managerial Transformation Process

The task of management is to transform the inputs, in an effective and efficient manner, into outputs. We are mainly concerned about the transformation process in such diverse functions as production, finance, personnel, and marketing.
The most comprehensive approach to management processes is to understand the managerial functions viz. planning, organizing, staffing, directing, and controlling.

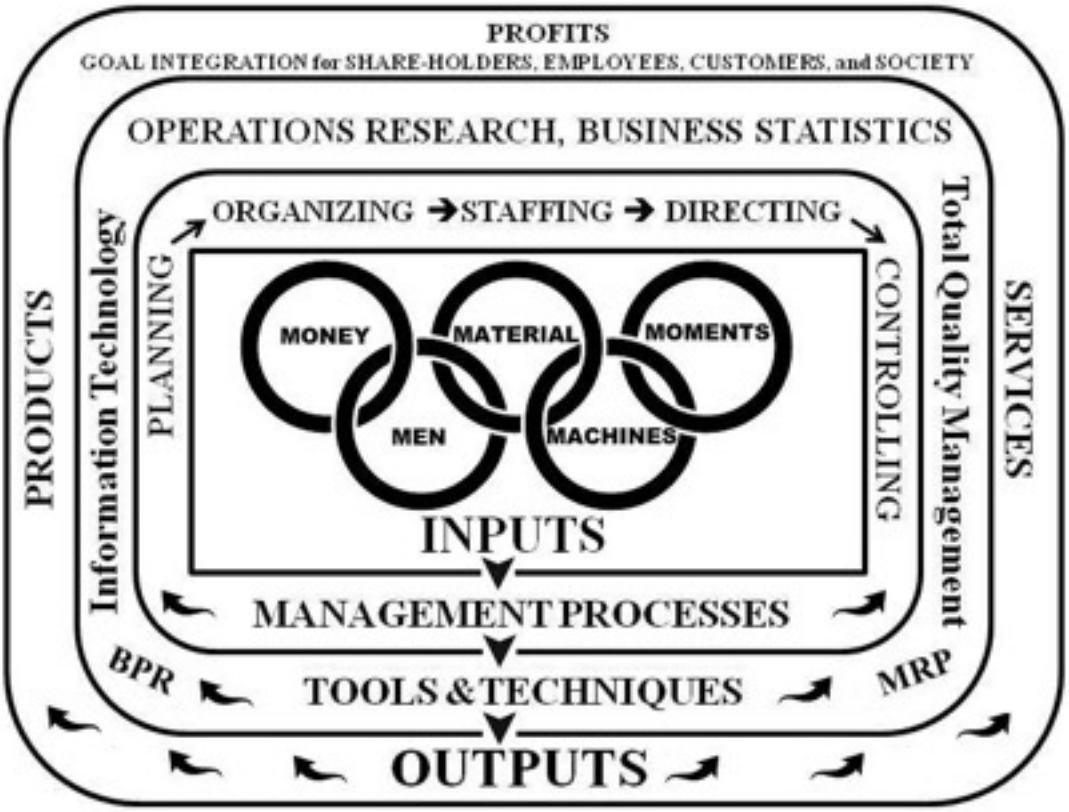
The framework of management process involves:

1. Inputs.
2. Management functions.

3. Tools and techniques.

4. Outputs.

This approach is used as the framework of management processes, illustrated by the following figure. This is ***"The Big Picture of Management".***



THE BIG PICTURE OF MANAGEMENT

Note: Please follow the arrows to comprehend the linkages among all aspects of management. **"INPUTS"** are transformed into **"OUTPUTS"** by **"MANAGEMENT PROCESSES"** by application of **"TOOLS and TECHNIQUES"**.

04.03.01 Inputs

These basic inputs are listed in the inner core of the above figure:

1. Money
2. Men
3. Material
4. Machines
5. Moments (Time)

04.03.02 Management processes / Functions

These management processes / functions are indicated in the first outer ring adjacent to the core in the above figure – **"The Big Picture of Management**". These functions are planning, organizing, staffing, directing, and controlling.

04.03.02.01 Planning

Planning is the basic function of management. Planning involves selecting objectives as well as the requisite actions to achieve them. Planning is deciding in advance - what to do, when to do, where to do, why to do and how to do. Planning is determination of courses of action to achieve desired goals. This subject will be dealt with in detail in the later chapter titled "Production and Operations Management".

04. 03.02.02 Organizing

Organizing is that part of managing which involves establishing a structure of roles to be played by the persons in an organization and their inter-relationship. Organizing is the process of bringing together physical, financial and human resources and developing productive relationship amongst them for achievement of organizational goals. Organizing is essential to provide a business with everything useful for its functioning i.e. raw material, machines, capital and personnel etc. The purpose of organization is to help create an environment for human performance.

04.03.02.03 Staffing

Staffing involves filling, and keeping filled – by retaining the existing staff or recruitment – the positions in the organization structure. The main purpose o staffing is to put right man on right job.

Staffing function comprises:

1. Identifying work-force requirement.
2. Taking the inventory of persons.
3. Recruiting.
4. Selecting.
5. Placing.
6. Promoting.
7. Apprising performance.
8. Career planning.
9. Training.
10. Compensating etc…

04.03.02.04 Directing

Directing is that part of managerial function which actuates the organizational methods to work efficiently for achievement of organizational purposes. Direction is influencing people and guiding them to contribute to achieving organizational goals. It has to do predominantly with interpersonal aspect of managing.

Direction has following elements:

- *Supervision*: Overseeing the work of subordinates by their superiors. It is the act of watching & directing work & workers.
- *Motivation*: Inspiring, stimulating or encouraging the sub-ordinates with zeal to work.
- *Leadership*: a process by which manager guides and influences the work of subordinates in desired direction.

- *Communication*: the process of passing information, experience, opinion etc from one person to another.

04.03.02.05 Controlling

Controlling is the act of measurement of accomplishment against the standards and correction of deviation if any to ensure achievement of organizational goals. The purpose of controlling is to ensure that everything conforms to the established standards. An efficient system of control helps to predict deviations before they actually occur.

Controlling has the following steps:

1. Establishment of standard performance.
2. Measurement of actual performance.
3. Comparison of actual performance vis-à-vis standards and finding out deviation, if any.
4. Analyzing the reasons for deviations and taking corrective action.

Some examples of controlling:

1. Budget vs. actual expenses.
2. Stage inspection of components.
3. Testing final product.
4. Comparison of actual sales with respect to plan.
5. Comparison of financial results year-to-year.

04.03.03 Tools and Techniques of Management

These techniques adopted by mangers in the conversion process are indicated in the second outer ring, in the above figure.

The tools and techniques used in management will be discussed in detail in the subsequent chapters, depending on the field of application.

Some of the techniques are:

1. Information Technology (IT).
2. Operations Research (OR).
3. Total Quality Management (TQM).
4. Business Process Re-Engineering (BPR).

5. Material Requirement Planning (MRP).
6. Manufacturing Resources Planning (MRP II).
7. Continuous Improvement (Kaizen).
8. Business Statistics.

04.03.04 Outputs

These outputs are indicated in the third and final outer ring in the above figure.

The outputs are:

1. Physical Products.
2. Services.
3. Profits.
4. Goal Integration for all Stake-Holders.

The nature of the first 3 outputs is obvious.

The most important output is the integration of the individual goals of all stake-holders viz. shareholders, employees, customers, society (community), and government.

Please refer to the following chart enumerating the goals of various stakeholders.

Stakeholder	**Goals / Concerns**
Shareholders	Return on investment (Dividends), Security of investment, Share values etc.
Employees	Remuneration, Job satisfaction, Job security, Self-esteem, Career progression, Recognition etc.
Customers	Product performance, Service Level, Personal safety, Esthetics, Prices, Return-policy, Warranty etc.
Suppliers	Steady demand, Continuity of relationship, Prices, Payment terms, Quality standards etc.

Society (Community)	Employment, Pollution, Ethics, Social-responsibilities of the enterprises, Public health & safety etc.
Government	Taxes, Compliance with laws, Public health & safety, Monopolistic tendency, Employment, Investments etc.

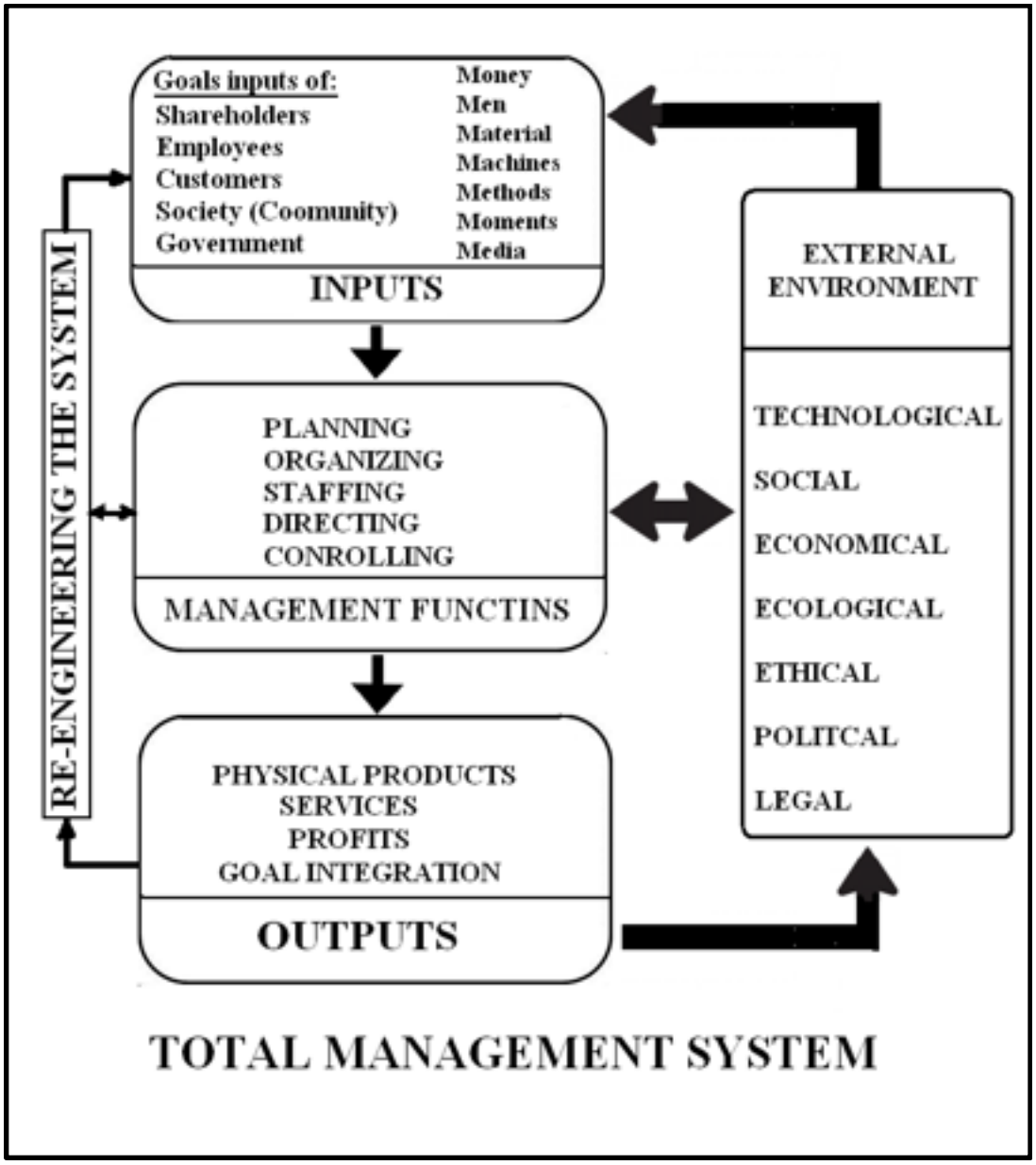
04.04.00 Total Management System and Re-Engineering

Please note that, in the systems model of the management process, some of the outputs become inputs again. The new knowledge or skills of employees become important human inputs. Likewise, the profits are reinvested in capital goods and / or business expansion.

We can take corrective action by comparing the characteristics of the outputs vis-à-vis standards and assessing the causes for the variations. Based on the feedback from the customers and observation of the changes in the environment, we can re-engineer the system for success in business.

Under exceptional situations, we may do some *"fundamental rethinking"* and effect *"radical changes*" in the business processes; which is termed 'Business Process Re-Engineering (BPR)". This is in contrast with "Continuous Improvement Process" where in we aim for only incremental improvements.

The following figure illustrates the total management system.


Goals inputs of:
Shareholders
Employees
Customers
Society (Coomunity)
Government
Money
Men
Material
Machines
Methods
Moments
Media
INPUTS
PLANNING
ORGANIZING
STAFFING
DIRECTING
CONROLLING
MANAGEMENT FUNCTINS
PHYSICAL PRODUCTS
SERVICES
PROFITS
GOAL INTEGRATION
OUTPUTS
RE-ENGINEERING THE SYSTEM
EXTERNAL ENVIRONMENT
TECHNOLOGICAL
SOCIAL
ECONOMICAL
ECOLOGICAL
ETHICAL
POLITCAL
LEGAL
TOTAL MANAGEMENT SYSTEM

Chapter 05
Production and Operations Management

05 Production and Operations Management (POM)

The production of too many useful things results in too many useless people … Karl Marx

Table of Contents

05.18.00	Plant / Facilities Layout
05.19.00	Maintenance Management
05.20.00	WORK STUDY: Method Study & Time study
05.21.00	Ergonomics
05.22.00	Reliability / Redundancy

05. 01.00 Overview of Production Management

This chapter is intended to serve as a useful guide for production managers and entrepreneurs alike. All the topics are explained in a simple and concise manner to sustain the interest of the readers.

Production and Quality are inseparable twins. Why?
The answer is extremely simple, indeed! It has to be so for survival of any business, of course.

Keep an eye only on profits and ignore quality aspects in any product or service; the customer will call the bluff sooner than later. You are certain to dive into a fathomless abyss!

It is understood that business is for profit and more profit; but within the framework of law and ethics. Customer satisfaction is the key success factor.

To realize this objective, we need to follow this mantra; Deliver a product or service with built-in quality as per the customer needs at the right price, time and place.
Hear the voice of the customer!

How do we know what the customer wants? It is simple again! Just ask the customer(s)! You will be more than enlightened!

“Manufacturing Management” is a term used generally for production of physical goods.

The term “Production and operations Management” has been evolved over the years, with the advent of emphasis on provision of services and phenomenal growth of this sector.

Production is a wider term used for describing manufacturing (production of physical goods) as also production of services. The word “production” is often used for describing “production of physical goods” as also “provision of services”.

The distinction between “production management” concerning “production of physical goods” and “operations management” concerning “provision of services” is so blurred that these terms are often used synonymously and interchangeably.

Production and Operations Management (POM)

The management techniques applied in “production of physical goods” and “provision of services” are similar and often identical.

There is always an element of some “input” to create an “output” by means of a “process” in any production activity, be it a “physical product” or a “service”.

Examples of production of physical goods:

- Automobiles.
- Consumer products.
- Machine Tools etc…

Examples of production of services:

- Hospitals.
- Educational Institutions.
- Gas Stations.
- Real Estate etc…

We shall enumerate the functions of Production Management in the next section.

05.02.00 Functions of Production Management

05.02.01 Management - Definition

Let us recapitulate the definition(s) of management stated in an earlier chapter.

Here is a comprehensive definition of management:

Management is the art and science of getting the work done by a group of persons for the attainment of an organization's goals and objectives – generally to convert certain inputs into desired outputs by means of a process, be it a physical product or a service – using requisite tools and techniques through the management processes comprising planning, organizing, staffing, directing, and controlling functions.

The verb *manage* comes from the Italian *maneggiare* (to handle - especially a horse), which in turn derives from the Latin *manus* (hand). The French word *mesnagement* (later *ménagement*) influenced the development in meaning of the English word *management* in the 17th and 18th centuries. (Source: Wikipedia)

05.02.02 Production and operations management – Conversion Process

05.02.02.01 Definition of Production and Operations Management

"Production and operations management" concerns itself with the ***conversion*** of inputs into outputs, using **physical resources***, to provide the desired utilities of – *form, place, possession or state or a combination there of* – to the customer while meeting the other organizational objectives of efficiency, effectiveness, and profitability.

Physical resources *: FIVE **Ms** of Production ➔ **M**EN, **M**ATERIALS, **M**ACHINERY, **M**ETHODS, and **M**OMENTS (Time)"

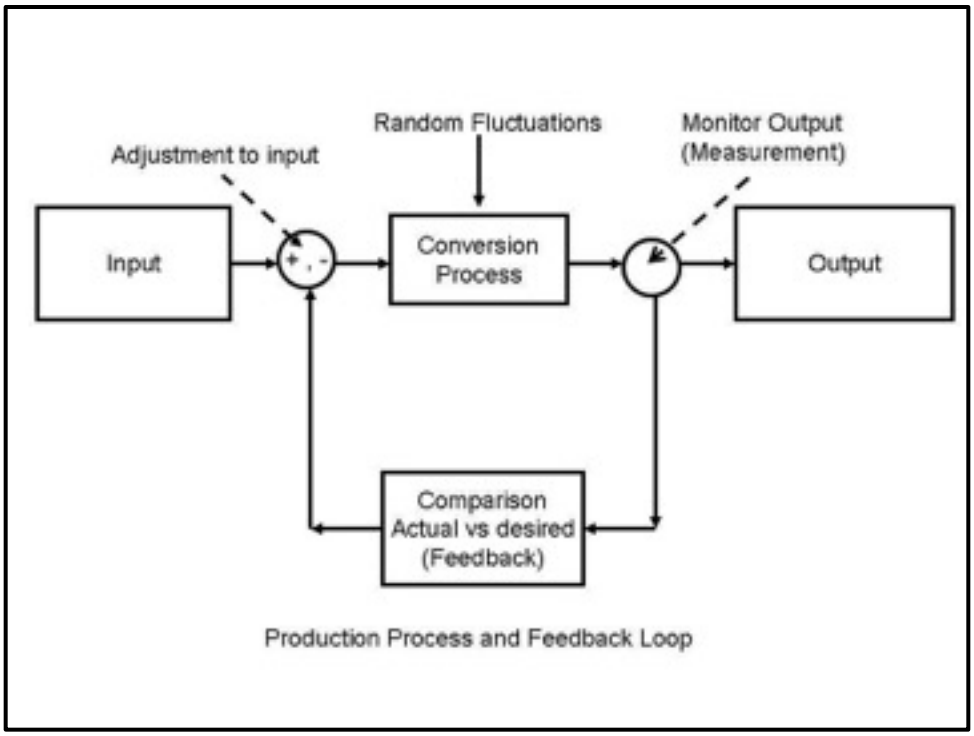
Examples of the nature of conversion processes:

1. Change in "***form"***: e.g. Conversion of wood into furniture; Conversion of ore into metals etc.
2. Change in "***place"***: e.g. Taxi service takes us from one place to another; Shipment to move goods from one place to another etc.
3. Change in "***possession"***: e.g. We take possession of Petrol at a gas station (petrol pump); Registration of real estate to transfer property from one person to another etc.
4. Change in "***state"***: e.g. Hospitals change the state of our health; Universities enhance our knowledge levels etc.

05.02.02.02 Control System / Feedback Loop

The most important concept in a systems model of organizations is the control function. Control involves measurement of output, comparison with desired results, and timely adjustments in inputs to obtain the desired output quality.

The following figure illustrates the production process and feedback loop.



Production Process and Feedback Loop

The output is measured against the established standards to determine the deviations. This information is monitored closely and continuously to give feed back in the conversion system. Then we make necessary *adjustments / corrections in the inputs to obtain desirable output.

* Examples of adjustments:

- Change of tooling in the production process.
- Change in the material specification.

- Operator training.
- Change in speed of metal cutting etc…

05.02.02.03 General Model / Framework - Production and operations management system

The general model / framework for production and operations management are demonstrated in the following diagram.

The specific management functions applicable to “Production and Operations Management” are indicated in the above diagram.

We shall deal with the above stated functions of management in detail, in the following chapters.

05.02.03 Functions / Jobs of Production and Operations Management

05.02.03.01 Basic Functions

The Operations Manager's job is to manage the process of converting the inputs into the desired outputs. All the elements shown in the Framework are the responsibility of Operations Manger.

A) **Planning**:

The Operations Manager selects the objectives for the operations subsystem of the organization and formulates the policies and procedures. Efforts are directed towards product planning, facilities design, and the conversion process.

B) **Organizing**:

The Operations Manager establishes an internal structure of roles within the operations subsystem.

He enumerates the activities to achieve the subsystem goals and delegates authority and assigns responsibility to the departments / persons involved for carrying out the operations as per plans.

C) **Directing**:

The basic functions are:

- Leadership / Team work.
- Decision-making.
- Communication.
- Motivation.

D) **Controlling**:

Operations manager compares the output with the norms, in terms of quantity and quality.

He monitors the deviations and analyses the reasons for deviations.

He then takes corrective action to ensure that the planned results are achieved.

The corrective action comprises changes in the input and /or the process.

Some of the problems encountered are:

Input problems:

- Shortage of material.
- Defective material.
- Machine breakdowns.
- Absenteeism.

Process / conversion problems:

- Defective tooling.
- Improper process.
- Improper scheduling.
- Quality control lapses.
- Inadequate safety measures and accidents.

05.02. 03.02 Classification of the Jobs of Operations Management

The jobs can be broadly classified into three categories viz. “Long-Term”, “Intermediate-term”, and “Short-Term” Horizons as follows.

A) Long Term Horizon - Decisions with long time implications for the organization:

- Technology Selection:
  Factors involved are: a) Obsolescence b) Safety c) Harmful waste by-products etc…
- Capacity Management:
  Factors involved are: a) Demand fluctuations b) Consequences of over-capacity and under-utilization c) Consequences of under-capacity and loss of business etc…
- Product Design:
  Factors involved are: a) Product life b) Product range / variety c) Safety d) Reliability e) Ease of service etc…
- Process Selection:
  Factors involved are: a) Manufacturing lead-times b) Cost of production c) Volumes of production etc…
- Plant Location:
  Factors involved are: a) Nearness to sources of raw materials b) Availability of skilled man-power c) Capital Investment / Cost of Land d) Nearness to Market e) educational facilities for the children of employees f) Health care facilities g) Entertainment services etc…
- Machinery Selection:
  Factors involved are: a) Capital investment b) Flexibility c) Obsolescence etc…
- Plant Layout:
  Factors involved are: a) Flexibility b) Material handling c) Warehousing d) Nature of production systems viz. “Continuous production / Mass production / Batch production / Job shop” etc…
- Quality Control System:
  Factors involved are: a) Conformance with design b) Product performance c) Product reliability etc…

B) Intermediate Term Horizon - Decisions affecting medium term performance:

- Product Range.
- Forecasting.
- Management Information System.
- Work force deployment.
- Personnel Policy / Recruitment / Training.
- Make or buy decisions.
- Inventory Policy.
- Time Standards / Incentive Schemes.
- Product Pricing.

C) Short Term Horizon - Routine Functions and day-to-day operations:

- Production Scheduling.
- Plant Maintenance.
- Documentation.
- Inspection Procedures.
- Shift Working.
- Deployment of casual labor.

05.03.00 Operations Strategy

05.03.01 Introduction to "Operations Strategy"

Operations Strategy is the determination of the basic long-term goals and objectives of an enterprise, and adoption of a course of action and the allocation of resources necessary for carrying out these goals.

All strategies originate from the need to satisfy the customer without who there is no business:

- ***Product differentiation is the basic strategy of a company for market leadership***. It means being different and superior in some aspect of business/ product/service that has value to the customer. It is the strategic *"Mantra"* for success of the organization.
- The product or service has to satisfy the needs of customer. An organization, which achieves customer satisfaction and keeps pace with changing customer needs, has a competitive edge in the market.
- Design of a product or service is a critical process for an organization.
- Product design deals with form and functionality of the product.
- Services design involves provision of physical benefits, sensuous benefits, and psychological benefits to the customer.
- Quality has to be built into the design and the design should be cost effective.

After having decided upon the mission, objectives and the targeted market segment in which the company would operate, the company has to choose between the fundamental strategic competitive options such as:

- Meaningful differentiation vis-à-vis competition.
- Cost leadership.
- Technology leadership.
- Volume leadership.
- Quality leadership.
- Service leadership.

05.03.02 Meaningful Differentiation

It means being different and superior in some aspect of business that has value to the customer.

E.g. Wider product range, functionally superior product, superior after- sales-service etc.

Differentiation is the strategy to win customer. Customer orientation is the key to success. The designer has to have the customer needs in mind. Always ask yourself the question: "What does the customer value in your product or service?"

While a company differentiates itself on one aspect, it should perform adequately in other aspects too. Concentration on one aspect at the expense / neglect of other aspects is not advisable.

Flexibility is an important differentiation strategy. We cannot hang on to a particular advantage for too long, as the market place is dynamic. The company has to be flexible enough to respond quickly to the changed customer needs. Therefore, the production and operations part needs to be flexible enough in terms of machinery, men, process and systems to introduce new products or altered designs in reasonable time.

A company has to provide flexibility in terms of:

- Product design updating.
- Product range / Product mix.
- Volumes.
- Fast Delivery.
- Quick introduction of new products/designs.
- Quick response to customer needs.

05.03.03 Strategies

Following are some examples of a differentiation strategy.

05.03.03.01 Differentiation Strategy through Product Availability

Strategy: Product should be available when and where needed by a customer.

A) Old approach:

- Keep adequate / excess buffer stock.
- Install surplus capacity in terms of Machinery and work force.

This approach has the following ill effects:

- Excessive costs because of inventory carrying costs.
- Increased complexities arising out of vide product-range.
- Obsolescence.
- Deterioration on long storage.

B) Modern approach:

- Reduce manufacturing lead-times through continuous improvements.
- Install flexible manufacturing systems.
- Improved plant maintenance.
- Total Quality Management (TQM).

This approach has the following benefits:

- Lower inventories / Lower costs.
- Improved deliveries.
- Lower obsolescence.
- Flexibility in acceptance of specification / delivery change requests from customers.

05.03.03.02 Differentiation Strategy through Cost Leadership

Strategy: Offer the product / service at the lowest price in Industry through cost reduction.

A) Old approach:

- Reduce budget allocations in HRD, vendor development etc…
- Defer investments in Technology / R&D.
- Defer investments in machinery.

- Reduce purchase prices.
- Control on consumption of stationery.

This approach has the following drawbacks.

- Increased uncertainties.
- Lower employee morale.
- Technology / Process obsolescence.
- Customer dissatisfaction.
- Setting in, of a vicious cycle.

B) Modern approach:

- Eliminate non-value adding activities.
- Achieve quality by design.
- Continuous improvement.
- Reduction in set-up costs.
- Reduce inventories by cutting short the manufacturing lead-times.
- Process improvements through higher technology.
- Maximize automation.
- Improvement in productivity.

This approach would result in:

- Flexible operations.
- Improved product / service quality.
- Improved customer satisfaction.
- Improved profitability.
- Setting in of a virtuous cycle.

05.03.03.03 Differentiation Strategy through Improved quality

Improved quality through:

- Better skills and knowledge.
- Better technology.
- Better designs.
- Better processes.
- Total Quality management (TQM).

05.03.03.04 Differentiation Strategy through Better Service

Better service through:

- Faster response to customer complaints.
- Extensive service setup.
- Reasonable billing for provision of service.
- Honoring warranty claims.

05.03.04 Key success factors

- Product Performance / Quality.
- Technology Leadership.
- New Product Introduction.
- Timely Delivery.
- Prompt Service.
- Flexibility of Product-Mix.
- Value to Customers / Right Pricing.

05.04.00 Decision Making

05.04.01 Introduction

A systematic analysis of problems helps managers to plan, organize, direct, and control the operations. Decision-making is the process of selection from among various alternative courses of action.

In a democratic style of management, employees at all levels are involved in the process of decision-making. Democratic leaders decentralize authority. It is characterized by consultation with the subordinates and their participation in the formulation of plans and policies. A democratic leader encourages participation in decision-making. He leads the subordinates mainly through persuasion and example rather than force.

An autocratic manager makes decisions without the consultation, serving as a dictator in communicating orders. The autocratic manager likes to be in total control of situations. This style of management leads to work getting done on time because there are less people involved in the decision making process. The problem with this type of management style is that the employees are going to eventually lose motivation working in such an environment due to lack of involvement in any decision making process. For situations or events where an 'on the spot decision' needs to be made, this type of leadership can serve a purpose, but trying to have an autocratic style of management in place for long periods of time is going to be problematic. This style of leadership is more suited for a prison setting or in the military and not so much for business management.

We use modeling techniques in analyzing problems and evaluating various alternatives.

05.04.02 Decision Making Process

Steps involved are:

1. Recognition of a problem.
2. Identification of alternatives.
3. Selection of criteria for decision-making.
4. Identification of variables involved.
5. Measurement of impact of the variables on the organization.
6. Evaluation of alternatives using modeling techniques.
7. Selection from among the alternatives / Decision-making.
8. Implementation of the decision.
9. Obtain feedback after implementation.
10. Modify the decision, if need be.

05.04.03 Management Science Approach to Decision Making

Management Science approach relies on scientific method and use of quantitative models. A model is a representation of something real; it shows relationships among variables and can be used to predict and explain. Coupling scientific method with quantitative models provides a powerful basis for analysis. A model can be used to predict results of a decision without tampering with the real existing system. Implementation of a decision without prediction of results could be dangerous. Models help us in this respect.

Modeling process gives us a simplified version of a complex problem, a representation in which all minor considerations are stripped away so that only major / critical / relevant factors are clearly visible.

05.04.04 Types of Models

05.04.04.01: Verbal Models

They describe the variables in words; e.g. describing the landmarks to go from place ‘A’ to place ‘B’: E.g. “Go straight on this road, take a left turn at the next cross-section, walk a 100 yards, and you will find the hotel located next to the cinema-theatre.”

05.04.04.02 Schematic Models

Schematic models show a pictorial relationship among variables; e.g. a road-map used by a motorist.

05.04.04.03: Iconic Models

Iconic models are scaled physical replicas of objects and processes; e.g. a building model presented by an architect.

05.04.04.04 Mathematical Models

Mathematical models show functional relationship among variables; e.g. $x + y = 10$ where x and y are variables.

a) Optimization models

If a solution procedure ensures best possible solution, it is called an optimization Model; e.g. Determination of economic order quantity in materials management. This is a least cost method of ordering material considering the effect of cost of procurement per order, inventory carrying cost etc. We shall deal with this model in detail in the subsequent chapter titled supply-chain management.

b) Heuristic Models

Heuristics involve the systematic application of rules of thumb resulting in "near-best solution". This reduces the amount of search / effort / time needed for a solution. It may not yield best results; but useful when optimization algorithms are not available. Nevertheless, it is a logical procedure using a set of rules.

Examples: Plant layout, Assembly line balancing etc…

c) Break-even Analysis

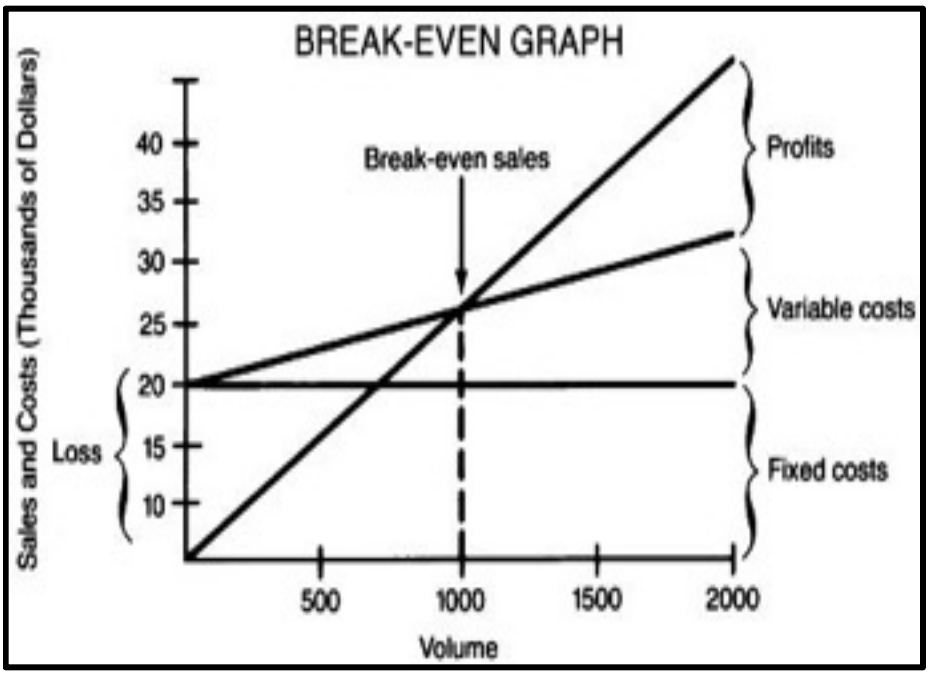
Break-even analysis is a graphical or algebraic representation of relationships among volume, cost, and revenues in an organization. We need to correlate cost and revenue (from sale of products / services) to assess loss or profit at any level of production. The point is at which level, there is no profit or loss is called "break-even point".

Fixed cost is not related to volume of production; e.g. administrative expenses, lighting, rent, office staff cost etc…

Variable cost is directly proportional to volume of production; e.g. material cost, direct labour cost etc…

Break-even level of production is the level at which the total cost of production (Fixed Cost +Variable Cost) equals the total revenue. There is a profit only at a level higher of production over the break-even level.

Following diagram illustrates this concept.



05.04.05 Decision Tree Analysis

One method of dealing with sequential problems is decision tree analysis.
The decision tree is a means of representing the sequential multi stage logic for a decision problem. The decision tree is an offshoot of probability trees. It uses 2 symbols.

□ A box to represent a decision node

○ A circle to represent a chance node

The outcomes emanating from chance nodes are the various events that may occur. These are referred to as "the states of nature", over which the decision maker has no control. Probabilities are associated with their occurrences.

"*Decision Tree Analysis*" consists of 3 steps:

1. Identify decision alternatives / chance events and draw a tree diagram showing sequence of decisions and chance events.

2. Estimation: a) Obtain a probability estimate of the chances of each component's occurrence. b) Obtain estimates of consequences of all possible outcomes and actions.

3. Evaluation and selection: a) Calculate the expected value of all possible actions. b) Select the action offering the most attractive expected value.

Let us now apply this technique of "Decision Tree Analysis" to decide whether to set up a large or small plant to manufacture a new product.

Let us take the case of Anika Industries. The company has decided to introduce a new range of refrigerators. There are many uncertainties involved in respect of demand pattern. We can only assign probabilities to an occurrence.

If we setup a large manufacturing plant and end up with low demand for the product, we have a serious problem at hand. This being a long-term decision involving huge capital investment, we need to be cautious in the process of decision-making.

On the contrary, if we build a small plant and the demand goes high, we miss an opportunity to expand business or to make profits.

We need to make a scientific decision.

Following example illustrates the technique of "Decision Tree Analysis".

This is a case of setting up facilities for manufacture of water coolers and a decision is to be made as to the size of the plant / level of investment in the absence of an assured market.

Example:

Anika Industries has to decide whether to set up a large plant or a small plant for its new range of pumps. A large plant would cost Rs 250 Lakhs and a small plant would cost Rs 120 Lakhs. As per market survey the following estimates are revealed for a period of 10 years.

Demand Level	**Probability**
High	0.5
Moderate	0.3
Low	0.2

Situation	**Profit / (Loss) Rs Lakhs**
Large plant with high demand	100
Large plant with moderate demand	60
Large plant with low demand	(20) Loss
Small plant with high demand	25
Small plant with moderate demand	35
Small plant with low demand	4

Solution:

Given below is a decision tree (Figure 1). We start with a decision node and draw 2 branches as follows.

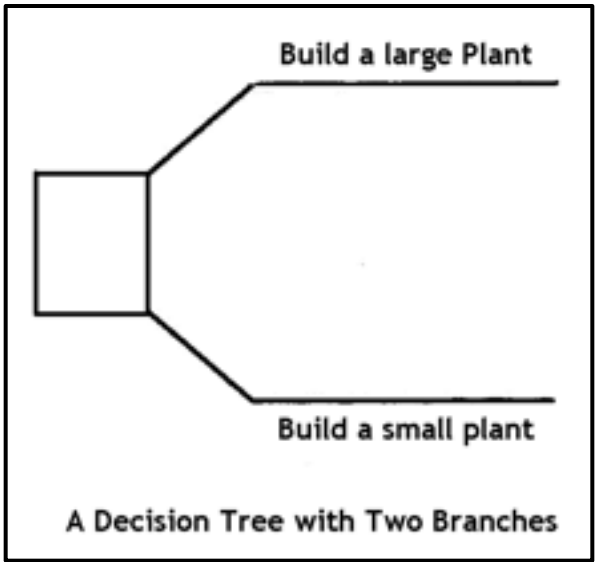


Figure 1

If we build a large plant, it can result in three outcomes viz. high demand, moderate demand, and low demand. Likewise for a small plant we have three outcomes. These outcomes are now added to the tree at the end of chance nodes as shown in figure 2.

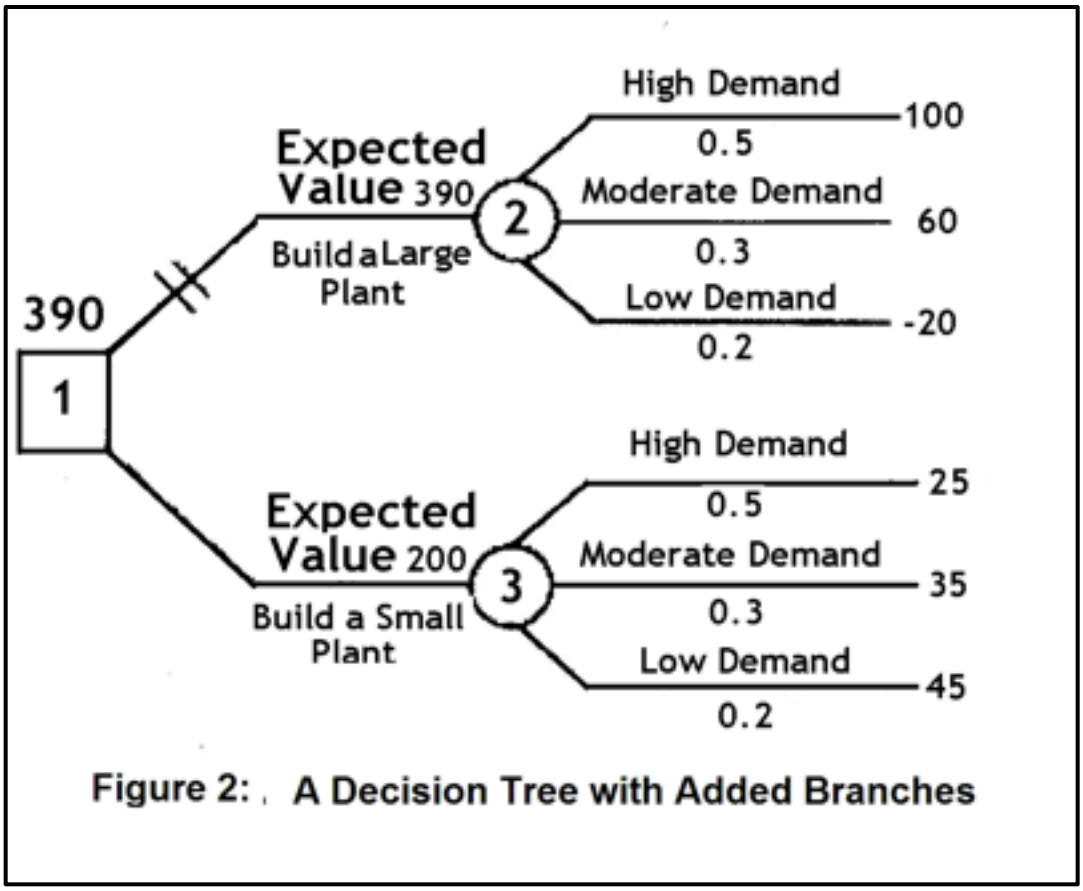


Figure 2

We have added the probabilities for each state of nature and have also added the payoff for each outcome. This step is called rolling out the tree. In order to calculate the value of the decision we now roll back tree.

The expected value at each chance node is computed as follows:

EV = 0.5 x 100 + 0.3 x 60 + 0.2 x (-20) = 64
Expected value in ten years = 64 x10 = Rs 640 Lakhs.
The cost of the large plant is Rs 250 Lakhs. Hence expected net gain at the end of 10 years is Rs 390 Lakhs (640 – 250 = 390).

Similarly we calculate the expected value at chance node 3:

EV = 0.5 x 25 + 0.3 x 35 + 0.2 x 45 = 32.
The expected value in ten years = 32 x 10 = Rs 320 Lakhs.
The cost of the small plant is Rs 120 Lakhs.
Hence the expected net gain at the end of 10 years is Rs 200 Lakhs (320-120 = 200)

The chance node with the higher value is carried backwards to the decision box and a decision is taken accordingly.

The decision in this case is to build a large plant with the expected value of Rs 390 Lakhs which is higher than the expected value of Rs 200 Lakhs worked out for a small plant.

05.04.06 Operations Research Techniques (OR)

Operations research is a discipline that deals with the application of advanced analytical methods to help make better decisions. Employing techniques from other mathematical sciences, such as mathematical modeling, statistical analysis, and mathematical optimization, operations research arrives at optimal or near-optimal solutions to complex decision-making problems. Operations research is often concerned with determining the maximum (of profit, performance, or yield) or minimum (of loss, risk, or cost) of some real-world objective.

Some of the OR techniques adopted for decision making are:

- Assignment Model.
- Decision Theory.
- Dynamic Programming.
- Inventory Models.
- Linear Programming.
- Network Analysis -PERT / CPM.
- Queuing Model.
- Regression Analysis.
- Replacement Model.
- Sequencing Model.
- Simulation Techniques.
- Transportation Model.

We shall enumerate on these techniques in a subsequent chapter titled **“Operations Research”**

05.05.00 Product / Service Design Concepts and Differentiation

05.05.01 Introduction

The product or service has to satisfy the needs of customer.
An organization, which achieves customer satisfaction and keeps pace with changing customer needs, has a competitive edge in the market. Design of a product or service is a critical process for an organization. Product design deals with form and functionality of the product. Quality has to be built into the design and the design should be cost effective. Services generally provide physical benefits, sensuous benefits, and psychological benefits.

Product differentiation is the basic strategy of a company for market leadership.
It means being different and superior in some aspect of business / product / service that has value to the customer.

05.05.02 Product Design

05.05.02.01 Product design - Traditional Approach

In earlier times, each function in an organization was acting in a watertight compartment and there was hardly any participatory approach or interaction.

The steps were:

Customer ➔ Product concept ➔ Marketing ➔ Product Specification ➔ Design Engineer ➔ Design specification ➔ Manufacturing Engineer ➔ Mfg Specifications ➔ Purchase ➔ Supplier ➔ Implementation.

This is a sequential process. At each stage, the customer needs are diluted, as the design parameters are not acceptable to the concerned departments and sometimes beyond their capabilities. Suppliers may not be able to make components as per the specifications. At each stage, the designs are modified from a departmental / practical point of view, with out much integration.

This results in the product being sub-standard and not in conformity with customer needs.

05.05.02.02 Modern approach – Concurrent Design

The modern approach is “concurrent design and integration of all functions from concept to implementation stage.”

Design teams are formed comprising representatives from all functions viz. marketing, design, manufacturing, and purchase. Even the suppliers are involved, to ensure supply of material as per the design specifications in the end. Concurrent design integrates design and manufacturing process.

Manufacturing engineers help in designing workable specifications. Suppliers’ capabilities are considered right from the early stages. Even the cost is reviewed at every stage. As a result, the final product would be cost effective and in line with customer needs. New products are introduced rapidly, as all the departments are fully geared up before hand. No disputes later!

05.05.02.03 Steps in Product Design Process

Research: Discovery of novel products, services, techniques, ideas and systems.
Development: Improvement of existing products, services, techniques, ideas and systems.
Design: Translation of requirement into a form suitable for operations, production and use; usually in the form of drawings, specification, process etc.

Design Steps:

1. Prepare a draft specification of product or service. Draft includes performance parameters, appearance / style, quantity requirement, statutory requirement, likely price and date of introduction in the market.
2. Circulation of draft to all the concerned departments in the organization.
3. Brain storming by the design team comprising representatives from all the concerned departments.
4. Prepare revised draft specification.
5. Testing for feasibility of the project in terms of marketing, manufacturing ability and plant capacity.
6. Release preliminary design.
7. Make a model / prototype.
8. Test the prototype as per specifications.
9. Revise the drawing / specifications, in light of the above experience.
10. Invite comments / suggestion from marketing and manufacturing.

11. Finalize the designs and release drawings for a pilot batch production. Consider simplification, standardization and modular options using existing sub assemblies / components.
12. Manufacture a pilot batch and test market.
13. Make improvements based on market feedback.
14. Release design / drawings for regular production as per forecast.
15. Design manufacturing / service facilities.
16. Implementation.
17. Continuous Improvement (kaizen: Japanese System).

05.05.03 Design of Services

Design of services varies from design of product, because of the characteristics of services. Services generally provide **physical benefits, sensuous benefits, and psychological benefits**.

Example at a restaurant:

- Table, chairs, tablecloth, napkins and cutlery are **the physical benefits.**
- Taste of food and music are **sensuous benefits.**
- Posh restaurant and brand give **psychological benefits.**

05.05.03.01 Characteristics of services

Let us examine the characteristics of services and as to how they affect the design.

A) Intangibility:

The expectation of a customer varies according to his experience, perception and preference. The service that is only felt by customer is difficult to assess, as it is not physical. Designers start by compiling information on how people think, feel and behave.

B) Perishability:

Services cannot be stored. Services have to be delivered simultaneously as they are produced. It is important to know what to deliver; and where, when and how.

C) Heterogeneity:

Service output varies because they are based on customer perceptions and preferences.

The customer base itself is heterogeneous.

D) Simultaneity:

This occurs because the customer is generally present as the service is rendered.
Often, the customer is part of the process. E.g. gym-services, hair-dresser, beauty-parlor etc…

There is a greater contact between the service provider and the customer.

05.05.03.02 Service Concepts

The design starts with a concept, which describes the target customer and the nature of service experience. Differentiation is an important factor to be considered. It describes as to how the organization's service would be different from that of competition. The customer should be able to see certain special values in our service as also in our product.

05.05.03.03 Service Package

This includes a package of physical benefits, sensuous benefits and psychological benefits the service would provide.
Let us take an example of a good management institute.

A) Physical benefits:

A/C classrooms, comfortable furniture, training aids such as projection systems, well stocked library, computer center, cafeteria etc.

B) Sensuous benefits:

Audio Video training aids, highly qualified faculty etc.

C) Psychological benefits:

The institute's brand name, stringent-screening system etc…
Being a member of such an elite group would provide the psychological benefits.

Of course, the physical, sensuous and psychological package has to be compatible with the nature of service.

05.05.03.04 Performance Specifications

These outline of customer requirement and customer expectation.

A) Design specifications:

- Specification of activities to be performed by the service provider to ensure consistency.
- Skills required of the provider.
- Cost and time estimates.
- Location and layout facilities.

B) Delivery specifications:

- Outline of work schedule.
- Location at which the work would be carried out.

05.05.03.05 Classification of Services

Services can be classified into the following categories.

A) Professional services:

E.g. Architects, solicitors, tax consultants etc…

These are characterized by low contact and high interaction with the customer.

B) Mass services:

E.g. Railways, bus service, hotels etc...

These are characterized by high contact and low interaction with the customer.
System based.

C) Service shops:

E.g. Clinics, cafeterias etc…

D) Service factories:

E.g. Banks, postal services etc…

These are characterized by low contact and low interaction with customers. The process is highly automated

05.05.03.06 Steps in Service Design

[Customer] ➔ Service concept (Desired services, Targeted customer) ➔ Service package ➔ (Physical items, Sensuous benefits, Psychological benefits) ➔ Design specifications (Activities, Facilities, Skills, Cost/time estimates) ➔ Delivery specifications (Schedule, Deliverables, Location) ➔ [Service]

05.05.04 Exercises

A) Design a service package for a kindergarten school.

Features: Service package for a kindergarten school?		
Physical	Sensuous	Psychological

POM / Product / Service Design Concepts and Differentiation

What is the differentiation strategy?

B) Design a service package for a high school.

Features: Service package for a high school?		
Physical	Sensuous	Psychological

What is the differentiation strategy?

C) Compare the packages…. How do they differ in terms of physical, sensuous and psychological features?

05.06.00 Forecasting

Philosophic view; Forecasting:

"It is a paradox. It is a dilemma. This is still unresolved. It is as complex as the laws of the universe. We can never plan the future by the past; neither do we know any other way of planning the future but by the past."

Irony of Forecasting; Statement in a lighter vein:
"The only way to forecast is to manufacture it, better still is to fabricate it."

Nevertheless, we need to forecast and hope for the best! There is no alternative!

05.06.01 Definition of Forecasting

Forecasting is a process of estimating a future event by casting forward past data. Forecasting can be made only when history of past data exists; generally for ongoing products and services. Forecasting requires statistical and management science techniques.

Prediction is a process of estimating a future event based on subjective considerations other than just past data.

For introduction of a new product / service, where no statistics are available, predictions are made based on managerial skills, experience, and judgment.

Production planning need not necessarily follow marketing planning. Sometimes the planning has to be done together by marketing and production and at times separately by production management. Forecasting is a very important activity for production planning.

Forecasting is a sub-phase of planning for operations.

E.g. forecasting the number of production units, number of patients in a hospital, number of books circulated in a library etc…

In case of production forecast, the estimates can be further subdivided into estimates of machine hours, direct labor hours or material requirement.

The product forecasts are used as basis for planning and controlling production sub-systems.

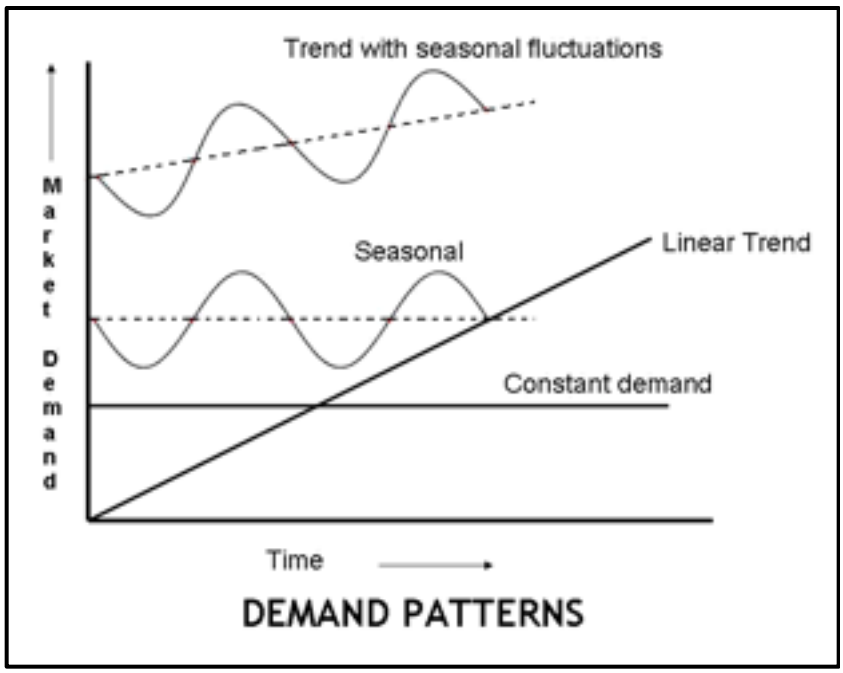
The following figure shows that Forecasting is a sub-phase of planning.

05.06.02 Demand Patterns

Types of demand:

- Seasonal demand.
- Linear demand.
- Constant demand.
- Composite (Trend + Seasonal) demand.

See the following figure regarding various types of demand patterns.



05.06.03 Elements of Forecasting

Forecasting is essentially the study of internal and external forces that shape demand and supply. Forecasting will be different for different strategies, offering multiple scenarios for management decision making.

Factors:

- Internal factors – past, present, and future.
- External factors.
- External and controllable.
- External and uncontrollable.

05.06.04 Types of Forecasting

05.06.04.01 Qualitative techniques

These are subjective and judgmental and based on estimates ("Guesstimates") and expert opinions. Market research for new products, seeking ideas from retailers and customers fall in this category. Delphi method of forecasting is a qualitative technique described as follows.

Panel consensus: E.g. Delphi method of forecasting

The Delphic Oracle exerted considerable influence throughout the ancient Greek world, and she was consulted before all major undertakings: wars, the founding of colonies, and so on. Delphi is known for the oracle at the sanctuary that was dedicated to Apollo during the classical period. The site of Delphi is located in upper central Greece, on multiple plateau / terraces along the slope of Mount Parnassus, and includes the Sanctuary of Apollo, the site of the ancient oracle. Delphi oracle is associated with the ability to forecast future events and hence this name for the forecasting technique.

Steps involved:

1. A moderator selects panel of experts.

2. Moderator obtains opinions of panel members, independently.

3. Panel members are not brought face to face, nor do they know who else is on the panel. This is to ensure that a member of the panel is not influenced by other members. All the opinions are recorded at each stage.

4. The summary of opinions is made known to all the members, with questions by moderator.

5. The process is repeated until a consensus is achieved.

6. This process eliminates the influence of dominant members on other members.

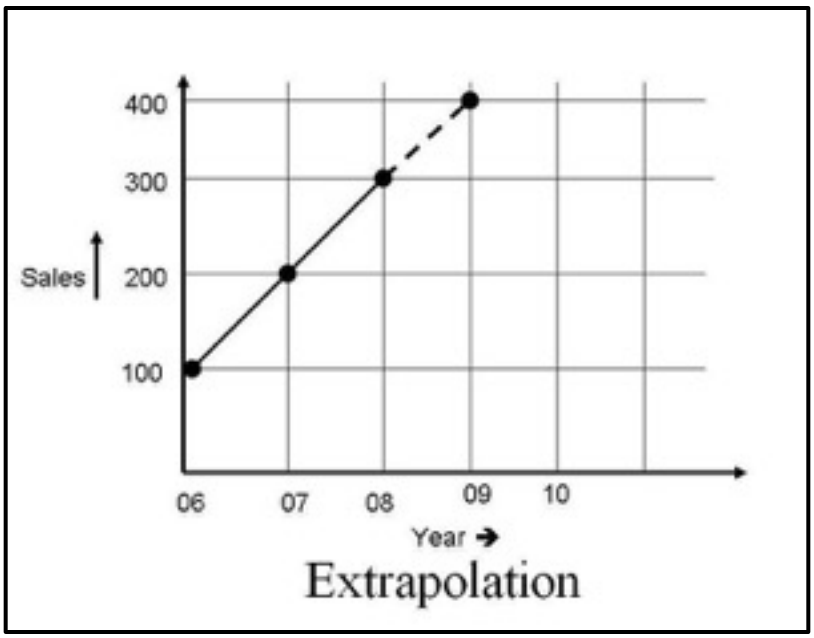
This is a good method for a long-term forecast.

05.06.04.02 Time series Analysis

Time series forecasting models attempt to predict future values based on past data.

Extrapolation: Extrapolation is easy if the previous data is linear. We need to eliminate one-time big orders in our extrapolation method, as also any other aberration.

The following graph is self-explanatory.
Past performance of sales
Sales 2006 = 100 units
Sales 2007 = 200 units
Sales 2008 = 300 units
Forecast for 2009 = 400 units.



05.06.04.03 Moving Averages Method

The moving average is a discrete averaging method, where periods beyond certain number are not taken into computation.
Suppose a company wants to use 10 week moving average for forecasting sales, they take the average of past 10 weeks. A week later, they would add newest week's sales and discards the oldest, so that once again they have current moving average for the latest 10 weeks.

Another example: 3 months' moving average:

Month	Sales , Units	3 Months' moving average
Jan	80	
Feb	120	
Mar	100	(80+120+100=300) / 3 =100 *
Apr	140	(120+100+140=360) / 3 =120*
May	120	(100+140+120=360 / 3 = 120*

*The moving average is taken as the forecast for the next month

05.06.04.04 Exponential Smoothing

Exponential smoothing is a specific averaging technique. It weights each of past demands in calculating an average. The pattern of weights is exponential in form.
Demand for the most recent period is weighed heavily; the weights placed on successively older periods decay exponentially.

Forecast for next period' demand =
Alpha factor (α) x {Most recent demand (D)} + (1 – Alpha) x {Most recent forecast (F)}

Value of Alpha (α) (weightage factor for current demand) lies between 0 an1

Example:

Alpha factor = 0.7
Forecast for Sept = 200
Actual Sales in Sept = 300 units
Forecast for October = 0.7x300+ (1.0-0.7=0.3) x200 = 210 + 60 = 270
Actual sales in October = 350
Forecast for November = 0.7x350+ (1.0-0.7=0.3) x 270 = 245 + 81 = 326

The advantage of this method is that, one needs to have only two figures: one for the old forecast and anther for actual sales.

The decrease in weights is non-linear / exponential….meaning rapid decay.
This concept is explained by expanding the above formula, as follows.

$$F_{t+1} = \alpha \cdot D_t + (1 - \alpha) \cdot F_t$$

where

D_t = demand during the present period t;
F_t = forecast of the demand made *for* the present period t;
F_{t+1} = forecast for the next period made during the present period.
α = weightage factor for the current demand.

$$\begin{aligned}
F_{t+1} &= \alpha \cdot D_t + (1 - \alpha)\, F_t \\
&= \alpha \cdot D_t + (1 - \alpha)\, [\alpha\, D_{t-1} + (1 - \alpha)\, F_{t-1}] \\
&= \alpha \cdot D_t + \alpha\,(1 - \alpha) D_{t-1} + (1 - \alpha)^2\, F_{t-1} \\
&= \alpha \cdot D_t + \alpha\,(1 - \alpha)\, D_{t-1} + (1 - \alpha)^2\, [\alpha \cdot D_{t-2} + (1 - \alpha)\, F_{t-2}] \\
&= \alpha \cdot D_t + \alpha\,(1 - \alpha)\, D_{t-1} + \alpha\,(1 - \alpha)^2\, D_{t-2} + (1 - \alpha)^3\, F_{t-2} \\
&= \alpha \cdot D_t + \alpha(1 - \alpha)\, D_{t-1} + \alpha\,(1 - \alpha)^2\, D_{t-2} \\
&\quad + \alpha\,(1 - \alpha)^3\, D_{t-3} + \alpha\,(1 - a)^4\, D_{t-4} + \cdots + (1 - \alpha)^n\, F_{t-n+1}
\end{aligned}$$

The last term is negligible for a very large ‘n” since $n < 1$.

The smoothing action takes place because the aberrations of earlier periods are filtered out i.e. older periods do not have much effect on current forecast, but not ignored totally.

This technique takes into account the demands for all the past periods with exponentially decreasing weightage being given to each of them.

The extent of smoothing depends on the value assigned to the alpha factor. When the alpha factor is small, it leads to assigning lower weightage to recent demands and more consideration to older demands. If alpha factor is large, the reverse is true.

The assignment of value to the alpha factor depends on the nature of our business.

Where the past statistics are of no consequence, as in the fashion industry, the alpha factor is high.

In case of provisions such as sugar, where the demand does not fluctuate violently, the alpha factor is assigned a low value.

The experience gathered in running a business would indicate the appropriate value to be assigned to the alpha factor, for an accurate demand forecast.

05.06.04.05 Causal Forecasting

This is based on determining the cause and effect relationships and expressing them in mathematical terms.

Linear regression: Linear regression establishes relationship between dependant variable and an independent variable. This technique is covered under the chapter titled "Operations Research".

05.06.04.06 Simulation

Demand may be forecast using Monte Carlo simulation. This technique is covered under the chapter titled "Operations Research".

05.06.05 Forecast Error Monitoring

05.06.05.01 Mean Absolute Deviation (MAD)

This is the arithmetic average of deviations between forecast and Actuals, ignoring the + or – signs. This gives a picture of the amplitude error.

05.06.05.02 Running Sum of Forecast Errors (RSFE)

This is the algebraic average of the deviations between forecast and actuals, considering the effect of + and – signs.

05.06.05.03 Tracking Signal (TS)

Tracking signal **TS** = RSFE / **MAD.**
This could be negative or positive.

Example:

Period	Forecast	Actual demand	Deviation
1	900	1000	-100
2	1000	1100	-100
3	1050	1000	+50
4	1010	960	+50
5	980	970	+10
6	985	970	+15
7	980	995	-15

Calculation of MAD

Arithmetic sum of deviations = 340 (100+100+50+50+10+15+15)
No of periods = 7
MAD = 340/7= 48.6

Calculation of RSFE:

RSFE =Algebraic sum of deviations = Minus 90

Calculation of tracking signal

Tracking signal index = Minus 90 / 48.6 = Minus 1.85
We have to monitor the amplitude (MAD), negative / positive bias (RSFE), Tracking signal, and modify our forecasting models suitably.

A good forecast must oscillate between positive and negative bias, with minimal amplitude.

05.07.00 Aggregate Planning

05.07.01 Definition / Concepts

Aggregate output planning is a process by which we plan the overall use of the conversion resources, by specifying the aggregate quantity of a family or group of products. At this point, the quantity of individual models is not stated.

For example, Tata Motors make different models of cars viz. Indica, Indigo, Safari, Nano etc, but the aggregate planning would specify the plan as, say 100,000 cars in a year.
The focus is on production planning.
Once the aggregate plan is made, we make a review of aggregate capacity. The aggregate capacity plan checks whether there is sufficient, capacity to meet the demand expressed in the "aggregate output plan".

This forms the basis for a more detailed planning for individual products, in terms of capacity allocation, sequencing, scheduling, material requirement planning and the like.

In our example of car mfg, we have certain overall resource requirement for each car, in aggregate terms, such as material requirement, man / machine hour requirement etc, with some model-to-model variations.

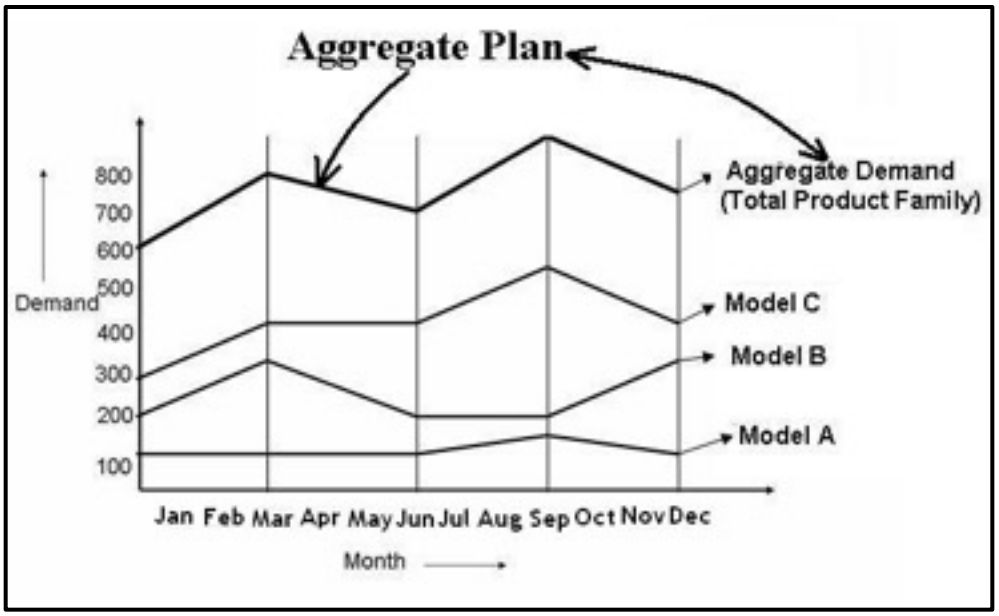
The following diagram shows that **"aggregate product planning"** is part of the "**planning function"**. This is an important function, which helps us optimize utilization our scarce resources.

Scheduling, a sub phase of planning, is simply the time sequencing of events.
Aggregate scheduling derives from the aggregate planning concept and these terms are used somewhat synonymously.

Please see the following figure for an aggregate plan offering three products.

A product group, for instance, could be that of Refrigerator. Let us call the three models as A, B and C.

The following graph shows the aggregate plan for the total family of refrigerator, as also plans for Products A, B and C.



05.07.01.01 Aggregate production planning

The first step in such planning would be to make a sales forecast of demand for the intermediate range, generally one year.
The aggregate production plan and the strategies are based on this sales forecast. If the capacity, inclusive of any additional capacity that may be installed or subcontract element, is not adequate we may have to scale down the sales plan to match the available capacity.

Aggregate production plan deals with overall out put.
Aggregate production plan does not deal with specific individual products.
Aggregate production plan is governed by the available capacity, hiring and layoff policies, subcontracting, order book etc.

05.07.01.02 Aggregate Capacity Planning

The aggregate capacity plan checks whether there is sufficient capacity to meet the demand as expressed in the aggregate production plan.
The plan lays down how the capacity would be utilized and how the over-capacity or under-capacity would be addressed, by actions such as deployment of additional staff, sub-contracting and the like. This plan sets limits on the master production schedule.

05.07.01.03 Master Production Schedule

This master plan disaggregates the product groups into individual products and lays down as to when these individual products should be produced to meet customer requirement. This plan is a LINK between the “Marketing Plan” and “Production Plan”.

05.07.02 Strategies and Costs

In trying to meet the demand with the production capacity in the intermediate range, we have the following strategies.

1. Deployment of overtime
2. Hiring or layoff / Working in single or multiple shifts
3. Carrying excess inventories to meet peak demands
4. Sub-contracting to other companies
5. Turning down some sales demands

Each of the above has a cost factor associated with it.

The costs involved are:

1. Marginal cost of overtime.
2. Hiring cost for new staff and training cost.
3. Inventory carrying costs (Interest, storage cost, cost of obsolescence, insurance etc...)

4. The additional cost of sub-contracting, if the purchase price is more than own manufacturing cost.

The combination, rather than a single strategy, will usually result in the most economical plan.

Most companies use graphical / trial and error methods to solve aggregate planning problems. Of course, previous experience concerning overtime, subcontracting, hire and fire etc help in this process.

Mathematical techniques such as linear programming, assignment model, and dynamic programming can also be applied to solve aggregate planning problems.
The basic objective is to work out an optimal solution.

These techniques are enumerated in a subsequent chapter titled “Operations Research”.

Now, the alternative production plans have to be made and the one that is most economical would be selected.

Alternative plans:

- Plan with peaks and valleys. (or)
- Steady plan (Average of peaks and valleys) to meet the total demand. (or)
- A combination of the above plans.

05.07.03 Aggregate Planning Strategies

Now, four alternative production-planning strategies are enumerated as under

(A) Chase Strategy – Variable Work Force / Hire and Fire Strategy:

In this strategy, we increase or decrease the level of work force to meet the market demand, by hiring and firing. This strategy can demoralize the work force. Moreover, we may not be able to recruit skilled labor as and when required, due to non-availability. Trade unions would protest at deployment of such strategies.
This strategy has its limitations.

(B) Level Production – Constant work Force Strategy:

In this strategy, we maintain a stable work force and the rate of production is kept constant. The number of workers is decided based on the total demand for the planning period. This may result in:

- Backlog of orders / Cancellation of orders due to shortages.
- Excessive inventories in case of lower demand.

The employees may be happy with this strategy due to job security; the customers may be dissatisfied due to uncertain deliveries.

(C) Stable Work Force – Variable work Hours / Offload Strategy:

In this strategy, we maintain stable workforce and adjust the rate of production by way of variable working hours. Overtime may be resorted to, in case of shortfalls.
This strategy may result in:

- Under-utilization of resources during slack period and consequent financial losses.
- Ill-effects of overtime and consequent escalation of cost due to overtime-wages.

(D) Mixed Strategy – A Combination of the above Strategies:

Apart from the above-mentioned strategies, we may also sub-contract the work, as and when required.

However, this strategy may not be applicable in locating sources of supply for critical / proprietary items, involving sophisticated technologies. Some quality problems may arise due to excessive sub-contracting.

When a single strategy is used, it is termed a ***pure strategy.***
When a combination of more than one strategy is used, it is termed a ***mixed strategy***.

05.07.04 Cost Considerations

While selecting a strategy, the main consideration is to minimize the cost.
The main cost factors are as under.

05.07.04.01 Basic Production Cost Elements

- Direct Material.
- Indirect Material / Consumables.
- Labor cost / Wages etc…

05.07.04.02 Hiring and Firing Costs

- Cost of recruitment.
- Cost of training etc…

05.07.04.03 Inventory carrying costs

- Cost of storage.
- Insurance.
- Obsolescence.
- Deterioration.
- Interest on working capital etc…

05.07.04.04 Backorder costs

- Loss of customer goodwill.
- Loss due to cancellation of customer orders.
- Cost of expediting etc…

We may work out the total cost involved in each of the alternate strategies and select the one with minimal cost.

05.08.00 Production Planning and Control (PPC)

05.08.01 Production Planning

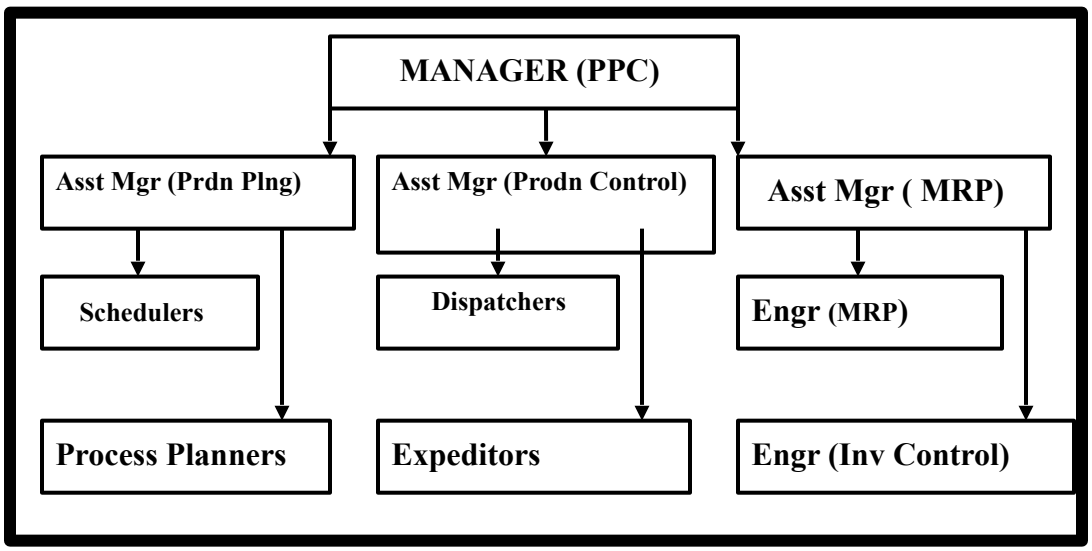
Production planning consists mainly of the evaluation and determination of production inputs such as labor, machinery, equipment, materials and utilities to achieve the desired output.

05.08.02 Production Control

Production control is basically a correcting mechanism which goes on throughout the implementation process of already drawn up production plans and schedules.
Basically outputs are measured and corrective action is taken, in case of deviations with respect to the plans.

05.08.03 Organization (PPC)

A typical organization chart of PPC is given below.



- A ***'SCHEDULER"*** is the person who works out detailed production schedules and determines sequences/priorities.
- A ***"DESPATCHER"*** is the person who issues work-orders, route cards and job cards etc on the shop floor for execution.

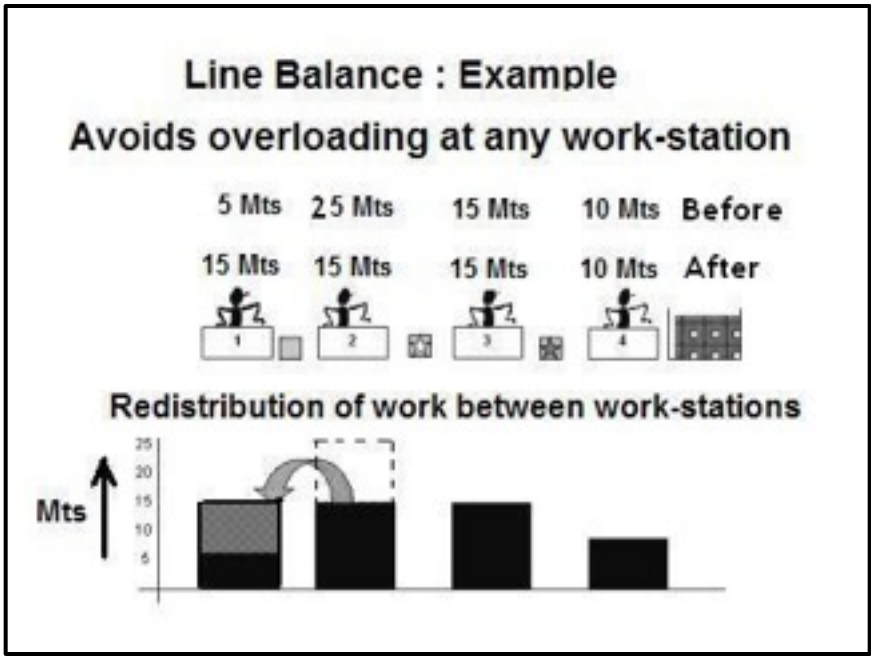
- An ***"EXPEDITOR"*** **is** the person who monitors progress and communicates decisions on the production lines. He does a lot of chasing too.

05.08.04 PPC Techniques

Some PPC techniques are

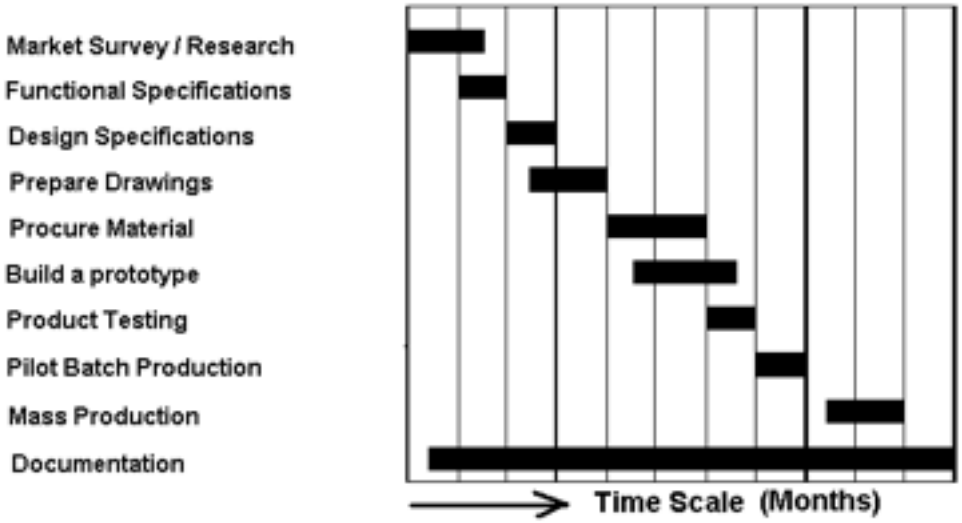
a) Line Balance - For balancing the work-load in assembly line.
b) Gantt Charts - For project planning / machine loading.
c) PERT/CPM - For project planning showing inter-relationship among the activities.

The following typical diagrams illustrate the above techniques.



Gantt Charts

Gantt Chart is a type of bar-chart / scheduling-technique developed by Henry Gantt in 1910s that illustrates a project schedule. Starting and finishing dates (periods of activities) are indicated in the chart on a time-scale either sequentially or with overlap depending on the nature of activities. This technique is useful in project scheduling .

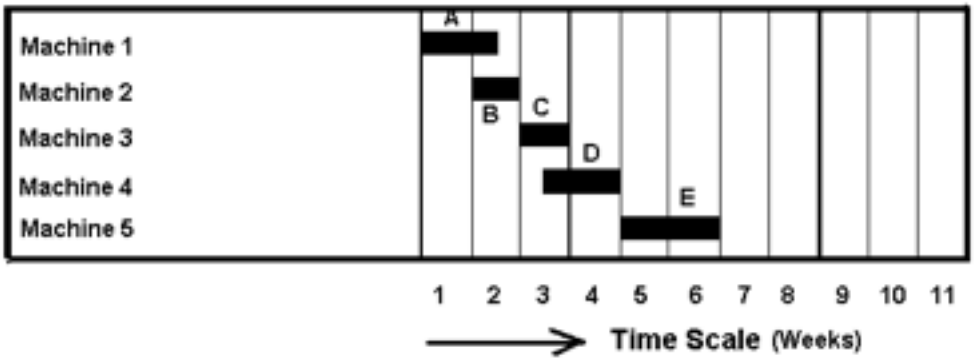


Gantt Chart for introduction of a new product

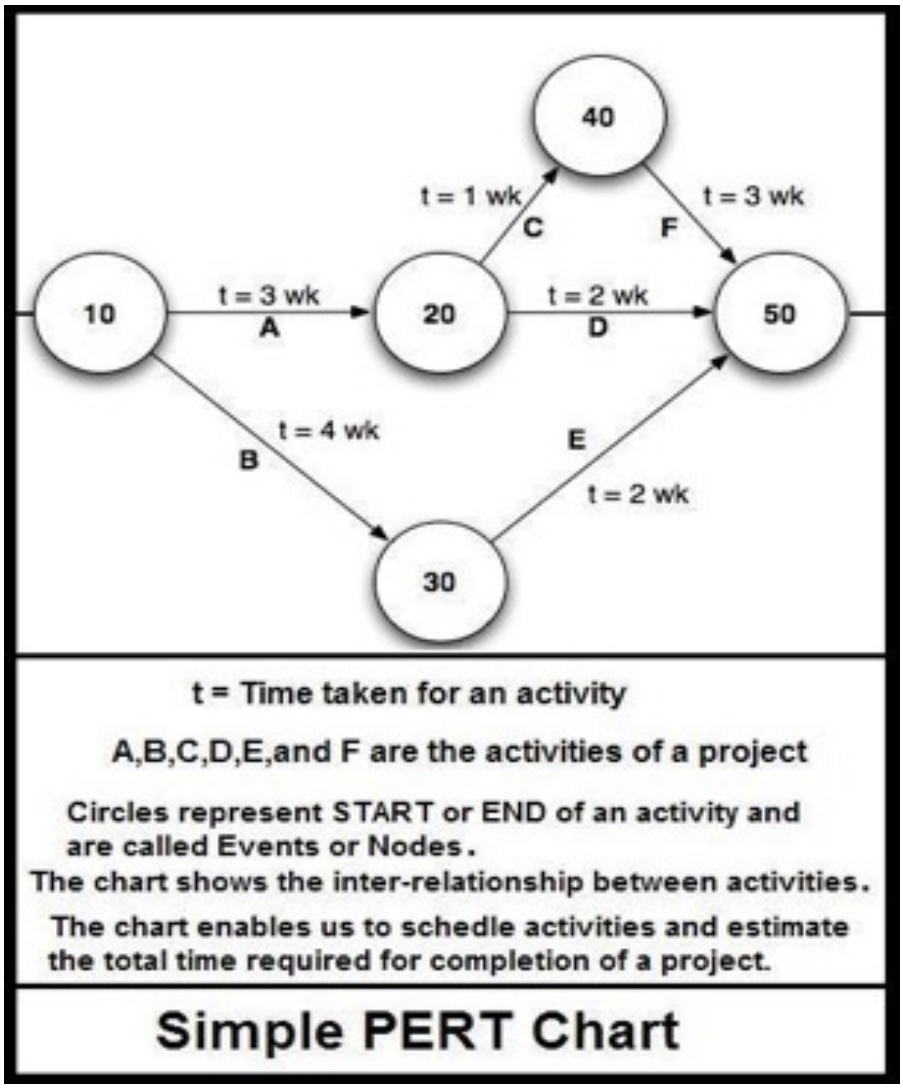
This technique can also be used for machine loading in a workshop.

e.g. Jobs A,B,C,D,and E are loaded on Machine 1,2,3,4,5

Several jobs can be super imposed in the same chart .



Gantt Chart for Machine Loading


40
t = 1 wk
C
t = 3 wk
F
10
t = 3 wk
A
20
t = 2 wk
D
50
t = 4 wk
B
E
t = 2 wk
30
t = Time taken for an activity
A,B,C,D,E,and F are the activities of a project
Circles represent START or END of an activity and are called Events or Nodes.
The chart shows the inter-relationship between activities.
The chart enables us to schedle activities and estimate the total time required for completion of a project.
Simple PERT Chart

05.08.05 Functions of PPC Department

a) Preparing broad Manufacturing Plans for the long range, say for 12 months.

b) Preparing rolling production plans every month, for the intermediate range, say for next three months.

c) Preparing detailed production schedules for the short term:
Weekly / Fortnightly / Monthly.

d) Issuing Drawings / work orders/material to the shop floor.

e) Dispatching: issuing work-orders, route cards and job cards etc on the shop floor for execution.

f) Monitor progress, measure deviations with respect to the plans.

g) Expediting.

h) Releasing of Rolling MRP (Material Requirement Plans) to purchase department.

i) Inventory Control.

PPC is an effort to optimize the process of conversion of raw material into finished products required in the market.

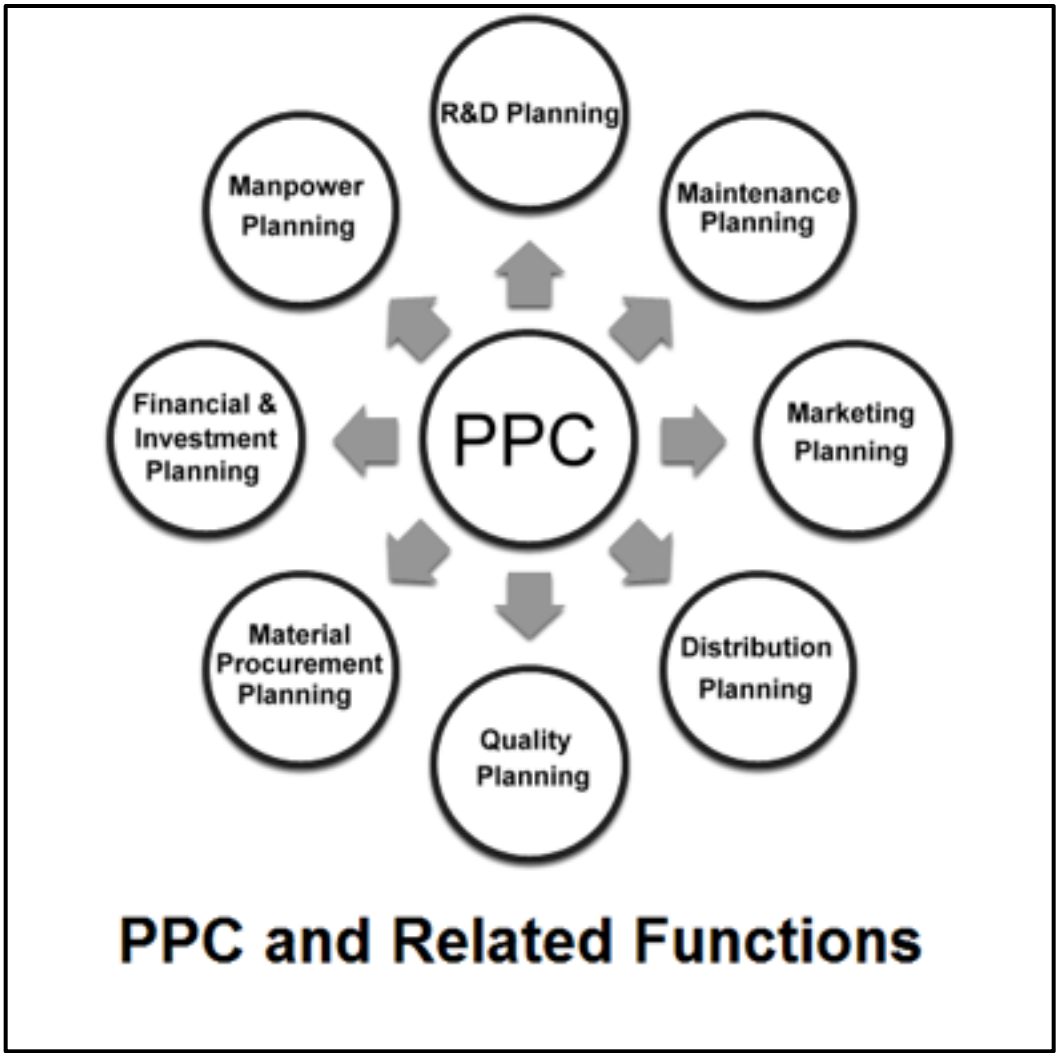
PPC is the main coordinating function in manufacturing operations.

PPC is the nerve centre of a manufacturing unit.

05.08.06 PPC – Nerve Center of the Organization

PPC dept is known as the ***"Nerve Center"*** of the organization. Top Management depends heavily on the feedback from PPC Department.

The following diagram shows various functional departments which are influenced by PPC.


R&D Planning
Manpower Planning
Maintenance Planning
Financial & Investment Planning
PPC
Marketing Planning
Material Procurement Planning
Distribution Planning
Quality Planning
PPC and Related Functions

05.09.00 Scheduling

05.09.01 Definition: A detailed Day-to-day planning operation is called scheduling.

Day-to-day implies a short time horizon, not necessarily for the day literally.

Scheduling deals with questions such as:

A) Which work centers will do the job?
B) When should an operation / job start and when should it end?
C) On which machine / equipment should it be done and by whom?
D) What is the sequence in which the jobs / operations need be carried out?

05.09.02 Planning Horizons

a. Perspective plan: Plan for a long period, say 5-10 years (Not very precise).
b. Forecast: Estimate for intermediate range / period and near future, say 1-3 years.
c. Aggregate plan: A plan for an intermediate range / period, for a year.
c. Annual detailed Production Plan: A model wise / month wise firm plan for 12 months.
d. Quarterly rolling plan: Plan for the current/next 2 months, on rolling basis.
e. Firm Production Plan for current month.
f. Schedule**:** Planning for the short term. Fortnightly / Weekly / Daily / Shift-wise / Hourly Plans.

Continuous production systems such as process plants or mass production systems such as automobile production lines may not need much day-to-day scheduling, because the operations are repetitive and continuous for several days together. Emphasis would have to be on activities concerning uninterrupted inputs viz. Material supply, Manpower deployment, machine maintenance etc
Scheduling assumes importance in job-shop type of production, involving high variety and low volumes.

05.09.03 Objectives of Scheduling

1. Meeting due dates.
2. Minimizing cycle time for completion.
3. Minimizing overtime work.
4. Minimizing idle time.
5. Maximizing machine / labor utilization.

6. Minimizing work-in-process levels.

The process of assigning jobs to work centers is called **loading.**
Routing indicates the sequence of operations to be carried out.
The act of releasing job orders to the workers to go ahead with the production process is called **dispatching.**

Loading: A job can be performed by various persons, machines or work centers, which have certain efficiency and/or cost implications. We need to load or assign the jobs to appropriate machines / work centers / men to optimize the efficiency and/or cost. We can use an assignment model, a special form of linear programming, to manage such problems in scheduling.

There are many quantitative techniques that can be adopted for scheduling.
These techniques are briefly outlined as follows.

05.09.04 Scheduling Techniques

05.09.04.01 Assignment Model

If we have 'M' number of jobs to be loaded on 'N' number of Machines (or work centers) and the cost of performing a job on different machines varies because of the capacity of the machine and the characteristics of the job. The jobs are to be exclusively performed on one machine as the set up costs are too prohibitive to permit setting up of another machine for the same job.

In such a situation, we prepare a cost matrix as under.

Machine► Job▼	Machine 1	Machine 2	Machine 3	Machine 4
Job A	C-A1 (Cost) …	C-A2	C-A3	C-A4
Job B	C-B1	C-B2	C-B3	C-B4

Job C	C-C1	C-C2	C-C3	C-C4
Job D	C-D1	C-D2	C-D3	C-D4

E.g. C-A1 is the cost of performing job ‘A’ on machine 1.

Then we go on to assign the jobs A, B, C, and D to the 4 Machines by using assignment Model Technique. This is similar to transportation Model used in Operation Research. We need to ensure minimum cost of executing the jobs.

05.09.04.02 Use of Priority Rules

- ➢ FCFS: First Come First Served basis.
- ➢ SOT: First, run the job with Shortest Operation Time.
- ➢ DDATE: Run the job in order of the due dates i.e. First start the job with earliest due date.
- ➢ CR: Critical ratio = [(Due date – Today’s date) / Remaining Process Time]; First, start the job with least critical ratio.

05.09.04.03 Heuristic Models: ‘n’ Jobs on ‘m’ work centers

We can use heuristic models to solve such problems. This involves assigning a job-value (JV) for each item based on duration of the job on each machine and sequencing the jobs in increasing order of job-value.

These techniques are enumerated in details in the later chapter titled “Operations Research”.

05.10.00 CEDAC - A Tool for Continuous improvement

05.10.01 CEDAC Technique

'CEDAC' is a tool used for continuous improvement and problem solving.

'CEDAC' is an acronym for "**C**ause and **E**ffect **D**iagram with **A**ddition of **C**ards"

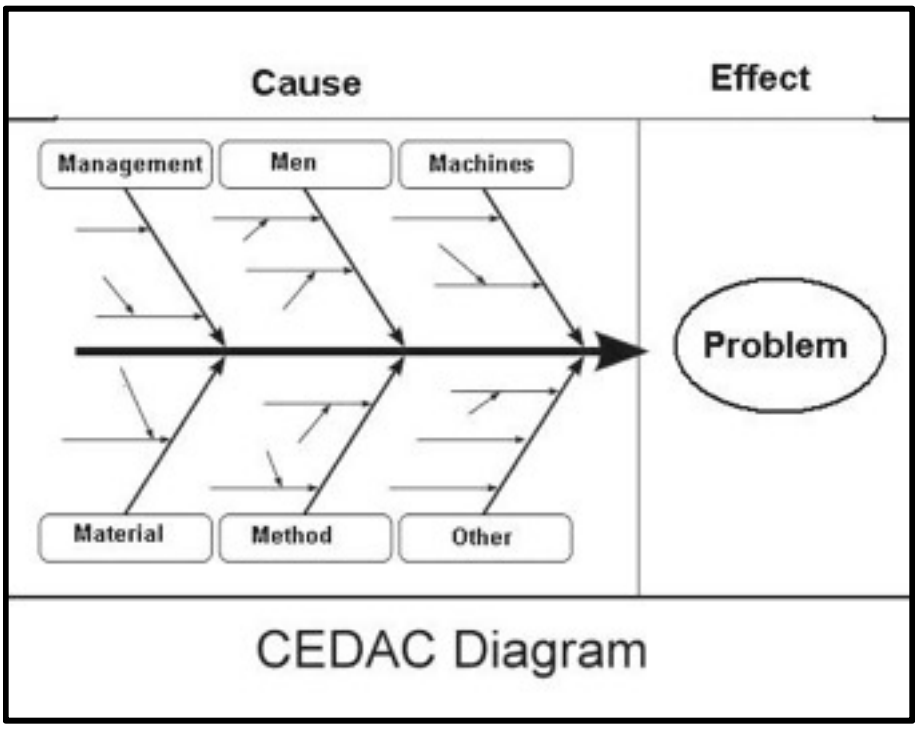
'CE DAC'

C ➔ CAUSE
E ➔ EFFECT
D ➔ DIAGRAM
A ➔ ADDITION
C ➔ CARDS

Dr Fukuda of Sumitomo Electric Company, Japan, developed 'CEDAC' system.
'CEDAC' can be applied to solve sophisticated problems.

Special features of 'CEDAC':

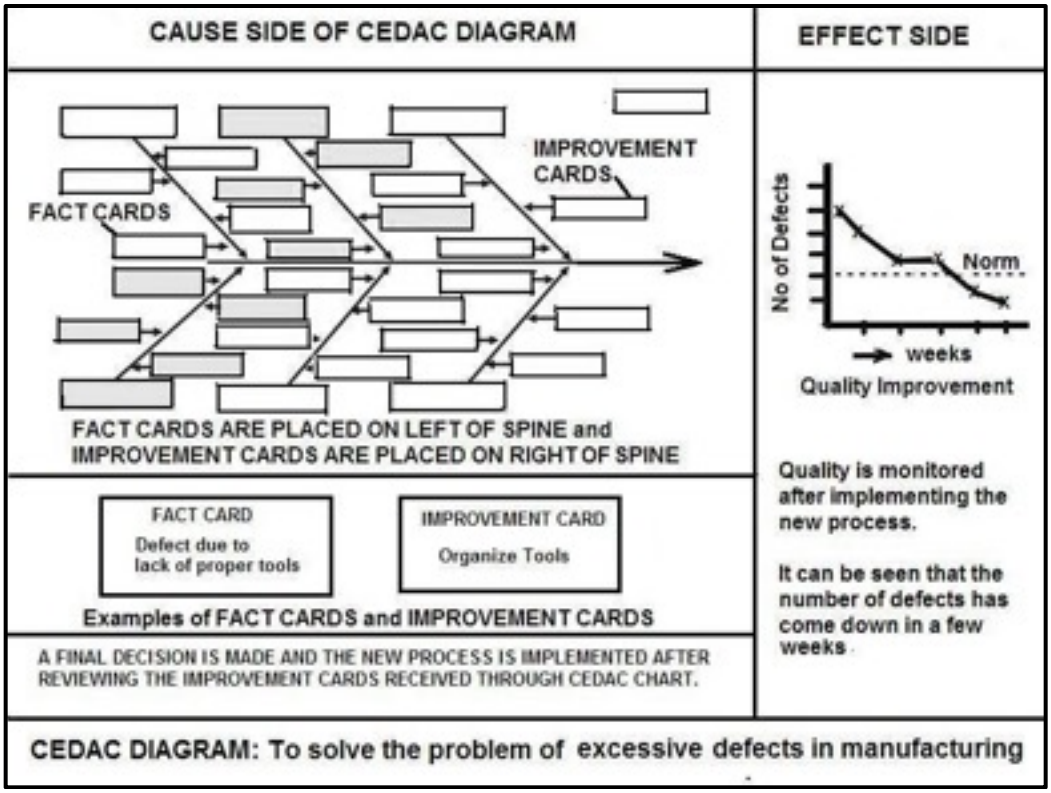
1. It is a tool for continuous improvement.
2. It is a standard procedure.
3. It is participatory: It makes full use of accumulated knowledge and experience of all employees in an organization.
4. It is universal and can be applied to any business.
5. It gives quick results.



Cause and Effect Diagrams help you to think through causes of a problem thoroughly. Their major benefit is that they guide you to consider all possible causes of the problem, rather than just the ones that are most obvious. The approach combines brainstorming with use of a type of concept map.

Cause and Effect Diagrams are also known as Fishbone Diagrams because a completed diagram looks like the skeleton of a fish; and as Ishikawa Diagrams, named after Professor Kaoru Ishikawa, a pioneer of quality management, who devised them in the 1960s.

A typical CEDAC DIAGRAM is given below; to demonstrate the steps involved in the process.



Steps:

1. **Select a problem** to be solved / area of operations to be improved.
2. Choose a project leader. The CEDAC leader should be the actual person in charge of the improvement project.
3. **Draw a Diagram** on white sheet of paper: size = 1 M x 2 M.
4. **Devise a way of measuring the results** on the EFFECT side of the diagram.
5. **Set a target** for the chosen problem area / area needing improvement: E.g. number of **defects** per week, inventory value, production efficiency, machine utilization, sales volumes, service-response time to attend to customer complaints etc…
6. **Format the effect side**: such as line-graph, bar chart etc to give a visual display.
7. **Gather the** "**Fact-Cards"** from the participating Managers, Supervisors and Workmen. The obstacles that hinder the attainment of the goal are written on the cards. Stick/pin them on the left side of the spine as shown in the CEDAC diagram. If there are two or more cards for the same fact, bunch them together. All the cards must be signed with date, so that they can be contacted for clarifications, if need be.

8. **Gather the** "**Improvement Cards" from** the participants. Improvement cards express an idea for solving the stated problem. The improvement cards are, in effect, a collection all the accumulated knowledge, experience and expertise in the chosen field. Stick / pin them on the right side of the spine as shown in the CEDAC diagram. All the cards must be signed with date, so that they can be contacted for clarifications, if need be.
9. **Test Improvement ideas.** Evaluate the substance of the improvement cards and put them into practice. Test results must be recorded and monitored on the effect side of **CEDAC** diagram/graph/bar chart.
10. **Classify the cards in a meeting:**
    (a) Unusable cards (unmarked).
    (b) Interesting cards. Mark these cards with ONE RED DOT.
    (c) Under preparation (arranging for tools, training, scheduling etc). Place TWO RED DOTS on these cards.
    (d) Under testing and monitoring results on the effect side of the CDAC diagram. Place THREE RED OTS on these cards.
11. **Choose the standard improvement cards** with good results recorded on the effect side of the CEDAC diagram**.** Mark these chose cards with FOUR RED DOTS and surround the four red dots with a green box. The leader signs on the standard cards as a token of acceptance and approval for implementation. In case of a tie between two ideas, the leader takes a final decision on implementation.
12. These standard cards are then placed in a transparent holder and displayed prominently at the work place.
13. Communicate the new standards and adhere to it.
14. Monitor the results of the new system.

A standard, that evolves as a result of collective effort is much easier to implement, rather than the one simply prescribed by the management.

Start CEDAC again when a new condition needing improvement emerges.

Following chart gives some examples of CEDAC application.

05.10.02 Areas of Application – CEDAC

CEDAC technique can be applied where ever there is a need for improvement. The following chart gives some examples.

What is to be improved?	Measurement / Quantifying Results
Quality defect reduction	• Fraction of defects • Failure cost (Monetary loss due to defects divided by total cost.) • Number of defects • Number of claims
Work-in-process reduction	• Amount of work-in-process • Number or rate of failure to meet delivery date • Production lead time • Average inventory level (Inventory level at the beginning of the term and inventory level at the end of the term divided by 2.) • Inventory turnover (Annual sales amount divided by average inventory level.)
Productivity improvement	• Labor productivity • Set-up time reduction ratio • Ratio of workers with multiple skills • Machine productivity • MTBF (Mean Time Between Failures) • Frequency of equipment failure • Rate of robotization • Equipment utilization ratio • Overall equipment effectiveness (Availability × Performance efficiency × Rate of quality products.)
Engineering and administrative work improvement	• Rate of new products in product mix • Profitability of new products • Number or rate of computer input errors • Achievement level of Visual Control Systems • Conformity between budget and actual result • Efficiency of visiting customers • Accomplishment of goals for attaining new orders • Number and contents of claims • Effectiveness of design reviews

05.11.00 Just-in-time Production (JIT)

05.11.01 JIT Concepts

Just-in-time (JIT) is an integrated set of activities designed to achieve high volume production using minimal inventories of raw material, work in progress, and finished goods. Parts arrive at a workstation just when they are required and move through operations quickly.

Toyota Motor Company, Japan tried it out successfully in 1970s.
This system cannot be easily applied to customized intermittent production.
JIT works best in a stable environment, where the demand is fairly steady.
It is best suited for repetitive production. There is no batch production, in general.
It can be perceived as an extreme job order system where a single unit is ordered, yet retaining the conveyor system and its advantages.

As and when the item is produced, it is conveyed to the next stage and there is no waiting time at any place. Of course, the operation times at each work place are balanced.

In essence, in J-I-T we have no delay either due to lot-size production or due to unequal production times of different workstations as the conveyor times are balanced.
J-I-T is a combination of single unit production and the conveyor system.

It is called ***"Ikko Nagare"*** in Japanese meaning, single unit production and conveyance.
If anything gets delayed anywhere, the whole line comes to a halt. Then there is psychological group pressure. Everyone contributes to solve a problem.
Every operator, when he finishes his job, is required to press a button. If, by end of the cycle time, all have not pressed the buttons, a red light comes on and the line stops.
It is like every work station is going through exactly the same cycle and all get delayed to the same extent.

05.11.02 Smoothing of J-I-T Production

Since inventories are to be minimized at all places including finished goods and to have uniform balanced work load at all work stations , it is essential to convert the demands for all products into a sequence of single unit productions, the sequence repeating itself in time. For instance, let us take a family of cars (Model A ,B &C) in an assembly line production with the monthly demand is 100 for Model A, 50 each for Models B & C. .
We could have a sequence of say, A-A-B-C / A-A-B-C / A-A-B-C / ……

This type of sequencing at a single unit of product level helps in eliminating lot sizes as it facilitates even-balancing of load at all work stations. At the same time, we do not accumulate stock of any single model and market needs are met more uniformly.

05.11.03 Need for Multi-skilled Workers

The worker should be able to operate different types of machines required for different jobs. He should be of help to his neighbor, carry out routine maintenance, and be his own quality inspector.

05.11.04 Need for Close Vendor Relations

J-I-T system demands close relations / contact with suppliers for timely supply of quality material to maintain uninterrupted production.

05.11.05 Need for Worker Motivation

The workers are motivated to produce defect-free items and cooperate among themselves. They are also empowered to take their own decisions and to inspect their own produce. They have to develop multi-skills and carryout multi-tasking.

05.11.06 Difference between J-I-T and MRP

J-I-T is often compared with MRP, because both lay emphasis on the question:

"When is the material required?"

These two systems are for different types of demand.
MRP is used for a dynamic situation where the demand may vary often, whereas J-I-T is basically designed for a stable demand situation and is incapable of handling large and sudden variations.

J-I-T is basically designed for a single unit production, whereas MRP involves lot sizes at all stages of production.

J-I-T tries to eliminate inventory, whereas MRP makes some compromises and even allows safety stock to insure against demand and supply variations, while trying to minimize the inventory levels.

J-I-T does not involve much planning, but involves close contact with suppliers for timely supplies, where as MRP involves detailed planning at all stages of production.

05.11.07 Elimination of Wastage

Following are seven causes of wastage:

1. Waste of overproduction.
2. Waste of time.
3. Waste of transportation and material movement.
4. Inventory waste.
5. Processing waste.
6. Waste of motion.
7. Waste from product defects.

Seven ways of elimination of wastage

Classification of techniques:

05.11.07.01 Focused Factories

Small factories designed for a single purpose can be operated more efficiently and economically. It is difficult to implement J-I-T in large integrated factories involving bureaucratic systems.

05.11.07.02 Group Technology

Jobs or products, which pass through similar operations – such as Engine blocks, cylinder heads, connecting rods, pistons etc – are identified and grouped into families.

Machines and equipment required to carry out these operations are grouped together to form a cell. The jobs are completed in the cell and do not have to move from department to department.

- This eliminates queues.
- This system reduces the inventory.
- The group develops multi-skills. The workers cooperate among themselves to achieve the targets and have greater job security.
- Work force is minimized.

- The groups are independent of each other, have the much desired autonomy, and are motivated.
- The workers are multi-skilled and can handle all the machines and equipment, besides carrying out inspection of their own output.
- Cost of tooling is minimized.

05.11.07.03 Quality at Source

Quality at source implies getting it right, the first time and every time. Worker inspects his own job concurrently as he produces. If something goes wrong, the whole line stops and the problem at any place is collectively and cooperatively solved to ensure quality at all stages of manufacture.

05.11.07.04 J-I-T Production

Just in time production, as described in paragraph no 05.11.01.

05.11.07.05 Uniform Plant Loading

The line is balanced for optimum production. We can also run a mixed line in a repetitive sequence, say three similar car models. Refer to paragraph 05.11.02: Smoothing of J-I-T Production.

05.11.07.06 Minimized Setup Times

Setup time has to be minimal in order to minimize delays / waiting time.

05.11.07.07 *Kanban* Production Control System

"Kanban" is the Japanese word for "instruction card".

The J-I-T production uses a unique system of drawing material and issue of work orders for production at various stages of production.

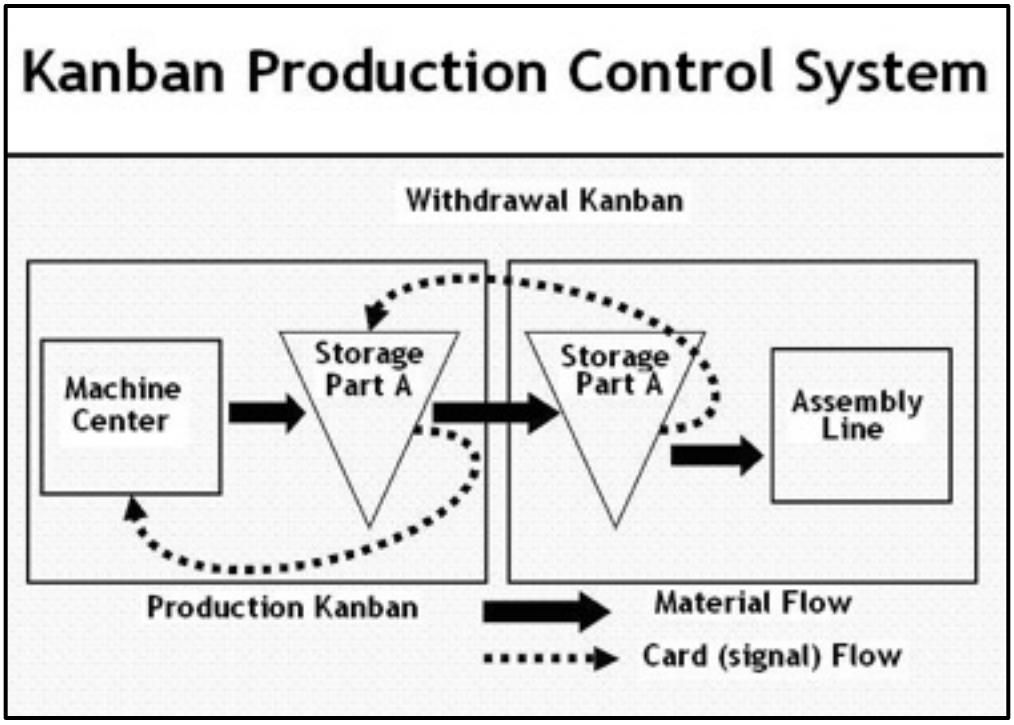
THIS IS A PULL SYSTEM. Sales pull the product from the final assembly line. The final assembly line pulls parts from various manufacturing cells. The manufacturing cells pull raw material / components from the suppliers.

This helps minimize the inventories, as only what is needed is pulled from the preceding/ previous stage.

Excess/surplus stock is not permissible anywhere under this system.

How does the Kanban production system work?

Details follow ➔



A schematic diagram of Kanban production control system

Kanban **production Control System**

Toyota, Japan introduced the Kanban system of production control.
Kanban in Japanese means “Instruction Card”.

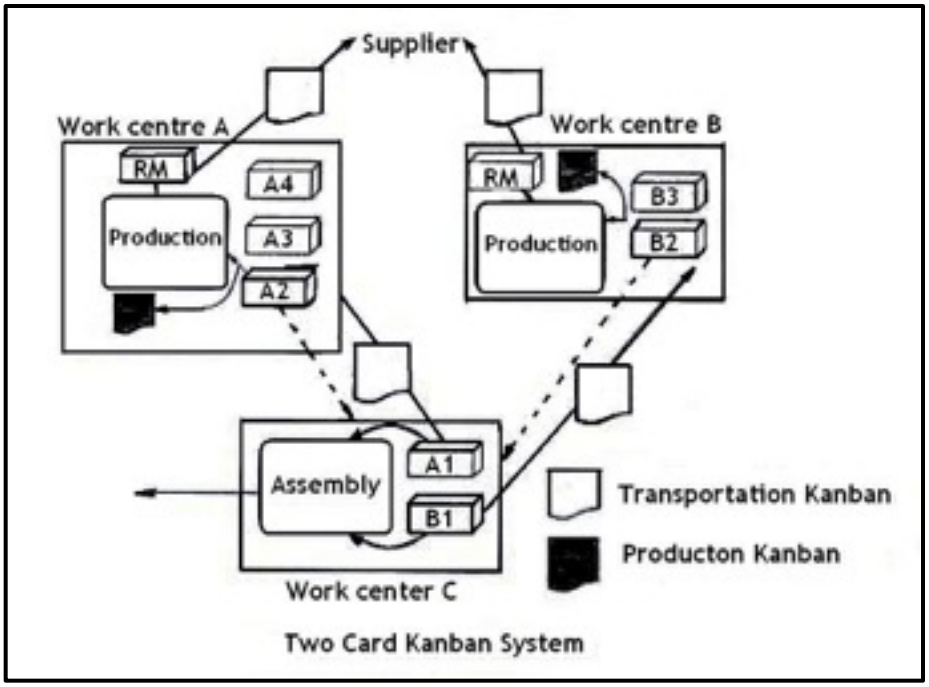
Kanbans are only used to signal or authorize movement of parts from an upstream workstation to a downstream workstation or to act as release for production order to an upstream workstation.

In paperless organizations, Kanbans may be replaced by crates or bins in which parts are transported from one workstation to another. In some cases, squares are marked on the

ground where stores are to be placed. An empty square signals that parts are required at that particular workstation and are moved from the preceding upstream station.
Lights, placards hung on posts or on storage bins, colored balls or any other convenient method of signaling can be adopted.

The system uses two types of Kanban cards viz. transportation Kanban and a production Kanban.

The following figure shows three work centers A, B, and C.



Work center C is a down stream center and work centers A an B are upstream of it. At work center C, a product is assembled using subparts produced at work centers A and B. As soon as a unit is pulled from work center C, work commences to assemble another unit. When the parts are removed from bins A1 and B1 available at work center C, the transportation Kanbans are removed from these bins and sent to work centers A and B. On receipt of the transportation Kanban at work center B, the production Kanban is removed from the bin B2 and placed on a rack near the production facility. The transportation Kanban is placed in bin B2 and the bin is ready to be transported to work center C. Production commences at work center B and the units are placed in the empty bin received from work center C. When the bin is full, the production Kanban is placed in

it and it is moved to storage area from where bin B2 was removed. Similar action also takes place at work center A.

Kanbans are used to regulate the flow of inventory. The quantity of inventory can be regulated by removing or adding Kanbans as required.

05.12.00 Flexible Manufacturing Systems (FMS)

05.12.01 FMS - Concept

A **flexible manufacturing system** (**FMS**) is a manufacturing system in which there is some amount of flexibility that allows the system to react in the case of changes in design of a product. This flexibility is generally considered to fall into two major categories.The first category, *machine flexibility*, covers the system's ability to be changed to produce new product types, and ability to change the order of operations executed on a part. The second category is called *routing flexibility*, which consists of the ability to use multiple machines to perform the same operation on a part, as well as the system's ability to absorb large-scale changes, such as in volume, capacity, or capability.

Most “Flexible Manufacturing Systems” comprise **three main systems:**

1. **CNC Machines.**
2. **Material Handling Systems.**
3. **Central Control Computer.**

The work machines which are often **automated CNC machines** are connected by a **material handling system** to optimize parts flow and **the central control computer** which controls material movements and machine flow.

The main advantages of an FMS are its high flexibility in managing manufacturing resources like time and effort in order to manufacture a new product.

05.12.02 FMS - Flexibility Aspects

For manufacturing science, several classes of flexibility have been identified.

Following are the flexibility aspects:

1. Machine flexibility: The different operation types that a machine can perform.
2. Material handling flexibility: The ability to move the products within a manufacturing facility.
3. Operation flexibility: The ability to produce a product in different ways.
4. Process flexibility: The set of products that the system can produce.
5. Product flexibility: The ability to add new products in the system.
6. Routing flexibility: The ability to use different routes to produce a product in the system.
7. Volume flexibility: The ease to profitably increase or decrease the output of an existing system.

8. Expansion flexibility: The ability to enhance the capacity of a system.
9. Program flexibility: The ability to run a system automatically; the ability to accommodate new products without major retooling.
10. Production flexibility: The number of products a system currently can produce.
11. Market flexibility: The ability of the system to adapt to market demands.

05.12.03 FMS - Introduction

In the middle of the 1960s, market competition became more intense.

During 1960 to 1970 ***cost*** was the primary concern. Later ***quality*** became a priority. As the market became more and more complex, ***speed of delivery*** became something customer needed.

A new strategy was formulated: ***Customizability***. The companies have to adapt to the environment in which they operate, to be more ***flexible*** in their operations and to satisfy different market segments (customizability).

Thus the innovation of FMS became related to the effort of gaining competitive advantage.

Firstly, FMS is a manufacturing technology.

Secondly, FMS is a philosophy. "System" is the key word. Philosophically, FMS incorporates a system view of manufacturing. The buzz word for today's manufacturer is "agility". An agile manufacturer is one who is the fastest to the market, operates with the lowest total cost and has the greatest ability to "delight" its customers. FMS is simply one way that manufacturers are able to achieve this agility.

An MIT study on competitiveness pointed out the American companies spent twice as much on product innovation as they did on process innovation. Germans and Japanese did just the opposite.

In studying FMS, we need to keep in mind what Peter Drucker said: "We must become managers of technology not merely users of technology".

05.12.04 FMS - Flexibility Concept

Today *flexibility* means *to produce reasonably priced customized products of high quality that can be quickly delivered to customers.*

Different approaches to flexibility and their meanings are shown in the following Table.

Approach	Flexibility meaning
Manufacturing	• The capability of producing different parts without major retooling • A measure of how fast the company converts its processes from making an old line of products to produce a new product • The ability to change a production schedule, to modify a part, or to handle multiple parts
Operational	• The ability to efficiently produce highly customized and unique products
Customer	• The ability to exploit various dimension of speed of delivery
Strategic	• The ability of a company to offer a wide variety of products to its customers
Capacity	• The ability to rapidly increase or decrease production levels or to shift capacity quickly from one product or service to another

So, what is flexibility in manufacturing?

While variations abound in what specifically constitutes flexibility, there is a general consensus about the core elements. There are three levels of manufacturing flexibility.

(a) Basic flexibilities:

- *Machine flexibility* - the ease with which a machine can process various operations.
- *Material handling flexibility* - a measure of the ease with which different part types can be transported and properly positioned at the various machine tools in a system.
- *Operation flexibility* - a measure of the ease with which alternative operation sequences can be used for processing a part type.

(b) System flexibilities:

- *Volume flexibility* - a measure of a system's capability to be operated profitably at different volumes of the existing part types.
- *Expansion flexibility* - the ability to build a system and expand it incrementally.

- *Routing flexibility* - a measure of the alternative paths that a part can effectively follow through a system for a given process plan.
- *Process flexibility* - a measure of the volume of the set of part types that a system can produce without incurring any setup.
- *Product flexibility* - the volume of the set of part types that can be manufactured in a system with minor setup.

(c) Aggregate flexibilities:

- *Program flexibility* - the ability of a system to run for reasonably long periods without external intervention.
- *Production flexibility* - the volume of the set of part types that a system can produce without major investment in capital equipment.
- *Market flexibility* - the ability of a system to efficiently adapt to changing market conditions.

05.12.05 FMS - Seeking Benefits on Flexibility

Today's manufacturing strategy is to seek benefits from flexibility. This is only feasible when a production system is under complete control of FMS technology. Having in mind the *Process- Product Matrix* you may realize that for an industry it is possible to reach for high flexibility by making innovative technical and organizational efforts. Volvo's process structure makes cars on movable pallets, rather than an assembly line. The process gains in flexibility. Also, the Volvo system has more flexibility because it uses multi-skill operators who are not paced by a mechanical line. So we may search for benefits from flexibility on moving to the job shop structures. Actually, the need is for *flexible processes* to permit rapid low cost switching from one product line to another. This is possible with *flexible workers* whose multiple skills would develop the ability to switch easily from one kind of task to another. As main resources, flexible processes and flexible workers would create *flexible plants* as plants which can adapt to changes in real time, using movable equipment, knockdown walls and easily accessible and re-routable utilities.

05.12.06 FMS- an example of technology

The idea of an FMS was proposed in England (1960s) under the name "System 24", a flexible machining system that could operate without human operators 24 hours a day under computer control. From the beginning the emphasis was on *automation* rather than the "reorganization of workflow". Early FMSs were large and very complex, consisting of dozens of Computer Numerical Controlled machines (CNC) and sophisticated material handling systems.

They were much automated, very expensive and controlled by incredibly complex software. There were only a limited number of industries that could afford investing in a traditional FMS as described above. Currently, the trend in FMS is toward small versions of the traditional FMS, called flexible manufacturing cells (FMC).

Today two or more CNC machines are considered a *flexible cell* and two ore more cells are considered a flexible manufacturing system.

Thus, a **Flexible Manufacturing System** (FMS) consists of several machine tools along with part and tool handling devices such as robots, arranged so that it can handle any family of parts for which it has been designed and developed.

Different FMSs levels are:

1. *Flexible Manufacturing Module* (FMM). Example : An NC machine, a pallet changer and a part buffer.
2. *Flexible Manufacturing (Assembly) Cell* (FMAC). Example : Four FMMs and an AGV(automated guided vehicle).
3. *Flexible Manufacturing Group* (FMG). Example : Two FMCs, a FMM and two AGVs which will transport parts from a Part Loading area, through machines, to a Part Unloading Area.
4. *Flexible Production Systems* (FPS). Example : A FMG and a FAC, two AGVs, an Automated Tool Storage, and an Automated Part/assembly Storage.
5. *Flexible Manufacturing Line* (FML). Example: multiple stations in a line layout and AGVs.

05.12.07 Advantages and Disadvantages of FMS implementation:

Advantages of FMS:

- Faster, lower- cost changes from one part to another which will improve capital utilization.
- Lower direct labor cost, due to the reduction in number of workers.
- Reduced inventory, due to the planning and programming precision.
- Consistent and better quality, due to the automated control.
- Lower cost/unit of output, due to the greater productivity using the same number of workers.
- Savings from the indirect labor, from reduced errors, rework, repairs and rejects.

Disadvantages:

- Limited ability to adapt to changes in product or product mix (E.g. machines are of limited capacity and the tooling necessary for products, even of the same family, is not always feasible in a given FMS).
- Substantial pre-planning activity.
- Expensive, costing millions of dollar.
- Technological problems of exact component positioning and precise timing necessary to process a component.
- Sophisticated manufacturing systems.

FMSs complexity and cost are reasons for their slow acceptance by industry. In most of the cases FMCs are favored.

05.12.08 The Future of FMS

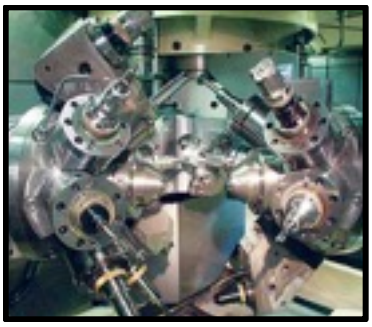
- FMS systems will deliver directly into warehouse, and do not require labor.
- The use of robots that have vision and tactile sensing will replace human labor.
- Technology will make 100% inspection feasible. Thus making faster process adjustment possible.
- Computer diagnosis will improve estimation of machine failure, and guide work crews repairing failures.
- International coordination and control of manufacturing facilities.
- Customers have completely custom orders made immediately, and to exact specifications, and at a lower cost.
- Networks will tend to eliminate the barriers caused by international borders.
- Standards will be developed which make installation of a new machine trivial.
- Networking between manufacturers and suppliers will streamline the inventory problems.
- Marketing will be reduced, as customers' desires are met individually.
- Finished goods inventories will fall as individual consumer needs are met directly.
- Better management software, hardware, and fixturing techniques will push machine utilization towards 100%.
- Computing power increases.

05.12.09 The Machines and Layouts

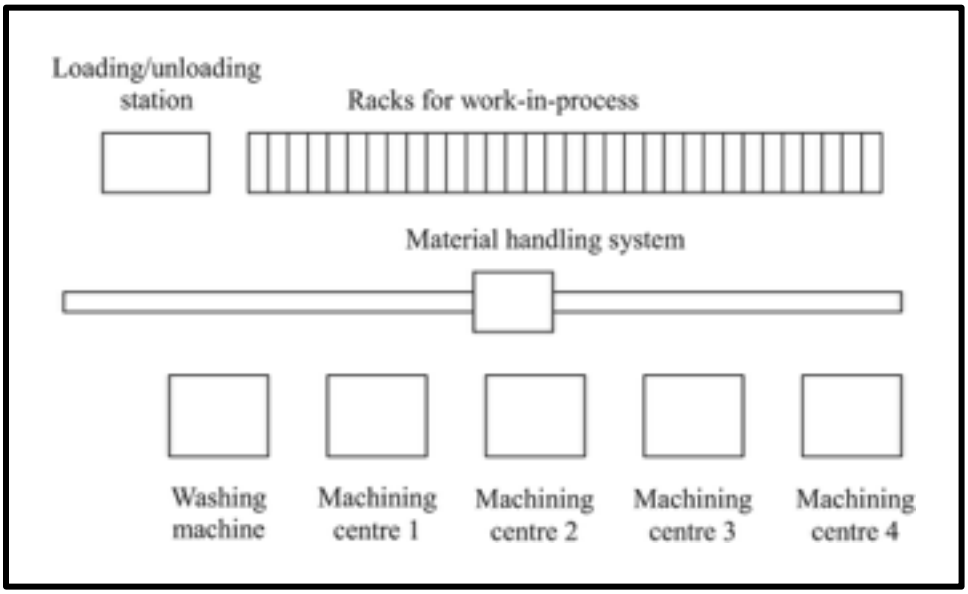
The Machines / facilities / Tooling can be seen in the following pictures.

FMS: CNC M/C & CONVEYOR PALLETS

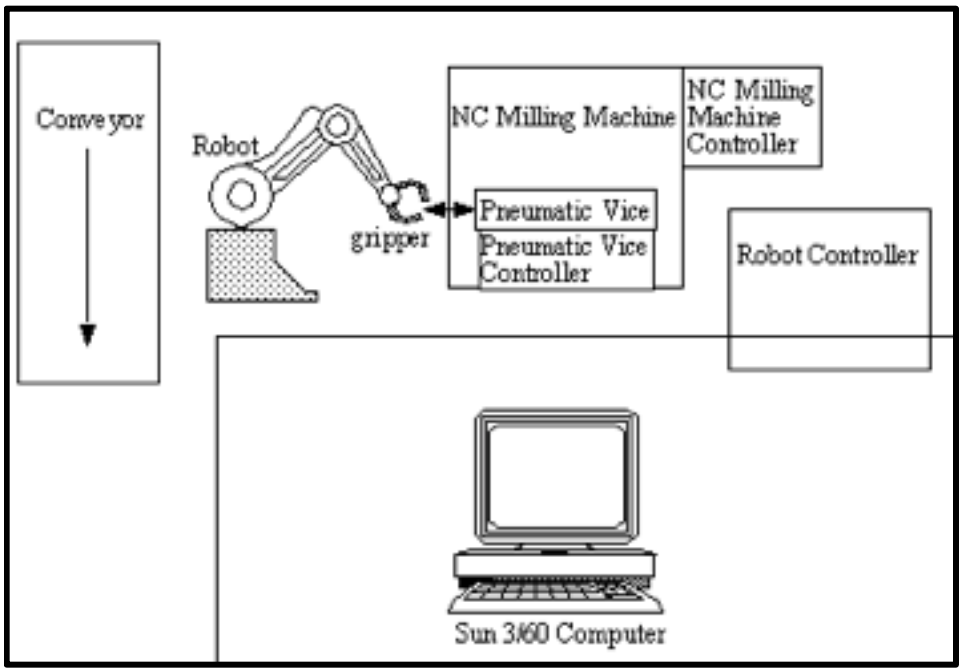
CNC MACHINING CENTER



CNC TOOLING



FMS: Layout



FMS: Schematic Diagram

05.13.00 Business Process Re-Engineering (BPR)

05.13.01 Overview

Business process reengineering (BPR) is, an approach aiming at improvements by means of elevating efficiency and effectiveness of the business process that exist within and across organizations. The key to BPR is for organizations to look at their business processes from a ***"clean slate"*** perspective and determine how they can best construct these processes to improve how they conduct their business.

Business process reengineering is also known as BPR, Business Process Redesign, Business Transformation, or Business Process Change Management.

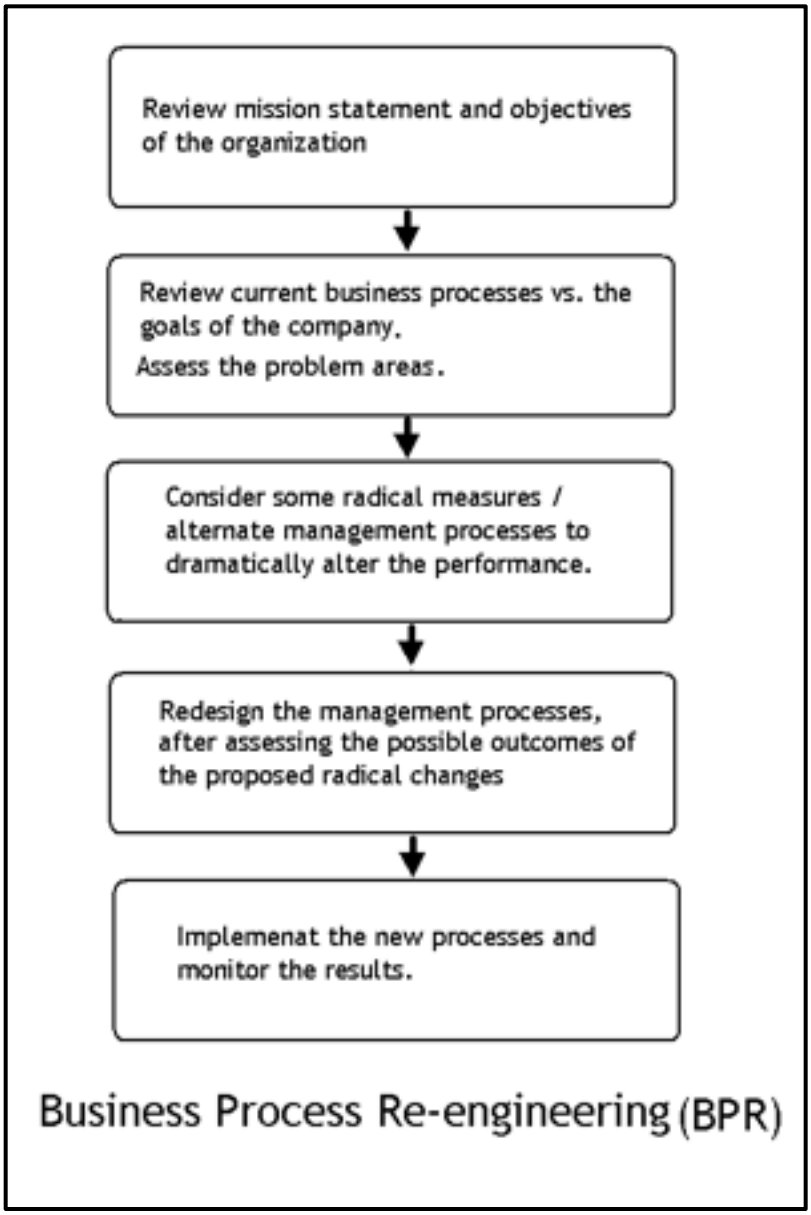
Business process reengineering (BPR) began as a private sector technique to help organizations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs, and become world-class competitors. A key stimulus for reengineering has been the continuing development and deployment of sophisticated information systems and networks. Leading organizations are becoming bolder in using this technology to support innovative business processes, rather than refining current ways of doing work.

Business process reengineering is one approach for redesigning the way work is done to better support the organization's mission and reduce costs. Reengineering starts with a high-level assessment of the organization's mission, strategic goals, and customer needs. Basic questions are asked, such as "Does our mission need to be redefined? Are our strategic goals aligned with our mission? Who are our customers?" An organization may find that it is operating on questionable assumptions, particularly in terms of the wants and needs of its customers. Only after the organization rethinks what it should be doing, does it go on to decide how best to do it.

Within the framework of this basic assessment of mission and goals, reengineering focuses on the organization's business processes – the steps and procedures that govern how resources are used to create products and services that meet the needs of particular customers or markets. As a structured ordering of work steps across time and place, a business process can be decomposed into specific activities, measured, modeled, and improved. It can also be completely redesigned or eliminated altogether. Reengineering identifies, analyzes, and redesigns an organization's core business processes with the aim of achieving dramatic improvements in critical performance measures, such as cost, quality, service, and speed.

Reengineering recognizes that an organization's business processes are usually fragmented into sub processes and tasks that are carried out by several specialized functional areas within the organization. Often, no one is responsible for the overall

performance of the entire process. Reengineering maintains that optimizing the performance of sub processes can result in some benefits, but cannot yield dramatic improvements if the process itself is fundamentally inefficient and outmoded. For that reason, reengineering focuses on redesigning the process as a whole in order to achieve the greatest possible benefits to the organization and their customers. This drive for realizing dramatic improvements by fundamentally rethinking how the organization's work should be done distinguishes reengineering from process improvement efforts that focus on functional or incremental improvement.



05.13. 02 History of BPR

In 1990, Michael Hammer, a former professor of computer science at the Massachusetts Institute of Technology (MIT), published an article in the Harvard Business Review, in which he claimed that the major challenge for managers is to obliterate non-value adding work, rather than using technology for automating it. This statement implicitly accused managers of having focused on the wrong issues, namely that technology in general, and more specifically information technology, has been used primarily for automating existing processes rather than using it as an enabler for making non-value adding work obsolete.

Hammer's claim was simple: Most of the work being done does not add any value for customers, and this work should be removed, not accelerated through automation. Instead, companies should reconsider their processes in order to maximize customer value, while minimizing the consumption of resources required for delivering their product or service.

This idea, to unbiased review a company’s business processes, was rapidly adopted by a huge number of firms, which were striving for renewed competitiveness, which they had lost due to the market entrance of foreign competitors, their inability to satisfy customer needs, and their insufficient cost structure. Even well established management thinkers, such as Peter Drucker and Tom Peters, were accepting and advocating BPR as a new tool for achieving success in a dynamic world. During the following years, a fast growing number of publications, books as well as journal articles, was dedicated to BPR, and many consulting firms embarked on this trend and developed BPR methods. However, the critics were fast to claim that BPR was a way to dehumanize the work place, increase managerial control, and to justify downsizing, i.e. major reductions of the work force, and a rebirth of Taylorism under a different label.

05.13.03 Definition of BPR

- BPR is fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service, and speed.
- BPR encompasses the envisioning of new work strategies, the actual process design activity, and the implementation of the change in all its complex technological, human, and organizational dimensions.

There is a major difference between BPR and other approaches to organization development (OD), especially the continuous improvement or TQM movement. Today firms must seek not fractional, but multiplicative levels of improvement – 10x rather than 10%.

Here is a description of BPR relative to other process-oriented views, such as Total Quality Management (TQM) and Just-in-time (JIT):

"Business Process Reengineering, although a close relative, seeks radical rather than merely continuous improvement. It escalates the efforts of JIT and TQM to make process orientation a strategic tool and a core competence of the organization. BPR concentrates on core business processes, and uses the specific techniques within the JIT and TQM ”toolboxes” as enablers, while broadening the process vision."

BPR derives its existence from different disciplines, and four major areas can be identified as being subjected to change in BPR - organization, technology, strategy, and people - where a process view is used as common framework for considering these dimensions.

Business strategy is the primary driver of BPR initiatives and the other dimensions are governed by strategy's encompassing role. The organization dimension reflects the structural elements of the company, such as hierarchical levels, the composition of organizational units, and the distribution of work between them. Technology is concerned with the use of computer systems and other forms of communication technology in the business. In BPR, information technology is generally considered as playing a role as enabler of new forms of organizing and collaborating, rather than supporting existing business functions. The people / human resources dimension deals with aspects such as education, training, motivation and reward systems. The concept of business processes - interrelated activities aiming at creating a value added output to a customer - is the basic underlying idea of BPR. These processes are characterized by a number of attributes: Process ownership, customer focus, value adding, and cross-functionality.

05.13.04 The Role of Information Technology

Information technology (IT) has historically played an important role in the reengineering concept. It is considered by some as a major enabler for new forms of working and collaborating within an organization and across organizational borders.

Early BPR literature identified several so called *disruptive technologies* that were supposed to challenge traditional wisdom about how work should be performed.

- Shared databases, making information available at many places.
- Expert systems, allowing generalists to perform specialist tasks.
- Telecommunication networks, allowing organizations to be centralized and decentralized at the same time.
- Decision-support tools, allowing decision-making to be a part of everybody's job.

- Wireless data communication and portable computers, allowing field personnel to work office independent.
- Interactive videodisk, to get in immediate contact with potential buyers.
- Automatic identification and tracking, allowing things to tell where they are, instead of requiring to be found.
- High performance computing.

15.13.05 Case Studies

BPR, if implemented properly, can give huge returns.

BPR has helped giants like General Motors Corporation, DELL Incorporated, Voltas ltd etc.

A) General Motors Corporation:

> General Motors Corporation implemented a 3-year plan to consolidate their multiple desktop systems into one. It is known internally as "Consistent Office Environment". This reengineering process involved replacing the numerous brands of desktop systems, network operating systems and application development tools into a more manageable number of vendors and technology platforms. This saved GM 10% to 25% on support costs, 3% to 5% on hardware, 40% to 60% on software licensing fees, and increased efficiency by overcoming incompatibility issues by using just one platform across the entire company.

B) Dell Incorporated:

> Michael Dell is the founder and CEO of DELL Incorporated, which has been in business since 1983. Michael Dell's idea of a successful business is to keep the smallest inventory possible by having a direct link with the manufacturer. When a customer places an order, the custom parts requested by the customer are automatically sent to the manufacturer for direct shipment to customers. This dramatically reduced the cost for inventory tracking and massive warehouse maintenance.

C) Voltas Ltd:

Material handling equipment unit of Voltas Ltd, Mumbai was initially manufacturing most of the components in-house for production of Fork-Lift-Trucks. This involved excessive labor and capital deployment, besides its inability to increase volume of

production. The critical / major items viz. gear box, drive Axle, and trail axle were manufactured using conventional machines such as horizontal boring, vertical boring, and radial drilling machines using elaborate toolings. This process involving too many operations, countless toolings, and excessive set-up time put a limitation on the production capacity besides resulting in long lead-time for deliveries. In a major BPR initiative, it was decided to offload most of the non-critical components to sub-contractors and CNC machines were installed to manufacture the critical / major components. This radical change enabled the company to double the production volume, halve the delivery lead-time, and double the profit.

05.13.06 Critique

The most frequent and harsh critique against BPR concerns the strict focus on efficiency and technology and the disregard of people in the organization that is subjected to a reengineering initiative. Very often, the label BPR was used for major workforce reductions. But the fact is, once out of the bottle, the reengineering genie quickly turned ugly.

Other criticism brought forward against the BPR concept include

- Exaggerated expectations regarding the potential benefits from a BPR initiative and consequently failure to achieve the expected results.
- Underestimation of the resistance to change within the organization.
- Implementation of generic so-called best-practice processes that do not fit specific company needs.
- Over trust in technology solutions.
- Performing BPR as a one-off project with limited strategy alignment and long-term perspective.

05.14.00 Material Requirement Planning (MRP)

05.14.00 Material Requirement Planning (MRP)

05.14.01 MRP Concepts

Economic order quantity models assume that the demand for an item is relatively constant and independent of demand for any other item.
When demand for material - components and raw material - is directly dependent upon the demand for other products, notably on production plan for end products, then we say the items have a **"dependent demand pattern".**

MRP is a computer based information system for scheduling production and purchases of dependent demand items. The basic philosophy and mechanics of MRP are simple. The system assumes that the end-product is made-up of a hierarchy of assemblies, sub-assemblies, components and raw material.

Basically, the computer explodes the Bills of material for various products / main assemblies and generates item wise gross and net material requirement(s) in line with a master production plan for end products / parts.

Using end product requirements, product structural data (Bill of Material) and lead time information, the MRP system traces back when assemblies, sub-assemblies, and components must be produced or ordered so that the items are available at appropriate time for further processing / for subsequent production steps, but no earlier than necessary to avoid excess inventories.

The power of computer would be evident, when we have a **multiple product** situation with **a dynamic demand** pattern, having a **complex hierarchy** and much **commonality** of items across various products.

05.14.02 MRP Inputs

05.14.02.01 Master Production Schedule

The master production schedule (MPS) is derived from:

A) An aggregate production plan based on forecast.
B) Customer orders.

C) Capacity limitations.

.

MPS is divided into time periods called **Time-buckets.** A time bucket could be a day, a week, a fortnight or a month. The time buckets need not be same for the entire scheduling horizon of MPS. For instance, we could use shorter time buckets such as a week, to plan short term requirements and longer time buckets such as a month to plan requirements months ahead.

The first short time bucket in the plan focuses attention on immediate shortages, to avoid production hold-ups for want of material.

Master Production Schedule (MPS) Example: Table 1

Sr. No	Model code	Description	Period-1	Period-2	Period3
1	D-2000	2 Ton Diesel Fork Lift Truck	5	7	8
2	D-3000	3 Ton Diesel Fork Lift Truck	7	4	5
3	E-1000	1 Ton Electric Fork Lift Truck	3	2	2
4	E-2000	2 Ton Electric Fork Lift Truck	4	3	2
5	Total Qty	Diesel/Electric Fork Lift Trucks	19	16	17

05.14.02.02 Bills of Material (BOM)

The bill of material file lists for each end-product, all main assemblies, sub-assemblies, components and raw material necessary to produce the product. A product hierarchy can be visualized by use of a product structure tree, having multiple levels.

Bill of Material for a Fork Lift Truck ▼

FORK LIFT TRUCK

Level -0 (Final Product): DIESEL FORK LIFT TRUCK (Model D-2000)

Level -1 (Major Assemblies)

1. Engine and transmission Assembly.
2.Drive Axle assembly.
3. Trail Axle Assembly.
4. Wheel Tyre Assembly.

Level -2 (Sub-Assemblies)

1a. Engine Assembly……. (Part of Engine and Transmission Assembly)
1b. Gear box Assembly…. (Part of Engine and Transmission Assembly)

2a. Differential Assembly ……... (Part of Drive Axle Assembly)
2b. Dr Axle Housing Assembly……. (Part of Drive Axle Assembly)

3a. Steering rod assembly……... (Part of Trail Axle Assembly)
3b.Trail Axle Assembly …… (Part of Trail Axle Assembly)

4a. Rim Assembly …….. (Part of Wheel & Tyre Assembly)
4b. Tires …….. (Part of Wheel & Tyre Assembly)

Level- 3 to Level-8… (Individual Components e.g. Gears, Counter-Weight etc)

!
!
Level -9..... (Raw Material / Castings / Forgings etc.)

15.14.02.03 Inventory Master Data Files

This data is required for MRP system to generate item wise gross and net material requirement quantity and sort the items in a desired order e.g. source code wise.
We can segregate high value items based on ABC code for closer inventory control.
We can have a separate list of critical items based on criticality code-VED code.
ABC Analysis and **VED Analysis** are valuable tools for "Inventory Control".
ABC analysis emphasizes on **value of inventory**, whereas **VED** analysis emphasizes on criticality of items, which might cause expensive production interruptions.

Table 3: ABC-VED Matrix:

	V	E	D
A	AV	AE	AD
B	BV	BE	BD
C	CV	CE	CD

We may classify material into 9 categories as above, for inventory control with the above codes.

Inventory master data fields:

This file contains master data on all stock items such as:

- Part Code:
- Description:
- Unit of Measure: (Kg, Lit, Nos etc)
- Source code: (Shop made, bought out component, bought out Raw Material etc)
- **ABC** code: ("**A" for high value, "B" for medium value and "C" for low value item**)
- Criticality code: **("V" for very critical, "E" for essential and "D" for desirable)**
- Buyer code

- Material class code: (Castings, Forgings, Steel Raw material, components, consumables, spares, hardware, proprietary items etc)
- Lead time for manufacture/purchase:
- Buffer/Safety Stock in days/weeks/months:
- Standard cost:
- Project Code:
- Store Location:
- Stock Qty:

05.14.03 MRP Logic and Mechanics / Outputs

05.14.03.01 Logic / Mechanics - Steps

A. Explode the bill of material (BOM) for an-end product and list "per unit quantity" of Major Assemblies, Sub–Assemblies, Components, raw material etc up to the last stage of BOM hierarchy.
B. Multiply the "per unit quantity" with MPS (Master Production Schedule) quantity for the respective time buckets.
C. This would give us gross requirement of components/raw material.
D. Match this quantity with stock in stores as per inventory master file / transaction file.
E. Calculate net requirement of material for all items for each time bucket. Net Requirement = Gross requirement minus stock quantity.
F. Offset this quantity to an extent of lead-time and shift the qty to the appropriate time bucket i.e. Schedule the item in such a way that it is received when required for subsequent production step / processing; not earlier and not later.

Example:

Plan quantity of Fork Lift Truck for the month = 10 Nos
Bill of material quantity of tyre per truck =4 Nos
Gross requirement of tyres = 4 x 10 = 40 Nos
Stock of tyres in stores = 20 Nos
Net requirement = 40 – 20 = 20 Nos

This sounds very simple indeed! The problem is one of logistics. A product with multi-level sub-assemblies may have thousands of parts distributed among various sub-assemblies at different levels. Commonality of some parts used in different products

makes the system more complicated. This is where the power of computers and the MRP program come into play.

05.14.03.02 MRP Outputs

Print the MRP outputs in any of the following formats, as may be required by the concerned department involved in production/inventory control/Purchase activities.

- ➢ Part code wise list, for use as a master reference list by PPC (Production Planning and Control Dept).
- ➢ Source code wise list for use by the department / section concerned.
- ➢ Source code / Buyer wise list, for use by a specific buyer.
- ➢ Only 'A' value items list, for inventory control of high value items.
- ➢ Criticality code wise list /VED code wise list, to ensure supply of critical items irrespective of value, for smooth and uninterrupted Production.

05.14.04 Updating of MRP and Benefits

05.14.04.01 Updating

MPS (Master Production Schedule) and MRP (Material Requirement Plan) are intended to be dynamic and need constant updating. We therefore need to determine the time horizon for iteration. We may, for instance, prepare MPS and MRP for 3 months (3 time buckets) at a time , but on a rolling basis ie make a 3 months plan in every month; showing figures for current and next two months.

05.14.04.02 Benefits

1. Optimal / Low Inventory levels.
2. Lower work in process.
3. Less interruption in production.
4. Easy tracking of material; stock and pending order status.
5. Dynamic scheduling of material deliveries in line with revised production plans.

05.14.05 Capacity Requirements Planning (CRP)

MRP ensures that material requirements are met. However, we also need to ensure that production resources such as machine-hours/man-hours are also available. Capacity

requirement planning (CRP) is very much akin to MRP. We can use MRP Model to make a capacity check.

Production Capacity = No of Machines or No of workers available x No of shifts per day x No of working hours per shift x utilization factor x Efficiency factor.

Utilization factor =

$$\frac{\text{Actual Machine hours worked (Net of breakdowns, absenteeism etc)}}{\text{Total machine hours available}}$$

$$\textbf{Efficiency factor} = \frac{\text{Output hours based on standard timings}}{\text{Actual input hours utilized}}$$

We have used BOM in MRP system/module as input.
Likewise, we use process plan / time standards (Equivalent of BOM) for each assembly/ sub-assembly/component as input for CRP (Capacity Requirement Plan).

We explode BOM and match gross requirement of material with stocks to get net MRP.

In case of CRP we explode the process standards for each assembly /sub-assembly/ components and work out gross requirement of machine-hour s and man-hours. Then, we match the gross requirement of machine-hours and man-hours with available capacity to see if we can meet the production plan with the available capacity. That is how we make a capacity check.

05.14.06 Examples of Material Requirement Plan (MRP) and Capacity Requirement Plan (CRP)

Let us take the case of a production plan for Worm and Gear assembly as an example for BOM and MRP / CRP.

Diagram: Worm Gear Assembly

05.14.06.01 INPUT DATA

05.14.06.01.01 BOM for worm gear assembly

Sr No	Part code	Description	Quantity	Input of Raw Material
01	W1	Worm	1	Metal bar : 1 ft
02	G1	Gear	1	Metal forging: 1 pc

05.14.06.01.02 Process time standards

Sr No	Part code	Description		Machine Capacity requirement
01	W1	Worm		Lathe 1 hour Milling Machine 2 hours
02	G1	Gear		Lathe 1 hour Gear Hobber 3 hours

05.14.06.02 Outputs

05.14.06.02.01 Material Requirement Plan

Let us assume that we plan to produce 100 worm gear assemblies per month.

Sr. No	Part code	Description		Reqt Month 1	Reqt Month 2	Reqt Month 3
01	W1-RM	Metal bar	Gross Reqt	100 ft	100 ft	100 ft
			Stock=150 ft			
			Net requirement	0	50	100 ft
			Lead time = 1 month			
			Offset requirement	50	100	0
Sr. No	Part code	Description		Reqt Month 1	Reqt Month 2	Reqt Month 3
01	G1-RM	Metal bar	Gross Reqt	100 Nos	100 Nos	100 Nos
			Stock=50 Nos			
			Net requirement	50 Nos	100 Nos	100 Nos
			Lead time= 1 month			
			Offset Reqt	150 Nos	100 Nos	0

05.14.06.02.02 Capacity requirement Plan

Let us assume that we have the following facilities, with 25 days working in the month and 8 hrs per shift.

Work centers and available capacity:

Sr. No	Work center code	Description	No. of Machines	Utiliz-ation factor	Eff. factor	Available Hours
01	L-01	Lathe	2	0.9	0.9	25x8x2x0.9x0.9 =324
02	M-01	Milling	1	0.9	0.8	25x8x1x0.9x0.8 =144
03	G-01	Gear Hobber	3	0.8	0.8	25x8x3x0.8x0.8 =384

Work centers and net requirement calculations:

Sr. No	Work center code	Description		Reqt Month1	Reqt Month2	Reqt Month3

01	L-01	Lathe	Requirement Available Shortfall Surplus	200 Hrs 324 Hrs --------- 124 Hrs	200 Hrs 324 Hrs --------- 124 rs	200 Hrs 324 Hrs --------- 124 Hrs
02	M-01	Milling	Requirement Available Shortfall Surplus	200 Hrs 144 Hrs 56 Hrs ---------	200 Hrs 144 Hrs 56 Hrs ----------	200 Hrs 144 Hrs 56 Hrs ---------
03	G-01	Gear Hobber	Requirement Available Shortfall Surplus	300 Hrs 384 Hrs --------- 84 Hrs	300 Hrs 384 Hrs ---------- 84 Hrs	300 Hrs 384 Hrs ---------- 84 Hrs

05.15.00 Manufacturing Resources Planning (MRP II) and Enterprise Resources Planning (ERP)

05.15.01 MRP II

05.15.01.01 Introduction to MRP II

While MRP that has grown out of traditional production and inventory management does an excellent job of planning for material, it cannot be fully effective in achieving the organizational objectives unless it takes into account all the resources of manufacturing organization.
Therefore, planning for requirement of material has to take into consideration:

- The business plans.
- The financial plans.
- The human resources.
- The available production facilities (Machinery/Equipment).
- The logistics (Shipping etc).

Because of these needs and considerations there evolved an integrated manufacturing management system called “manufacturing resources planning (MRP II)”

We are using the term MRP II for “Manufacturing Resources Planning” just to distinguish it from MRP which represents “Material Requirement Planning”.

05.15.01.02 Definition of MRP II

MRP II has been defined by “American production and inventory control society” (APICS) as:

“MRP II is a method of effective planning of all resources of manufacturing company. Ideally it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer “What if?” question. It is made up of a variety of functions each linked together: Business Planning, Production Planning, Master Production Scheduling, Material requirement Planning, Capacity Requirements planning, and the execution system for capacity and priority. Outputs from these systems integrated with financial reports, the business plan, the purchase commitment report, shipping budget, inventory etc.”

05.15.01.03 Role of Information Technology

The advanced Information Technology has made this integration of entire manufacturing function, rather than addressing just a single task within that function in isolation, possible.

05.15.01.04 MRP II Concepts / Modules

The newer system, called MRP II, contain the classical MRP scheduling function as their centerpiece.

MRP II system may include a **module** that collects sales and customer order data and generates an **MPS** (Master Production Schedule), using a **forecast model.**
In addition, an MRP II system may convert information from the material requirement plans into specific work schedules for departments and machines, evaluate department work loads and capacity conditions, generate shipping documents and customer invoices , and produce **management reports on production and financial performance.**

MRP II systems are an expansion of **MRP** to inter connect with and support other activities, but the basic method used to generate material requirement plans is the same.

In our earlier examples enumerated in Para 6.0, we have a module that integrates "Material Requirements Plan **(MRP)"** and "Capacity Requirement Plan **(CRP)"**

05.15.02 Enterprise Resource Planning (ERP)

05.15.02.01 Concept of ERP

Manufacturing Resource Planning (MRP II), deals with only **manufacturing resources.** With the advent of **globalization** this is found be somewhat inadequate.

Some aspects of globalization:

a) Intense competition.
b) Large-scale operations.
c) Mega Investment Plans.

d) Multiple currencies.
e) Multiple trade rules and regulations.
f) Complex logistics/distribution network.

It was no longer just manufacturing resources, but all the resources of entire enterprise needed integration, such as:

a) Marketing.
b) Order processing.
c) Product design.
d) Production planning and control (PPC).
e) Materials Management/Inventory control.
f) Production processes.
g) Quality management.
h) Logistics.
i) Human Resources.
j) Research and development.
k) Accounting.
l) Finance.

Such an enterprise-wide system of management is known as the ENTERPRISE REOURCE PLANNING (ERP)

ERP software is an integrated software program that allows various functional departments to share information and communicate with each other, on a common platform.

ERP provides a holistic view and enables an organization to look at itself as well as outwards in to the Market, globally.
All the departments that were islands once are effectively interconnected with the introduction of **ERP.**

05.15.02.02 Benefits of ERP

1. ERP provides up-to-date and uniform information across the organization.
2. ERP integrates, linking all the functional departments and divisions.

3. ERP software embeds best practices followed by successful corporations.
4. ERP helps managers to obtain comprehensive information instantaneously for appropriate decision making with speed and quality.
5. ERP integrates work flow in the entire organization.
6. ERP enables an organization to respond to market needs with great agility.
7. ERP enables identification of problem areas that need improvements.
8. ERP reduces drudgery and consequently enables creativity and innovation.

05.15.02.03 Steps in ERP Implementation

1. Identify the need for introduction of ERP.
2. Assess the readiness of the organization for ERP in terms of Management skills and employee attitudes.
3. Assess the costs of installing ERP and ability of the organization to finance the project.
4. Locate a software vendor.
5. Select the persons to coordinate with consultants and ERP software vendors.
6. Document the old process➔Document and evaluate new process➔Apply Models to assess results➔Iterate the process and revise➔Consolidate the new process.
7. Select the software and a suitable vendor or its associate to do the job. Consider all factors such as the credentials of the software vendor, degree of specialization, obsolescence of the package, Price of the package, cost of implementation, ease of implementation and after-sales support offered by the vendor or its associates.
8. Draw up a plan of implementation:
   a) Form a team for implementation.
   b) Train the team.
   c) Map the business process onto the package.
   d) Organize the systems/data base as may be required by the package.
   e) Customize where required.
   f) Prepare a schedule of implementation and test runs.
   g) Organize user training.
   h) Implement ERP seamlessly across the organization, gradually.

05.15.02.04 Leading ERP Software Vendors

A) SAP is a German Company. Its flagship product is SRP R/3. It meets the needs of modern day corporations that have global accounting standards, modern business practices, multiple currencies, multiple languages, multiple products etc. P&G, LG and HP in India have implemented SAP.

B) BaaN is a company that operates from The Netherlands as also from California, USA. BAAN IV package can take care of alignment with the changing business processes and organization models. It enables use of Dynamic Enterprise Modeling.

C) Other companies in ERP software packages are PeopleSoft, Oracle, JD Edwards and Gartner etc.

05.15.03 What Next? ERP II

ERP II is a web-enabled system that operates seamlessly across different organizations. Useful in multi-organization supply chains involving e-commerce. SAP R/3 and Oracle are two such applications used for B2B e-commerce.
Gartner has come out with ERP II to position an enterprise in supply and value chain.

05.15.04 Case study

Let us take the case of an export oriented unit dealing in specialized silk fabric.
When an enquiry for a large order arrives from a foreign country, we need to quote quickly and confirm the order immediately on receipt.
We need to collate the information regarding stock in warehouse, power loom capacity, dying unit's present load and capacity, availability of a particular grade of silk yarn, delivery lead times and capacity of suppliers.
In addition, the price has to be quoted in foreign currency considering price fluctuations for raw material in the international market, the internal cost of production, and the costs of dispatch and delivery. Statutory taxes also need to be considered carefully while quoting and invoicing.
Of course, the price has to be competitive in the international market to bag the order.
On receipt of the order, we also need to take all actions to deliver the consignment(s) in proper time, for credibility as also to secure further orders from the customers in future.
Order fulfillment with adequate profit margins is the key success factor.
The whole process of order receipt and order execution has to be carried out in an interactive way.

ERP could make all this possible.

Generally, ERP has a central database and a cross-enterprise interface facility shared by all functions of the enterprise. ERP offers a total solution by virtue of seamless integration across all functions and divisions of an enterprise.

In this case of export of silk fabric, ERP enables us to act promptly at all stages of order execution and take corrective actions when ever required, by virtue of having access to relevant and reliable information, almost instantaneously.

We could monitor progress of order execution closely from start to finish.

05.16.00 Productivity

For any system, productivity is defined as ratio between output and input.
In earlier days of industrial management, the term productivity generally meant labour productivity.

Productivity is the ratio of outputs of goods or services from the conversion process to inputs consumed in generation of these outputs.

Labour productivity alone will not give overall results. This is where management productivity comes in to play.

There are many ways of measuring productivity. Very often, it is situation-dependent.

05.16.01 Some Ways of Measuring Labour Productivity

- ➢ Worker productivity = Workers' output expressed in standard hours / Actual hours worked.
- ➢ Labour productivity = Workers' output expressed in Rupee Value / Workers' wages expressed in Rupee Value.
- ➢ Group productivity = Number of units produced / Number of man-hours taken.

05.16.02 Managerial Productivity Measures

- ➢ Number of Tons of Aluminum produced / Number of units of power consumed.
- ➢ Number of units of power generated / Quantity of Gas consumed (Kg).
- ➢ Number of units produced / Number of persons employed.
- ➢ Material Productivity = Production output Value / Material Value consumed.
- ➢ Capital Productivity = Value added / Capital employed.
- ➢ Inventory Turnover = Sales / Inventory.
- ➢ Receivables Turnover = Sales / Amounts Receivable.
- ➢ Value added per employee = Value added / Number of employees.

05.16.03 Multi Factor Productivity

However, such single productivity measures considered in isolation may not yield desired results. Improvement in one measure could lead to deterioration elsewhere.
Total Factor Productivity = Production Value / [Cost of Labour + Cost of Material + Cost of Overheads]

Example

If 180 pieces are produced at a standard price of Rs 500 each, with labour cost of Rs 4,000, material cost of Rs 20,000, and overhead cost of Rs 12,000, the Multi-Factor-Productivity would be:

MFP= [180 x 500] / [4,000 + 20,000 + 12,000] = 2.5.

05.16.04 Efficiency and Effectiveness

There should not be efficiency for efficiency sake. Some work may be done at a high efficiency, but the work itself may be totally unnecessary.
Ask a question "Why to performs a particular function" rather than ask "How to perform a function."
The question is whether we are doing the right thing; a thing of value to the customer. What we do has to be effective not merely efficient.

05.16.05 Some Ways of Improving Productivity

- TQM (Total Quality Management); Ref. Chapter 07
- BPR (Business Process Reengineering); Ref. Chapter 05.13.00
- Bench Marking; Ref. Chapter 07.10.01

A company must have a basis of establishing performance goals. The basis for comparison could be the best practice in the Industry, which process is known as BENCH MARKING.

05.16.06 Types of Bench Marking

05.16.06.01 Internal Bench Marking: Follow the best practice of another efficient department, in the same organization.

05.16.06.02 Competitive Bench Marking: Follow the best practice of a successful competitor.

05.16.06.03 Functional Bench Marking: Follow the best and relevant practices, within the same broad Industry, not necessarily in direct competition.

05.16.06.04 Generic Bench Marking: Some practices are same regardless of type of business, such as billing and collections. We could emulate any successful organization in the relevant aspect of business, not necessarily in the same type Industry.

05.16.07 Some measures to increase productivity

- ✓ Be clear about your goals and align all actions towards meeting these goals
- ✓ Follow the right and relevant management techniques: TQM, BPR, Benchmarking etc…
- ✓ Look for effectiveness, more than mere efficiency.
- ✓ Be customer oriented and Provide value to customer.
- ✓ Encourage creativity.
- ✓ Empower the people involved.
- ✓ Assign right jobs to the right people.
- ✓ Make the organization flexible.
- ✓ Keep things simple.
- ✓ Remember - “Honesty is the best policy.”

05.17.00 Plant/Facilities Location Planning

05.17.01 Introduction

Facility **L**ocation **P**lanning (**FLP)** may be viewed as a part of planning the conversion system in Production and Operations Management.

Facility Location Planning is the process of determining the physical / geographical location of manufacturing, service and the associated facilities of an enterprise.

- ➢ **FLP** involves large capital outlays that are not easily reversible.
- ➢ **FLP** has long-term implications in terms of revenues and costs.
- ➢ Efficiency and effectiveness of conversion process heavily dependent upon the Location of facilities.

05.17.02 FLP and Organizational Strategies

The Location decision is an integral part of organizational strategies.
Strategy is the determination of the basic long term goals and objectives of an enterprise, and adoption of a course of action and allocation of resources necessary for achieving these goals. In addition, all strategies must be aligned with the customer needs.
The facility location must be aligned with the strategies of an enterprise.

FLP is a product of all the strategic considerations of an enterprise, such as:

- Marketing Strategy.
- Technology Strategy.
- Resources Strategy.
- Financial Strategy.

All strategies feed into one another. As shown in the following diagram, a marketing strategy may suggest a necessary technology strategy (Product, process etc).
A technology strategy may suggest a resource strategy (Regional availability of skills material etc). Financial strategy feeds into all other strategies; and the reverse is also true.

Therefore, the **FLP** must be aligned with organizational strategies and in turn, all the strategies must be aligned with each other.

Alignment of inter related strategies:

05.17.03 Choice of Region / State

Factors to be considered are:

1) Organization strategies.
2) Location of existing facilities, if any.
3) Managerial control considerations and capabilities.
4) Regional environment considerations such as economic, legal, social, geographical and labour productivity aspects etc…
5) Transportation costs to move Raw material/ components and finished goods etc…
6) Industrial policy of the State/region; Tax considerations, Backward area benefits etc…

05.17.04 Choice of Location within the Region / State

Factors to be considered are:

1) Cost considerations (Cost of Land / Building).
2) Proximity to suppliers of raw material and components.
3) Proximity to customers.
4) Availability of skilled / unskilled labour.
5) Availability of infra structure (e.g. Housing, Amenities, Transport, Communications, Services- Electricity & water supply etc…)
6) Climatic conditions for specific Industries / Services (e.g. Textile / Yarn production, Holiday Homes, Beach Resorts, Water sports etc…)
7) Safety and environment (e.g. Chemical and pharmaceutical industries).
8) Integration of the whole business (Location of Head quarters, Factories, Ware Housing, Marketing network etc…)

05.17.05 Globalization and Foreign Locations

Globalization has arrived and it is here to stay. Trade and capital flows are freer. Multinationals set up facilities all over the world. There are Indian companies operating from USA, Europe and China etc.

05.17.05.01 Virtual Proximity

Example: Software Industry can operate from any where in the world due to advancement in the field of Communications. This is a case of virtual location.

05.17.05.02 Virtual Factory Concept

An India BPO firm is a virtual factory of a foreign Company, sub-contracting Jobs to India. Call centers are virtual factories.

Likewise, India can have a factory in USA employing American citizens and the "distinction between a foreign company and a local company" diminishes and the Indian company becomes a "***virtual local".***

05.17.06 Reasons for Foreign Locations

Tangible reasons:

1) Capturing Market share and reaching foreign customers.
2) Host country may offer tax advantages.
3) Lower cost of manufacturing / providing service.
4) Lower cost of material.
5) To overcome tariff barriers (e.g. Import Duty).
6) To build a global brand / brand equity.

Intangible reasons:

1) Customer confidence due to proximity.
2) Technological Environment (Availability of suppliers of Hi-Tec parts, research facilities, Educational Institutions etc…)
3) Possibility of learning from foreign customers and competitors.
4) Closer contact with foreign suppliers.
5) The firm becomes a **"virtual local".**
6) Reduction of supply risks.
7) Insurance against fluctuating demand in the local market.

05.17.07 Break even Analysis / Trade offs Between Costs and Revenues

Major considerations are:

A) Revenues

Revenues may depend on having a facility near the customer; especially services.

B) Fixed Costs

Fixed Costs (Capital Investment).
The magnitude of land and construction costs depends on location of plant.

C) Variable Costs

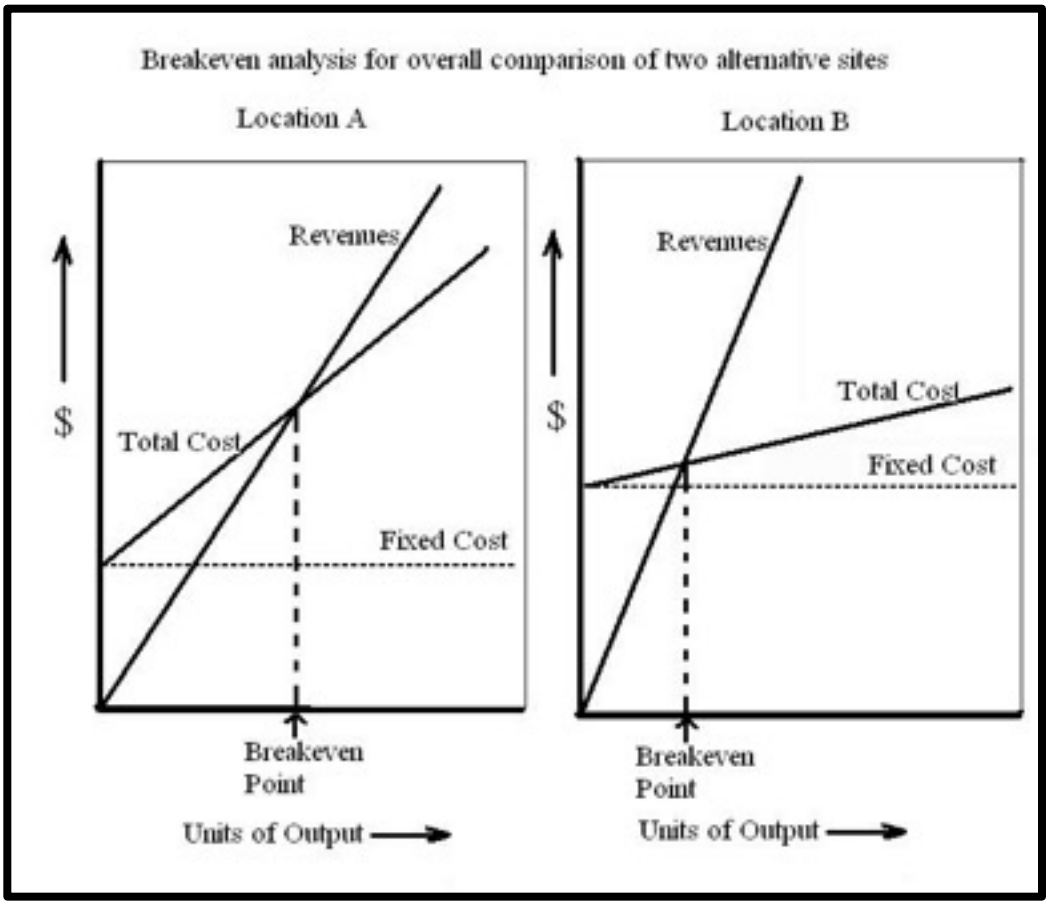
Factors influencing variable costs:

1. Availability of labor locally and wage structure.
2. Nearness to Sources of Raw Material and components (Lower in transportation costs).
3. Nearness to customers (Lower Transport costs and lower service costs).

In order to decide on a location, some trade offs must be made among Fixed & Variable costs and Revenue Potential.

The final location-choice should be the one that offers the best overall balance.

Break-even analysis for overall comparison of two sites is illustrated in the following graph.



Location A has a lower fixed cost and lower revenue potential.
Location B has a higher fixed cost, but has a higher revenue potential. Here, the break even level is lower in spite of higher fixed / capital cost.
Location B may be preferred in spite of higher investment.

05.17.08 Quantitative Techniques

Consideration of minimal transportation cost:

Let us examine a case where we have, presently, 3 factory locations and 2 raw material sources.
How do we decide on a 3rd raw material source / location of new supply facility in case of expansion of production?

We may use transportation model for an optimal solution.

Destination ► Source ▼	D1	D2	D3	Shipments available
S1	C11	C12	C13	300
S2	C21	C22	C23	400
S3	C31	C32	C33	200
Shipments Needed ➔	200	300	400	

Cost Matrix

S = Source of Raw material; D= Destination (Factories); C= Cost of transport per truck/ shipment
S1 and S2 are the existing sources
Let S3 be the new source of raw material.

Suppose we have narrowed down our third source to two alternatives for S3, we can make two corresponding cost matrices and evaluate optimal distribution and consequent total costs. We then choose a new location of raw material with the minimum-transportation cost option.

05.17.09 Limitations of Strategic Models: Behavioral Impacts and Cultural Differences

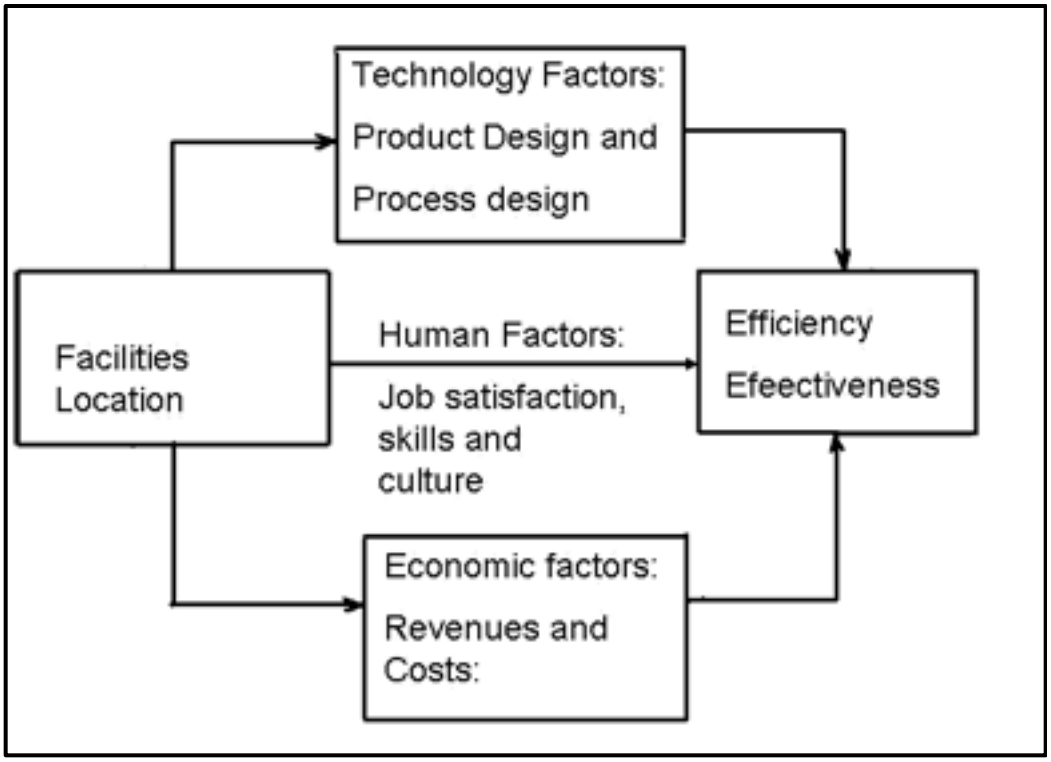
The models focus on costs and an optimization-model's results are deceptively precise. But, human aspect is more critical, especially in case of cultural differences among people at various geographical regions. More so, in case of a foreign locations, involving significant cultural differences.
New location means new environment and affects overall management.
Recruitment, transfers, training, and acclimatization pose problems.

Cultural differences at international level – country-to-country differences - are difficult to manage.

For instance, in west less supervision is required whereas in developing countries more supervision is required. Consequently, the organization pyramid is flat in the west and it is steep in India, which is top heavy. In extreme cases there could be an inverted pyramid type of Organization, with inadequate staff at the cutting edge level; and of course this is an exaggeration.
The following behavioral aspects need to be considered while deciding on a foreign location.

- In under developed world, there is a shortage of skilled labour. Most people are unemployable.
- In the developed world, the employees are out priced. High cost of labour inhibits profitability.
- Work ethics are different in different countries.
- Cultural differences exist at inter national level.

Factors influencing facility location planning:



05.17.10 Dimensional Analysis / Intangibles

Dimensional Analysis

It is easy to decide on a plant location if all the factors can be quantified. However, there are many intangible factors – such as educational facilities for children – that need to be considered in determining the location of a plant. In most cases, the intangibles are better expressed in relative terms than in absolute terms. The rela1ive merits / demerits of two alternative sites can be compared easily. For instance, one site may be considered twice as good as another; with respect to available facilities for education of the children.

Bridgeman's Dimensional Analysis consists in comparing these relative merits (or cost ratios) for each of the cost items, giving each of the ratios an appropriate weightage by means of the power (index) to which it is raised, and multiplying these weighted ratios in order to come up with a comprehensive figure on the relative merit of the two alternative sites

Thus if,

$C1^M$, $C2^M$, ……. Cz^M are the different costs associated with the site M on z different cost items

and

$C1^N$, $C2^N$, ……. Cz^N are the different costs associated with the site N on z different cost items

And

W1, W2 …… are the weightages given to these cost items, and then the relative merit of site M and site N is given by:

$$\left[\frac{C_1^M}{C_1^N}\right]^{W_1} X \left[\frac{C_2^M}{C_2^N}\right]^{W_2} X \cdots\cdots \left[\frac{C_z^M}{C_z^N}\right]^{W_z}$$

If this is > 1, it means the site N is superior and vice versa.

Let us illustrate this with an example as follows.

Costs ► Site ▼	Labour	Power	Educational Facilities (score)	Entertainment Facilities (score)

M	Rs 1,50,000	Rs 40,00,000	2	2
N	Rs 1,00,000	Rs 25,00,000	6	4
Weightage	1	1	2	2

Substitute these values in the above formula to get the relative cost of site M to site N.

Then the relative cost of site M to site N is:

$(1,50,000/1,00,000)^1 \times (40,00,000/25,00,000)^1 \times (2/6)^2 \times (2/4)^2 = 0.0666$

Thus site M is much preferable to site N, although the tangible costs (Labour and power costs) are higher for site M, as the effect of intangibles is overwhelming.

05.18.00 Plant/Facilities Layout Planning

05.18.01 Introduction

Facilities Layout refers to the placement of Departments, work groups within departments, workstations, machines and stock holding points within a production facility. A good layout ensures smooth flow of work, material, persons and information.

05.18.02 Factors affecting Layout

05.18.02.01 Flexibility

A good lay out should be flexible enough to respond to changes in conditions, such as technology, process, volumes etc
Certain facilities such as water piping, drainage, storage of material, electric cables etc , once setup, can not be easily altered easily at a later date. Ample provision and flexibility must be incorporated at the outset.

05.18.02.02 Flow of Work, Material and Personnel

Work and material must flow long designated patterns.
The entry into and exit from a functional area should be coordinated in such a way that it is convenient to issuing and receiving departments. There should be minimal back tracking of material. Zigzag movement of material must be avoided.

05.18.02.03 Use of Space

Space should not be visualized only as floor space, but must be seen volumetrically. Overhead space can be utilized to run cables, pipelines and conveyors. Sometimes tools can be suspended from the ceiling. Visibility of entire space is important for supervision.

05.18.02.04 Working Environment

Working environment must be conducive:

- Lighting should be adequate.
- Excessive sunlight, noise, vibrations, draughts, heat etc must be minimized.
- Safety is another important factor: e.g. storage of chemicals and inflammable material must be isolated and safety measures taken.

- Facilities: Rest areas, drinking water, wash rooms, medical/first aid facilities etc must be provided adequately and in keeping with industrial regulations.

05.18.03 Basic Production Layout Formats

- ➢ Process Layout.
- ➢ Product Layout.
- ➢ Fixed position Layout.
- ➢ Cellular manufacturing Layout (Group Technology / Hybrid Layout).

05.18.03.01 Process Layout (Functional Layout)

In this type of layout, all machines and equipment which perform the same function are grouped together.

Examples:

- All lathes are installed together in a machine shop.
- All welding machines are located together in a fabrication shop.
- All painting equipment is placed in a paint shop.

The jobs are routed through various shops catering to particular operations, as per the sequence of operations for the job. This is ideal for batch production.
This is also a suitable method in Hospitals: Surgical wards, IC units, Testing Labs etc.

05.18.03.02 Product Layout (Flow Line Layout)

In this layout, equipment and work processes are arranged in the progressive steps in which the product is made. The workflow follows a straight line.
Examples: Cement Plant, Automobile Production, Steel Plant, Chemical Plant etc

05.18.03.03 Fixed Position Layout

In a fixed position layout, the product stays fixed at a particular location because of its bulk and size. The worker teams and equipment move to the work site.
Examples:

- Ship Building.

- Bridges.
- Huge furnaces.

Equipment used more frequently is positioned closer to the product.
Material is arranged around the job based on process requirement.

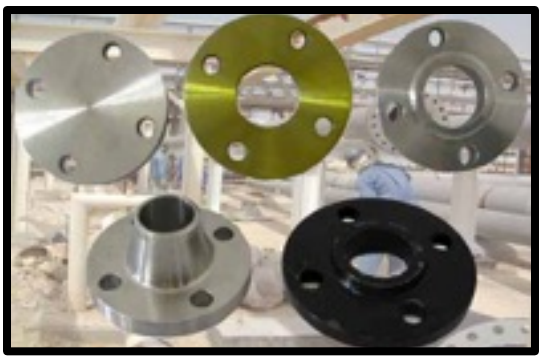
05.18.03.04 Cellular Layout / Group Technology Layout

In this type of layout, dissimilar machines are grouped together into a work center which manufactures a family of products having similar processing requirements. This is also known as Hybrid layout. This layout is akin to process layout in as much as the machines perform different processes. This layout is also similar to product layout as the machines are grouped to perform processes required by a limited set of products or a family of products.

Examples; Families of products:

- Pistons.
- Flanges.

PISTONS



FLANGES

05.18.03.04.01 Benefits of Cellular Manufacturing

✓ Reduced setup times. We have common set up for several components.

- ✓ Reduced idle time. There are always some components to manufacture.
- ✓ Reduced Inventory. We manufacture only what is needed.
- ✓ Reduced Material handling. All operations are carried out at a single location.
- ✓ Easier production planning. All items are similar.
- ✓ We have better technology absorption due to specialization.
- ✓ We have better quality control.

05.18.04 Layout Techniques

05.18.04.01 Process layout - Load-Distance Model

Let us take the case of a mfg unit with 8 departments A, B, C, D, E, F, G and H.
Each dept size= 10 meters x 10 meters
Total area= 20 meters x 40 meters
Distance between adjacent departments = 10 meters (center to center).
Cost of moving one load (a Bin or a Pallet) by a distance of ten meters = Rs 1
Possible movements are recti-linear.
Layout/Positions:

B	D	E	H
A	F	G	C

Layout (Location of various departments)

Number of Loads between the departments are tabulated in the following matrix.

Dept	A	B	C	D	E	F	G	H
A		180	60	20	40	240	30	35
B			10	110	90	100	90	100
C				20	95	140	100	200
D					20	30	30	20

E						5	200	220
F							380	100
G								10
H								

Matrix of number of loads between departments

[Load] x [distance] calculations for the Layout in Fig 3 above are as follows:

1. Calculations for movement from A to B:

Distance = 10 Meters
No of Loads = 180
Cost of movement = Rs 180 (@ Rs 1 for 10 meters per load)
= [180] Loads x 10 meters x Rs [1] / [10] meters = **Rs 180**

2. Similarly make calculations for movement from A to C:

Distance = 30 meters.
No of Loads = 60
Cost of movement = [60] Loads x [30] meters x Rs [1] / [10] meters = **Rs 180**
3. Similarly make calculations for movement from A to D:

Distance = 20 meters.
No of Loads = 20
Cost of movement = [20] Loads x [20] meters x Rs [1] / [10] meters = **Rs 40**

Likewise, calculations can be made for all the movements of loads in the matrix.

Department Pair	**Number of Loads**	**Distance**	**Cost of Movements (Rs) @ Rs 1 per 10 Meters**
A-B	180	10	180
A-C	60	30	180
A-D	20	20	40

A-E	40	30	120
A-F	240	10	240
A-G	30	20	60
A-H	35	40	140
B-C	10	40	40
B-D	110	10	110
B-E	90	20	180
B-F	100	20	200
B-G	90	30	270
B-H	100	30	300
C-D	20	30	60
C-E	95	20	190
C-F	140	20	280
C-G	100	10	100
C-H	200	10	200
D-E	20	10	20
D-F	30	10	30
D-G	30	20	60
D-H	20	20	40
E-F	5	20	10
E-G	200	10	200
E-H	220	10	220
F-G	380	10	380
F-H	100	30	300
G-H	10	20	20

		TOTAL	**4170**

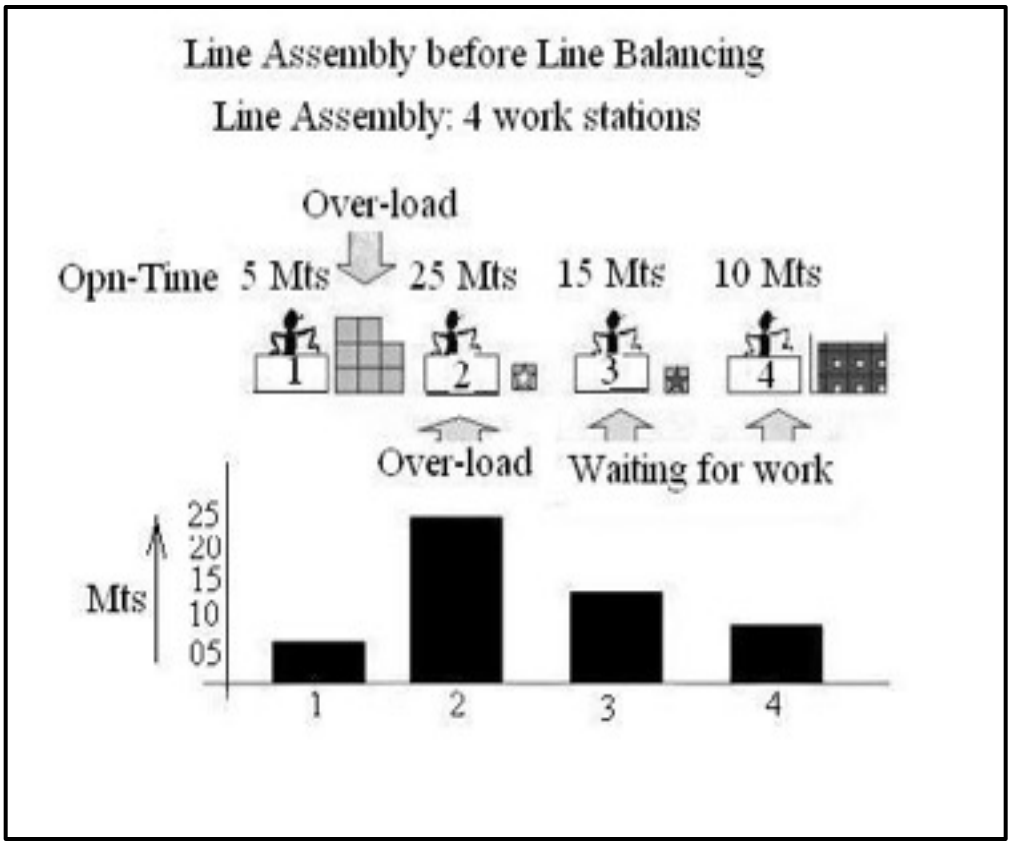
We can also use a software package called **CRAFT** (**C**omputerized **R**elative **A**llocation of **F**acilities **T**echnique). CRAFT is similar to the method shown above, where in we give an initial layout input. We try various combinations and select the least cost option.

05.18.04.02 Concept of line balancing

Every workstation takes same amount of time for the prescribed job(s) and variation is 'smoothed' and no one is waiting.

Everyone is working together in a **BALANCED** fashion.

Example:

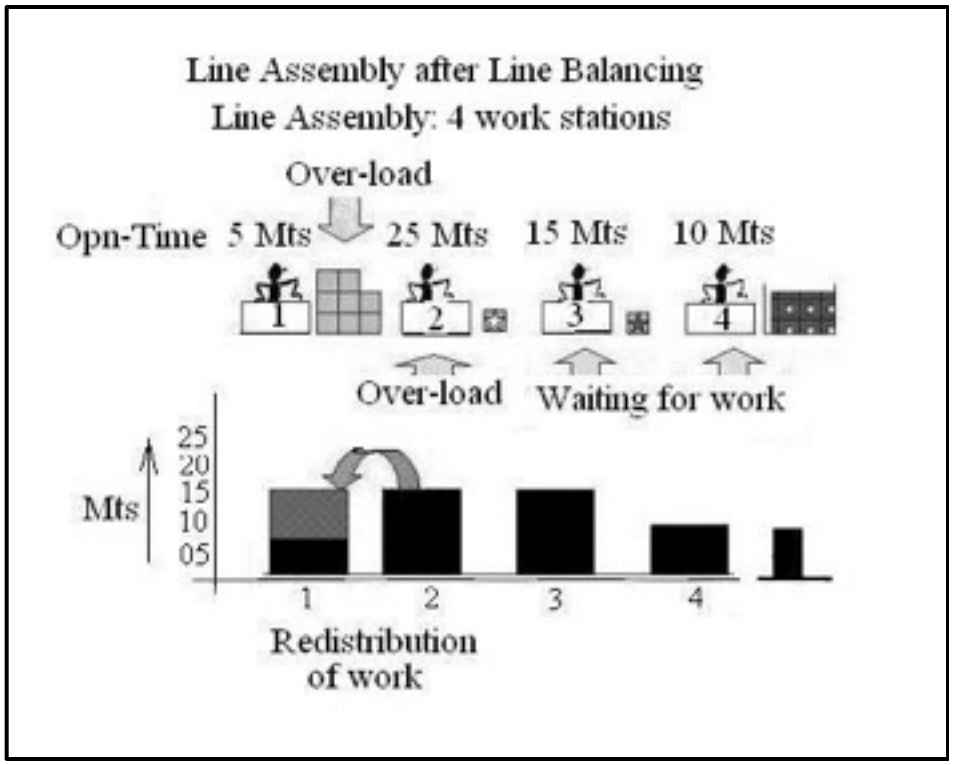


Here we see operator number 1 (with lower cycle time) is over-producing, thus creating wastes. We simply re-balance the work content (Redistribute some of the work or

combine operations or increase/alter the capacity at any workstation, to balance the times at all workstations), using a line balancing technique.

We now transfer 10 minutes' work from station 2 to station 1

The cycle time goes down to 15 minutes from 25 Minutes as both work stations 1 and 2 have equal load of 15 minutes.



Balanced work load and uniform cycle time after line-balancing (after transfer of work load from station-2 to station-1)

05.19.00 Maintenance Management

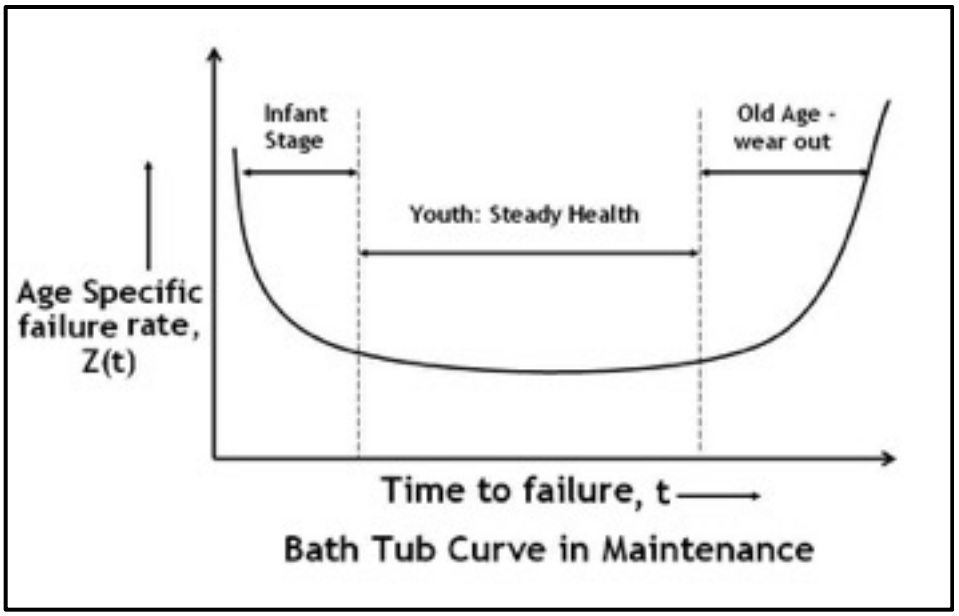
05.19.01 Primary objective of maintenance management: Maximum availability of the operating system.

The objective of maintenance is to facilitate the optimal use of capital equipment through actions such as replacement, repair, service, modification of machinery so that these would continue to operate at a specified availability.
Availability = t-running / (t-running + t-down).
t-running = Total time of operating in normal state.
t-down = Total time of which the plant is out of operation.

05.19.02 The availability of a plant can be improved by various means such as:

1. Early diagnosis of faults.
2. Preventive maintenance programs.
3. Design and installation of equipment in such a manner as to maximize. maintainability; E.g. easy access of components in the equipment for repairs
4. Suitable replacement policy.
5. Standard times and standard procedures for maintenance of equipment.

05.19.03 Bath Tub curve in Maintenance



When the machine is new, it may have teething problems and failure rate may be high initially. Over a short period, the failure rate comes down exponentially as debugging goes on.
In youth, the maintenance problems are few and the probability of failure is constant.
In old age, the machine deteriorates rapidly due to wear out of parts.

05.19.04 Preventive Maintenance

Preventive maintenance is alternatively known as planned maintenance.

05.19.04.01 Preventive maintenance includes the following:

- Usual care of equipment such as lubricating, cleaning, adjusting/resetting etc…
- Periodic inspection and overhauling of the equipment and scheduled replacement of parts.
- Contingent work at regular intervals when equipment is down e.g. changing of furnace lining etc…
- Condition monitoring of high cost critical equipment, based on certain parameters: temperature, vibrations, noise, corrosion, leaks, lubricants etc…

05.19.04.02 Benefits of Preventive Maintenance:

- Reduction in total down time.
- Reduction in the number of major repairs.
- Reduction in rejection of the produce.
- Reduction in the inventory of spare parts.
- Reduction in the number of accidents.
- Increased life of the plant.

05.19.04.03 Costs Associated with Preventive Maintenance:

- Scheduled down time of production.
- Replacement of parts.
- Instrumentation in case of condition monitoring.
- Wages of preventive maintenance staff.

There has to be a balance in allocation of resources for preventive maintenance and break down maintenance.

In designing a preventive maintenance program, the failure statistics would be of much use. There has to be trade off.
We may treat failures as arrivals in a Queuing theory model. The number of service technicians (mechanics/engineers) would be the number of servers. The costs of different strategies, with different number of servers may be compared in order to arrive at an optimal solution as to the allocation of resources for preventive and break down maintenance.

05.19.04.04 Replacement Policies

Example: Replacement of special purpose bulbs in a system of illumination.

Four replacement policies are possible.

1. Independent breakdown replacement - Replace bulbs when they actually fail.
2. Group break down replacement - Replace the entire group when one bulb fails.
3. Individual preventive replacement - Replace each bulb after certain number of days.
4. Group preventive replacement - Replace all bulbs at fixed intervals while replacing failed bulbs individually.

Exercise:

Following is the data available on the failure of 10 identical special purpose bulbs.

Time in months	Failure probability
1	nil
2	nil
3	nil
4	.05
5	.15
6	.30
7	.25
8	.15

9	.10

Cost of replacing a failed bulb individually = Rs 100
Cost of preventive replacement of a bulb=Rs 70
Cost of replacing all 10 bulbs at a time = Rs 500
Calculate the cost of each strategy. What is the lowest cost option?
Answer:

Cost of Independent replacement = Rs 151.5 pm
➔ **Lowest Cost Option:** Cost of Group replacement = Rs 106.22 pm
Cost of Individual preventive replacement = Rs 147.83 pm
Cost of Group preventive replacement= Rs 137.50 pm

05.19.05 Total Productive Maintenance (TPM)

So far, we had assumed that breakdowns are inevitable and hence the trade-off or compromise between preventive maintenance and breakdown maintenance; or, hence computations for optimal stock of spares. Once there is a compromising attitude in maintenance, it leads to compromise in other areas – may be in quality.

Japanese have shown a path to the world of management by working towards the ideal goals of zero breakdown and zero defects.

Lesser the breakdowns, lesser would be the number of defects in the produce.

Breakdown of equipment can occur in the following ways.

1. Equipment stops functioning.
2. Equipment deteriorates e.g. lowering of speeds / yields etc…
3. Equipment has hidden defects, which are not evident until a total breakdown situation.

All these breakdowns are to be eliminated.
There is no room for trade-off or compromise.

THIS IS THE RATIONALE BEHIND THE TPM (Total Productive Maintenance) CONCEPT.

TPM includes:

1. Elimination of all types of breakdowns.
2. Autonomous maintenance by operators. Prevention of maintenance itself through their suggestions for improved design of machines, processes, systems, materials and products.
3. Company-wide participation of all employees through small group activities and continuous improvement.

05.19.06 Evolution of Maintenance Management

Stage I	Total Operations Orientation	Breakdown Maintenance.
Stage II	Cost Optimization	**P**reventive **M**aintenance (**PM**) in addition to Breakdown **M**aintenance (**BM**). **P**rofitable **P**reventive **M**aintenance (**PPM**) = **PM +BM**
Stage III	System Orientation	Productive Maintenance= **BM+PM +MI**(Maintainability improvement through designs)+**MP** (Maintenance Prevention)
Stage IV	**C**ompany-wide **I**nvolvement (CI)	**TOTAL PRODUCTIVE MAINTENANCE : TPM = BM+PM+MI+MP+CI (Company-wide Involvement)**

As automation is rapidly on the rise, TPM has gained center stage in the present industrial scenario.

05.20.00 WORK STUDY: Method Study & Time study

05.20.01 Scope

Work Study concerns itself with better ways of doing things and control over the output of those things by setting standards with respect to time.

The means of improving ways of doing things is called **Method Study**. The primary purpose of improving methods is to save time, and therefore effort of labor and machinery.

The aspect of setting work standards for comparison, control and managerial actions is termed as "**Work Measurement" or "Time Study".**

WORK STUDY comprises METHOD STUDY and TIME STDY.

05.20.02 Foundation of Work Study

Frederick W Taylor, Frank G Gilbreth, and Lillian M Gilbreth were some of the pioneers in the field of Work Study.
Dr Taylor's conclusion was: "The greatest production results when each worker is given a definite task to be performed in a definite time and a definite manner."
This is the foundation on which modern work study stands today.

05.20. 02.01 Subdivision of Work: "Therblig" (Gilbreth spelt backwards)

Frank B Gilbreth suggested subdivision of work into its basic component elements involving movement of hands and human body. Gilbreth's elementaliztion was general in the sense that any work done by hand and body movements could be classified into a few or all of 18 ***"THERBLIG" work elements.***
Following are some of the ***Therbligs***

- ***Search*:** When a hand or a body member tries to locate an object.
- ***Find***: Finding an object by eye movement.
- ***Select:*** To locate a specific object from a group of objects.
- ***Grasp:*** Gaining control over an object.
- ***Hold:*** Holding an object.
- ***Transport:*** Changing the location of an object.
- ***Assemble***: Assemble two parts together.

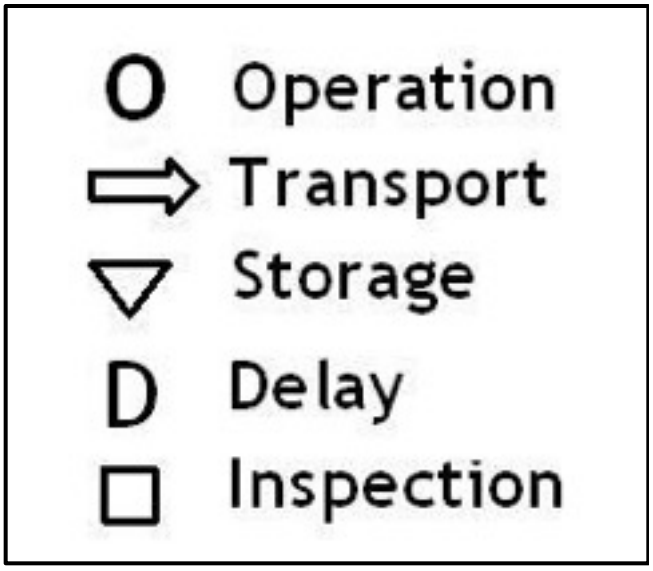
- ***Inspect:*** Determine the quality of an object.
- ***Rest:*** Resting a body member to overcome fatigue.
- ***Unavoidable delay:*** Idleness, of a body member, where it is part of the method.

05.20.02.02 General Principles of Motion Economy

Use of human body	**Arrangement of work place**	**Design of tools/equipment**
Use both hands	Fixed place for tools	Use jigs and fixtures to relieve hands
Move hands in symmetrical and opposite directions	Use gravity to assist work – Use chutes	Combine two or more tools.
Smooth motion of hands	Good illumination	Proper design of handles
Maintain rhythm	Arrange material in the sequence of work requirement	Proper layout: e.g. keyboard of a type-writer.
Etc……	Etc……	Etc…..

05.20.03 Process Flow Charts

Any job or process can be studied for methods improvement by recording all the events. Process flow charts are prepared, giving the sequence of events occurring in the process from beginning to the end.
The ASME symbols which are universally accepted are:



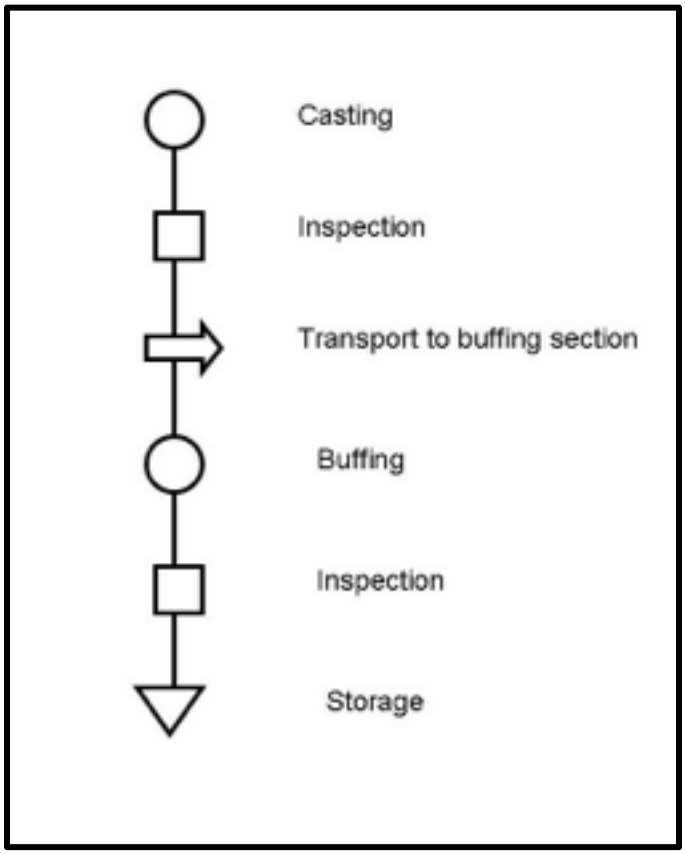
Process flow charts give a clear picture of process and help analyzing whether the efforts in the process are useful are wasteful.

Each one of the activities can be analyzed to find whether it could be:

- Eliminated.
- Reduced in time.
- Substituted by another activity.
- Put elsewhere in the sequence.

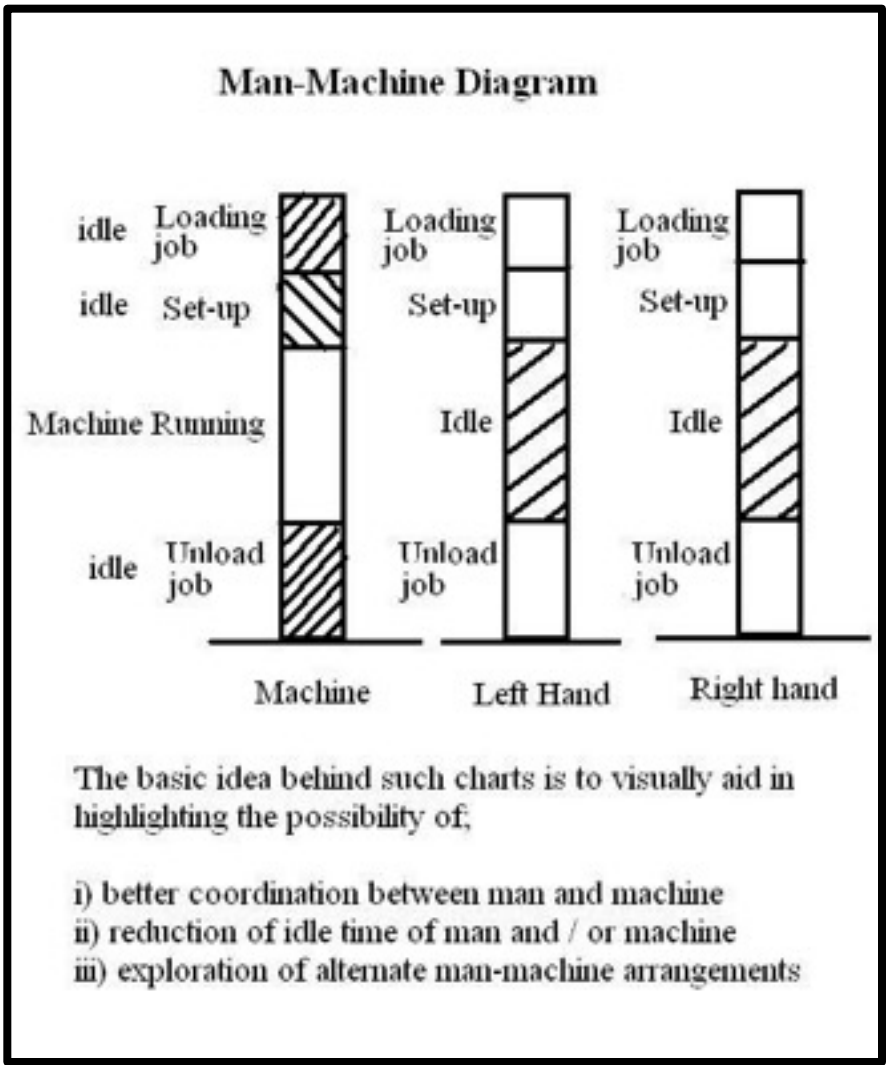
to improve the method.

Example of a process flow chart for manufacture and storage of Castings:



05.20.04 Man Machine Diagrams

Other types of charts used are man-machine charts, which on a vertical time-scale indicate various activities done by man and machine both on the same chart, for carrying out certain operation by man and machine team. Similar charts can also be made for multiple machines and men at a work-station.



05.20.05 Main Components of Method Study

The main components of method study are:

1. Gaining information on the process.

2. Understanding the process in detail and making visual charts such as process flow charts, man-machine charts etc…
3. Analyzing each step of the process critically by asking questions *"WHY SO? - Any alternative?*
   Ask questions: What? Who? When? Where? How?

4. After critical examination, chalk out improved alternative method.
5. Test for acceptance.
6. Follow up for implementation.
7. Reevaluation / periodically monitoring.

05.20.06 Criteria for Methods Improvement

- Improved cost performance.
- Improved time performance.
- Improved worker satisfaction.
- Improved standardization of operations and products.

05.20.07 TIME STUDY

Once the method is established, the next thing to do would be to set standard times for work. This aspect of work-study is called **"TIME STUDY".**

05.20.07.01 The setting of time standards is done basically by the following three methods.

1. Using Stopwatch.
2. Using Synthetic time standards.
3. Using statistical sampling techniques.

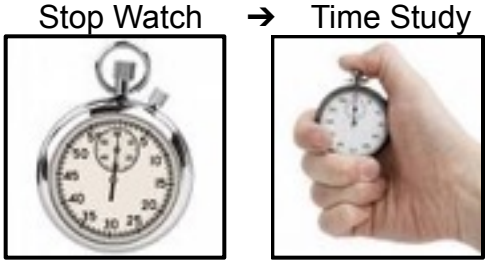
05.20.07.01.01 Using a Stopwatch

Stopwatch time study makes direct observation of the job element. The precision is usually .01 minute. Sample size of stopwatch readings depends on the degree of variability.

Normal time =

[Arithmetic average of recorded times X Performance rating %] / 100

Standard time = Normal time + Allowances (for personal time, fatigue and unavoidable delays.



05.20.07.01.02 Using synthetic time standards

Methods Time Measurement (MTM)

MTM was developed by the MTM association for Standards and Research, which has its head quarters at Michigan, USA with co-operating national associations at England, France, Germany, Japan etc.
The basic MTM approach is to classify the human work motions into certain fixed standard categories such as Reach, Move, Turn, Apply pressure, Grasp, Release, Position, Foot-motion etc. In each of these categories there are different sub-classes or cases of motion. These pre-determined times for motion are used to synthesize a "TIME STANDARD" for a Job. The job is visualized to consist of a series of micro-motions from the MTM inventory of standard micro-motion, the times are looked up from the MTM tables, they are totaled and appropriate allowances are added and the result is the **Standard Time** for the job.

05.20.07.01.03 Using Statistical Sampling

As the name suggests, it is a statistical sampling method. It estimates the proportion of time devoted to a given type of activity over a certain period of time by means of a large number of random 'spot' observations.
Sample size is determined statistically, based on the required confidence level of the results so obtained. More number of readings would give results that are more accurate. For example, a sufficiently large number of spot observations at random time intervals throughout a week of a personal assistant's (PA's) work would give a fair estimate of the time spent by the PA for an activity such as making phone calls, typing etc.

Likewise if we take random samples on working of a machine and note that the machine is idle 2400 times out of a total of 8400 readings the idle time percentage would be 2400 / 8400 x 100 %.

05.20.08 Work Study in an Office Environment

This is known as “ORGANIZATION and METHODS” (O & M).

The “Methods” study principles are very much the same as were discussed for a manufacturing situation. Instead of studying flow of material, the analyst would chart the flow of papers or make a Procedure flow chart. Method study in an office in a large measure amounts to designing a **Management Information System (M I S)**
Improving **MIS** involves a study and redesign of the organization and decision-making structure.

05.21.00 Ergonomics

05.21.01What is ergonomics?

Ergonomics is the study of people and their relationship with the environment around them. Ergonomics is the science of designing the job, equipment, and workplace to fit the worker. Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability.

What is Anthropometrics?

Anthropometrics is the study of the human body and its movements.

05.21.02 Overview

Ergonomics is concerned with the 'fit' between people and their work. It takes account of the worker's capabilities and limitations in seeking to ensure that tasks, equipment, information and the environment suit each worker.

To assess the fit between a person and their work, ergonomists consider the job being done and the demands on the worker; the equipment used (its size, shape, and how appropriate it is for the task), and the information used (how it is presented, accessed, and changed). Ergonomics draws on many disciplines in its study of humans and their environments, including anthropometry, biomechanics, mechanical engineering, industrial engineering, industrial design, kinesiology, physiology and psychology.

Typically, an ergonomist has a degree in Industrial/Mechanical Engineering or Health Sciences, and usually an MS or PhD in a related discipline. In the 2000s, occupational therapists have been moving into the field of ergonomics and the field has been heralded as one of the top ten emerging practice areas.

05.21.0 3 Five Aspects of Ergonomics

There are five aspects of ergonomics: safety, comfort, ease of use, productivity/ performance, and aesthetics. Based on these aspects of ergonomics, examples are given of how products or systems could benefit from redesign based on ergonomic principles.

1. Safety - Medicine bottles: The print on them could be larger so that a sick person who may have bad vision (due to sinuses, etc.) can more easily see the dosages and label. Ergonomics could design the print style, color and size for optimal viewing.
2. Comfort - Alarm clock display: Some displays are harshly bright, drawing one's eye to the light when surroundings are dark. Ergonomic principles could re-design this based on contrast principles.

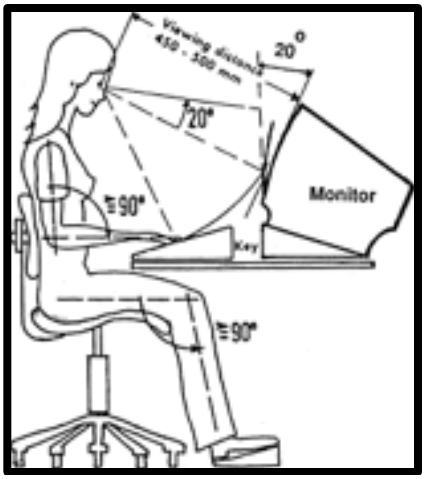
3. Ease of use - Street Signs: In a strange area, many times it is difficult to spot street signs. This could be addressed with the principles of visual detection in ergonomics.
4. Productivity/performance - HD TV: The sound on HD TV is much lower than regular TV. So when you switch from HD to regular, the volume increases dramatically. Ergonomics recognizes that this difference in decibel level creates a difference in loudness and hurts human ears and this could be solved by evening out the decibel levels.
5. Aesthetics - the look and feel of the object, the user experience.

05.21.04 Domains

The International Ergonomics Association (IEA) divides ergonomics broadly into three domains:

- Physical ergonomics: is concerned with human anatomical, anthropometric, physiological and biomechanical characteristics as they relate to physical activity. (Relevant topics include working postures, materials handling, repetitive movements, work related musculoskeletal disorders, workplace layout, safety and health).
- Cognitive ergonomics: is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. (Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design).
- Organizational ergonomics: is concerned with the optimization of socio-technical systems, including their organizational structures, policies, and processes. Relevant topics include communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organizations, and quality management.

05.21.05 Applications



Ergonomic Tips for Computer Users.: Employees, who use a desktop computer, whether at work or home, can improve their own personal ergonomics - and avoid injury - by incorporating a few basic principles. One must sit on an ergonomically designed chair and place the computer / keyboard at correct height.

Physical ergonomics is important in the medical field, particularly to those diagnosed with physiological ailments or disorders such as arthritis (both chronic and temporary) or carpal tunnel syndrome. Pressure that is insignificant or imperceptible to those unaffected by these disorders may be very painful, or render a device unusable, for those who are. Many ergonomically designed products are also used or recommended to treat or prevent such disorders, and to treat pressure-related chronic pain.

05.21.06.00 Ergonomics in the workplace

Fundamentals for the Flexible Workplace Variability and compatibility with desk components, that flex from individual work activities to team settings. Workstations provide supportive ergonomics for task-intensive environments.

Workplaces may either take the reactive or proactive approach when applying ergonomics practices. Reactive ergonomics is when something needs to be fixed, and corrective action is taken. Proactive ergonomics is the process of seeking areas that could be improved and fixing the issues before they become a large problem. Problems may be fixed through equipment design, task design, or environmental design. Equipment design changes the actual, physical devices used by people. Task design changes what people do with the equipment. Environmental design changes the environment in which people work, but not the physical equipment they use.

05.21.07 Seating Ergonomics

The best way to reduce pressure in the back is to be in a standing position. However, there are times when you need to sit. When sitting, the main part of the body weight is transferred to the seat. Some weight is also transferred to the floor, back rest, and armrests. Where the weight is transferred is the key to a good seat design. When the proper areas are not supported, sitting in a seat all day can put unwanted pressure on the back causing pain.

The lumbar (bottom five vertebrate in the spine) needs to be supported to decrease disc pressure. Providing both a seat back that inclines backwards and has a lumbar support is critical to prevent excessive low back pressures. The combination which minimizes pressure on the lower back is having a backrest inclination of 120 degrees and a lumbar support of 5 cm. The 120 degrees inclination means the angle between the seat and the backrest should be 120 degrees. The lumbar support of 5 cm means the chair backrest supports the lumbar by sticking out 5 cm in the lower back area.

Another key to reducing lumbar disc pressure is the use of armrests. They help by putting the force of your body not entirely on the seat and back rest, but putting some of this pressure on the armrests. Armrest needs to be adjustable in height to assure shoulders are not overstressed

05.22.00 Reliability / Redundancy

05.22.01 Reliability

The aim of making a product reliable is to ensure that it can be used without failures. While a failure-proof product is an unachievable fantasy, the user would like a product to perform for a particular period without any failures. From a designer’s point of view, reliability is the quality of a product under specific environmental conditions for a specified period. From the user’s point of view, it is the quantum of dependence that may be placed on a guarantee of failure-free performance of a product for a specific purpose and duration. From the maintainer’s point of view, reliability of a product is its susceptibility to quick and effective repairs after failure.

Reliability can be defined as the probability of successful performance of a product or a component over a specific period of usage under specified conditions.

Reliability of a product is a function of the reliability of its components. If the components function in series then the failure of a single component will result in the failure of the product.

If the product consists of components which work in parallel, the product will function as long as at least one part is functional.

05.22.02 Redundancy

In engineering, redundancy is the duplication of critical components of a system with the intention of increasing reliability of the system, usually in the case of a backup or fail-safe. In many safety-critical systems, such as fly-by-wire and hydraulic systems in aircraft, some parts of the control system may be triplicated.

An error in one component may then be out-voted by the other two. In a triply redundant system, the system has three sub components, all three of which must fail before the system fails. Since each one rarely fails, and the sub components are expected to fail independently, the probability of all three failing is calculated to be extremely small. Redundancy may also be known by the terms "majority voting systems" or "voting logic".

05.22.03 Reliability Engineering

Definition: Reliability engineering is an engineering field that deals with the study of reliability: the ability of a system or component to perform its required functions under stated conditions for a specified period of time. It is often reported in terms of a probability.

05.22.03.01 Overview

Reliability may be defined in several ways:

- The idea that something is fit for purpose with respect to time.
- The capacity of a device or system to perform as designed.
- The resistance to failure of a device or system.
- The ability of a device or system to perform a required function under stated conditions for a specified period of time.
- The probability that a functional unit will perform its required function for a specified interval under stated conditions.
- The ability of something to "fail well" (fail without catastrophic consequences).

05.22.03.02 Types of Reliability Engineering

Many types of engineering employ reliability engineers and use the tools and methodology of reliability engineering. For example:

- System engineers design complex systems having a specified reliability.
- Mechanical engineers may have to design a machine or system with a specified reliability.
- Automotive engineers have reliability requirements for the automobiles (and components) which they design.
- Electronics engineers must design and test their products for reliability requirements.
- In software engineering and systems engineering the reliability engineering is the sub discipline of ensuring that a system (or a device in general) will perform its intended function(s) when operated in a specified manner for a specified length of time. Reliability engineering is performed throughout the entire life cycle of a system, including development, test, production and operation.

05.22.03.03 Concerns of Reliability Engineering

Reliability engineering is concerned with four key elements of this definition:

1) First, reliability is a probability. This means that failure is regarded as a random phenomenon: it is a recurring event, and we do not express any information on individual failures, the causes of failures, or relationships between failures, except that the likelihood for failures to occur varies over time according to the given probability function. Reliability engineering is concerned with meeting the specified probability of success, at a specified statistical confidence level.

2) Second, reliability is predicated on "intended function:" Generally, this is taken to mean operation without failure. However, even if no individual part of the system fails, but the system as a whole does not do what was intended, then it is still charged against the system reliability. The system requirements specification is the criterion against which reliability is measured.

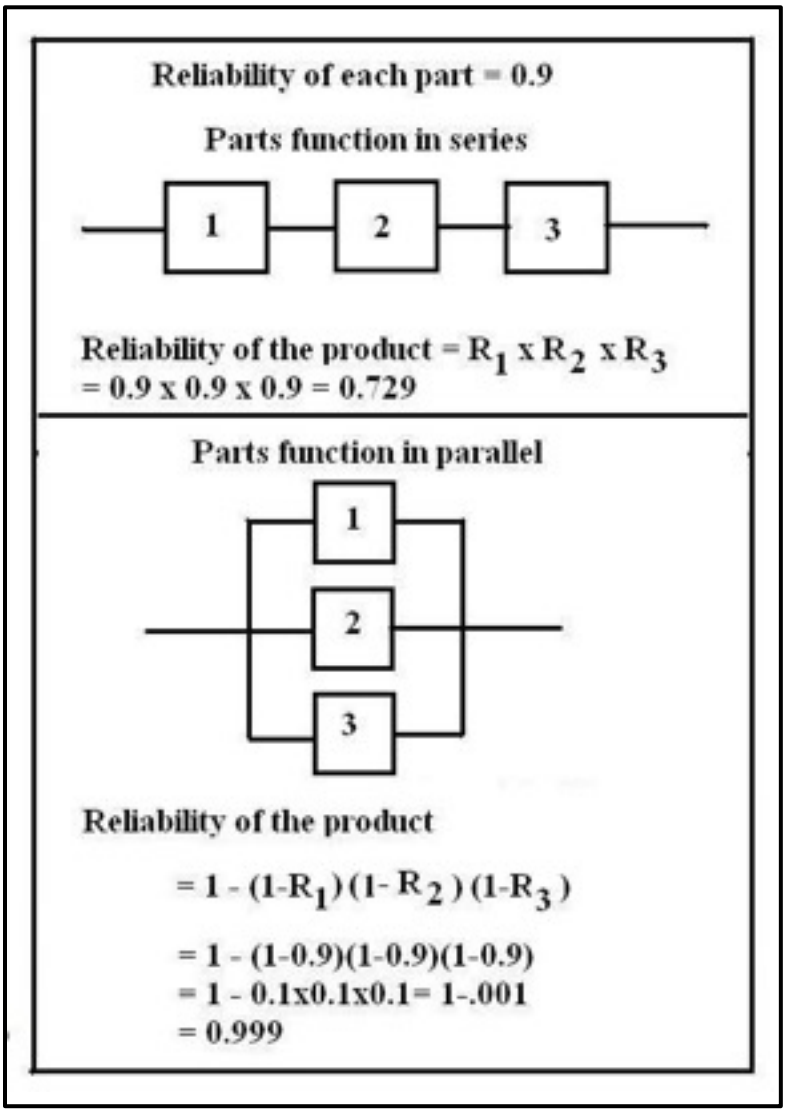
3) Third, reliability applies to a specified period of time. In practical terms, this means that a system has a specified chance that it will operate without failure before time t. Reliability engineering ensures that components and materials will meet the requirements during the specified time. Units other than time may sometimes be used.

4) Fourth, reliability is restricted to operation under stated conditions. This constraint is necessary because it is impossible to design a system for unlimited conditions.

05.22.04 Reliability Calculations

Let us consider a product having 3 parts, each having a reliability of 0.9.

We shall calculate the reliability factors in cases of series and parallel connections.



Chapter 06
Supply Chain Management

06 Supply Chain Management

A supply chain is as good as the weakest link in the supply chain.

... Reddigari Seshadri Reddy

Index

06.01.00 Introduction to Supply Chain Management

Supply of components, raw material and services are essential to the running operations in any business. Such chains of ***supplier to➔ factory to➔ customers of the factory*** had always existed. The traditional tasks will retain their importance as long as a factory has to cater to its customers. What is new is that, currently a huge emphasis is placed on the linkage or CHAIN aspect of the process and these chains have to strengthen for successful operations.

Supply Chain: **SUPPLIER'S SUPPLIER ➔ SUPPLIER ➔MANUCATURING COMPANY ➔ CUSTOMER ➔ CUSTOMER'S CUSTOMER**
We need to know minute details of all the players in this chain and their problems. It cannot be a solo performance. Every party in the chain has to perform and it should be a win-win situation for all.

Note: The competition is no more between two individual companies, but between different supply chains.

It ought to be emphasized that all traditional functions such as purchase, inventory control, material handling, warehousing, transportation etc will remain. What changes is the orientation- a new outlook of teamwork and the way managers would look at the participants in the supply chain. With this new outlook would emerge new systems and procedures that would support the new business logic. All the techniques of materials management would have to be applied with the "chain" in view.

According to **CSCMP (Council of Supply Chain Management Professionals)"**
"Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, who can be suppliers, intermediaries, third party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies."

A typical Manufacturing supply chain comprises the following processes:

A. Inbound Supply Chain:

1. Sourcing.
2. Incoming quality control.

3. Inbound transportation from supplier to Factory.
4. Imports (Documentation, Customs clearance etc…)
5. Goods receiving and warehousing.
6. Inventory management.

B. Manufacturing Process:

1. Production planning and control.
2. In process quality control.
3. Work-in-process inventory management.

C. Outbound Supply Chain / Distribution:

1. Outbound transport.
2. Finished product quality control.
3. Warehousing.
4. Finished goods' inventory management.
5. Packaging.
6. Shipment.

D. Customer Service:

1. Fixing distribution channels (This subject is extensively covered in the chapter titled "Marketing and Distribution Management).
2. Order execution.
3. Product Improvement / development.
4. Managing field complaints.

06.02.00 Purchasing

Major part of a company's profits could arise from an efficient purchase function. Objectives of a purchase department are:

- To ensure timely supplies of material.
- To procure quality material at reasonably low costs.
- To select proper vendors and monitor their performance.
- To research on possible alternate materials and new developments.
- To develop systems for procurement.
- To coordinate with other functions in the organization.

A purchase Mgr must be very knowledgeable, who understand design, Engineering, Production, Marketing, finance and other related functions. He has to be familiar with internal operations of the company as well as external supply market in order to be able to procure at right qty, quality, time and cost so that he can contribute substantially to the organization.

Purchase Mgr has to maintain close inter-organizational and intra-organizational relationships.

06.02.01 Purchase Documentation

- PR: Purchase Requisition from Planning Dept.
- PO: Purchase order on Supplier by Purchase Department.
- Invoice: Billing/Invoice from supplier.
- GIA: Goods inward advice on receipt of material at warehouse.
- IR: Inspection report by Quality Control Department.

06.02.02 Value Analysis and Value Engineering

To find a better substitute material, a purchase Mgr may apply Value Analysis technique. The idea is to find a substitute giving same or better functional value, yet costing same or less.

Steps : Gather information on substitutes ➔ Functional analysis (Attach a weight to each function, on a 1-100 scale, in terms of its importance and place alongside the costs involved ➔ Brain storming ➔ Evaluation ➔ Implementation

06.02.03 Vendor Relations

- Vendor development: Locate and select vendors and maintain a data bank, on a continual basis. Keep looking for new vendors and new technologies.
- Vendor performance: Assess vendor performance rating in terms of deliveries, quality, price, technical capability etc…
- Vendor participation: Involve vendors in the process of design and development activities to ensure supplies as per agreed specifications.

06.02.04 Make or Buy Analysis

Factors to be considered are:

- Cost of own Mfr vis-à-vis purchase price.

- Investments involved.
- Skills in the organization.
- Logistics/transportation.
- Confidentiality of design.
- Vendor reliability.
- Criticality of the item/ cost of shortages.
- Mfg facilities in the company.

06.03.00 Inventory Control

Inventory is working capital and has financial implications for a company.

The basic questions in the management of inventory are:

1. How much Inventory is to be kept and
2. When?

Inventory is needed for the definite consumption demand of material, and to take care of uncertainty involved in usage and availability at any stage of manufacture. Work in process is also an inventory.
The inventory to take care of normal consumption is called normal inventory and the inventory to take care of uncertainty is called safety stock or buffer stock.

06.03.01 Inventory Carrying Cost

Costs involved in holding inventories are

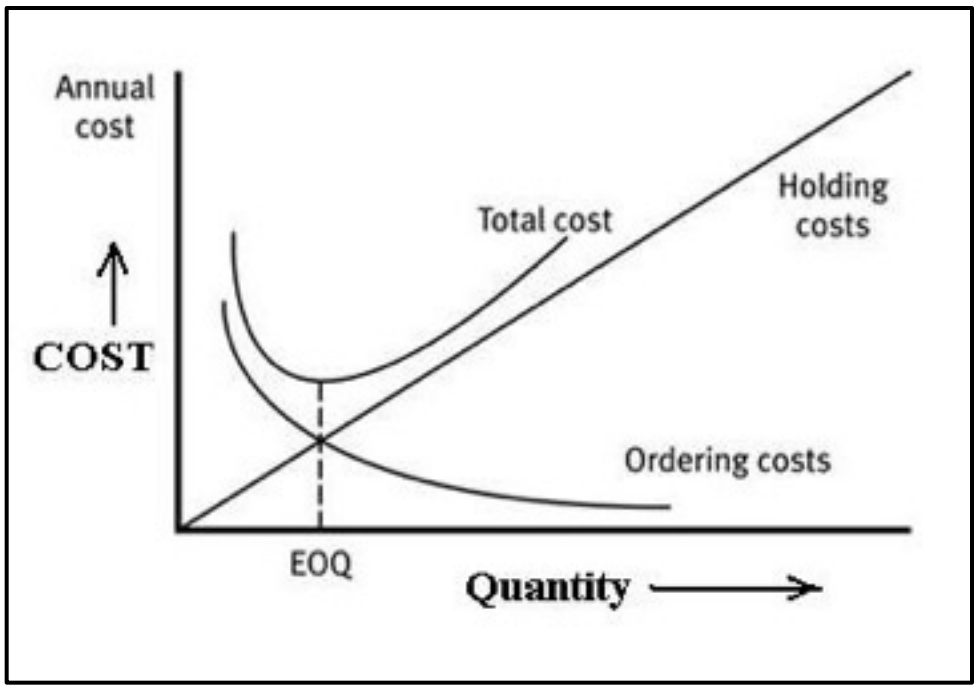
- Cost of Capital (Interest).
- Cost of space.
- Cost of obsolescence.
- Cost of deterioration in storage.
- Cost of Insurance.
- Cost of administration.
- Cost of procurement.

06.03.02 Economic Order Quantity (EOQ)

Factors affecting economic order quantity:

- Ordering cost.
- Inventory carrying cost.

The following graph shows the effect of ordering cost and inventory carrying cost on the total cost. EOQ can be derived from this graph which is self explanatory. Obviously, the EOQ lies at the point of minimum "total cost"



Formula for EOQ (Economic Order Quantity):

A = Annual requirement
Q = batch quantity
CC = Cost of carrying inventory per one unit per year
CP = cost of procurement per order.
EOQ = Economic batch quantity.

Average inventory in saw tooth model = Q / 2

Annual inventory carrying cost = CC x Q / 2
Number of orders per annum = A/Q
Ordering cost per annum = CP x A / Q

Total cost TC= [CC x Q / 2] + [CP x A / Q]

This total cost (TC) is to be minimized.
Take derivative of TC with respect to Q.

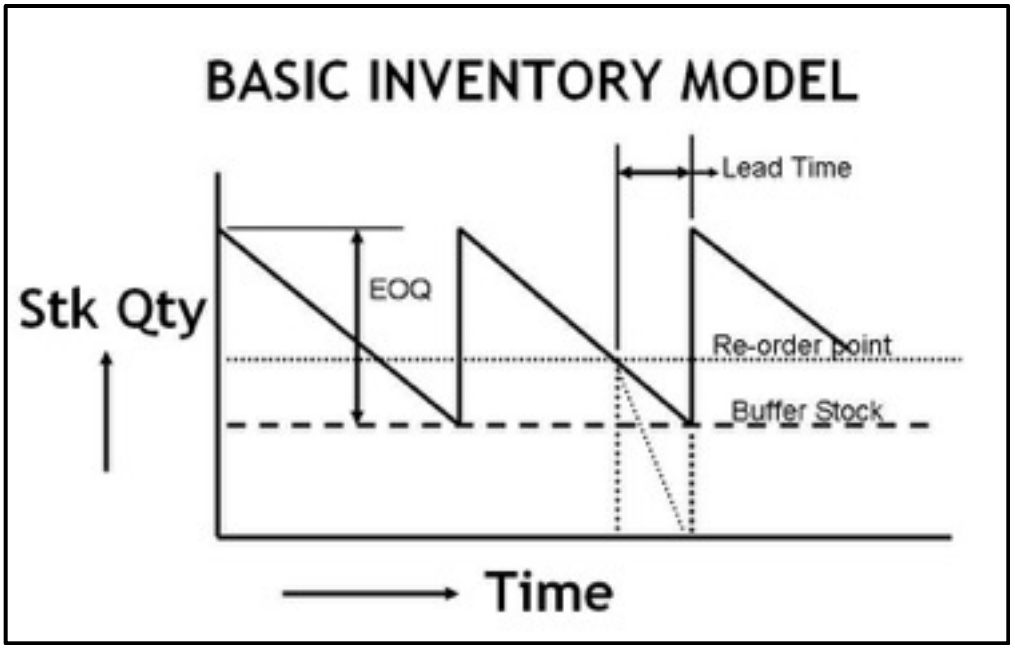
d (TC) / d(Q) = [CC / 2] – [CP x A / Q x Q]=0

Therefore EOQ = Square root of [2 x CP x A / CC]

06.03.03 Basic Inventory Model with Buffer (Safety) Stock

Since Inventory control involves the trade-offs between a) the cost of not having material, such as cost of production interruptions (Under stocking cost) & b) Cost of excess material in stock, inventory-carrying costs (Over socking cost).
The amount of buffer stock = Consumption during lead-time.
Fig 3. Basic inventory model showing requirement of buffer stock.

Basic Inventory Model / Saw Tooth Curve:



06.04.00 Classification of Material: ABC / VED Analysis

06.04.01 ABC Analysis by Value

In most industries, the number of items in stores runs into 1000s and it is impossible to tightly monitor stocks of all items. We have to narrow down the list for closer management control. ABC Analysis is a technique whereby we classify materials in order of importance, mainly based on value. If we tabulate all the items in descending order of value of annual material consumption, it can generally be seen that only a few items, 10% of the total number of items constitute 75% of the total value

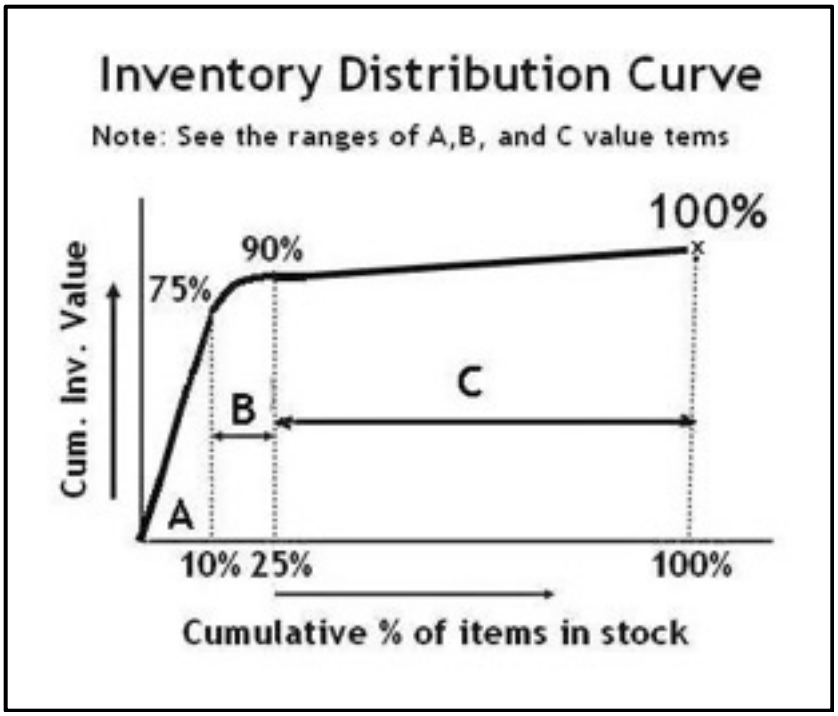
Typical distribution chart is given below:

Material Class	% number of items	Cum % of items	Coverage by % of Value	Cum coverage % value
A	10%	10%	75%	75%
B	15%	25%	15%	90%

C	75%	100%	10%	100%

A Value items need to be tightly controlled to minimize/optimize inventory levels.

The following graph shows ABC distribution of items in stock.



06.04.02 VED Analysis

The inventory items can also be classified in order of their criticality.
Shortage of some low value items can also lead to costly production interruptions.
An item can also be of high value and be critical at the same time.
Classification codes for criticality irrespective of value:

- **"V"** for vital (extremely critical) items.
- **"E"** for essential items.

- **“D”** for desirable items.

“V” class items need to be tightly monitored to avoid costly production hold-ups.

06.04.03 Combination of ABC and VED Analysis

ABC-VED Matrix classification matrix:

VED ► ABC▼	V	E	D
A	AV	AE	AD
B	BV	BE	BD
C	CV	CE	CD

The service levels of inventory increase from D to V and from A to C.

06.05.00 Material Requirement Planning (MRP)

This topic had been covered in the previous chapter titled “MRP”, a sub-title under “Production and Operations Management” (Ref. chapter 05.14.00).

06.06.00 Stores and Codification

06.06.01 Stores Functions

- Receiving material and arranging Inspection.
- Storage of material systematically/ Arrangement.
- Preservation of material.
- Issue and dispatch.
- Maintain stock records.
- Stock taking periodically/ physical verification.

06.06.02 Codification

Codification of materials can be termed as identification of material and deals with uniquely identifying each item of inventory.

Codification is essential for:

- Inventory management.
- Preparing Product Bills of Material.
- Standardization and Avoiding duplication of items/stocks.
- Computerization.
- Classification of material.
- Issue of material to production lines.
- Costing.
- For preparing meaningful stock statements

  etc…

Example of a 9-digit code for typical items:

9 digit structure	➔	X	X	–	X	X	–	X	X	–	X	X	X
Digit position	➔	1	2		3	4		5	6		7	8	9
9 digit code	➔	1	5		2	2		4	1		6	4	5
Description (1)	➔	Steel			Carbon steel			Round bar			Serial number		
Description (2)	➔	Garments			Cotton			Shirt			Design Sr #		
Description (3)	➔	Electrical			Instruments			Voltmeter			Serial number		

Digits 1 & 2 signify the main category of the material.
Digits 3 & 4 signify sub-category of the material.
Digits 5 & 6 signify type/shape of material.
Digits 7, 8 & 9 signify a running serial number for that type of material.



(1) Carbon steel round bar (2) Garment: Cotton shirt (3) Elec. Instrument: Volt-Meter

06.07.00 Objectives of Supply Chain

a) Service orientation (i.e. service to the customer) and ensuring that the customer gets value.

b) System orientation i.e. looking at the supply chain as a whole and not in terms of is constituent partner companies.

c) Competitiveness and efficiency.

06.08.00 Binding Factors for the Supply Chain Constituent Members

a) Mindset:

- Alignment of strategies.
- A culture of trust and cooperation.

b) Coordination:

- Flow of information, finance and material.
- Improved process orientation.

c) Sharing information:

- Short-term production schedules and material requirement.
- Long term production plans.
- Changes in design and product mix.

d) Sharing of risks and rewards:

- Each company should feel that it has got its appropriate share of financial profits or other gains.
- There should also be proportionate sharing of risks involved in business.

e) Joint problem solving:

- Supply chain is a family having common interests.
- All problems pertaining to product design, quality, logistics etc are solved by mutual cooperation. For instance, they could participate in TQM jointly.

Chapter 07
Total Quality Management (TQM)

07 Total Quality Management (TQM)

Quality is never an accident. It is always the result of intelligent effort. ... John Ruskin

Table of Contents

07.01.00 Introduction to TQM

07.01.01 Overview of TQM

People define quality in many ways. It is generally perceived that the main reason to pursue quality is to satisfy the customer.

ANSI (The American National Standards Institute) and ASQ (American Society for quality) define quality as: “Quality is the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs.”

To beat competition, organizations should not only satisfy the customer needs, but must often exceed the customer expectations. One of the most popular definitions of quality is “Product or service performance must exceed customer expectations”.

When we talk of quality, we usually think in terms of excellent product or service that fulfils or exceeds our expectation. The expectations are based on the intended use and selling price. It is somewhat an intangible based on perceptions. Quality can be quantified as:
$Q = P / E$
Q= Quality
P= Performance
E= Expectation

The customer is seen to have a good feeling, if $Q > 1$.

Of course, the determination of P and E is also likely to be based on perceptions of an organization. A more definitive definition of quality is given in ISO 9000: 2000. It is defined as the degree to which a set of inherent characteristics in the product or service fulfils the stated requirement.

Quality has 9 different dimensions:

1. Performance (Efficiency and Productivity).
2. Product Features (Special characteristics).
3. Conformance (Meeting Specifications).

4. Reliability (Consistency of Performance).
5. Durability (Useful Life).
6. Service (Resolution of Complaints).
7. Response (Human-to-Human Interface).
8. Aesthetics (Sensory Characteristics).
9. Reputation (Past Performance and Credibility).

Most of these dimensions revolve around the design of a product. The tools and techniques for achieving total quality are enumerated in the following chapters.

07.01.02 Definition of TQM

TQM is a set of management practices throughout the organization, geared to ensure that the organization consistently meets or exceeds customer requirements.

TQM places strong focus on process measurement and controls as means of continuous improvement. TQM is a business management strategy aimed at embedding awareness of quality in all organizational processes.

- ❖**T**otal: Made up of the whole
- ❖**Q**uality: Degree of excellence a product or service provides
- ❖**M**anagement: Act, art, manner of handling, directing and controlling etc.

07.01.03 TQM: Six basic concepts

07.01.03.01 A committed involved management to provide long-term top-to-bottom organizational support

- Management must participate in the quality program.
- A quality council must be set up to develop clear vision, set long-term goals and direct the program.
- TQM must be a continual activity entrenched in the culture.

07.01.03.02 Focus on the customer, both internally and externally

- We must listen to the voice of the customer.
- Customer satisfaction is the most important consideration.
- Emphasis is on design quality and defect prevention.

07.01.03.03 Effective involvement and utilization of the entire work force

- All personnel must be trained in TQM techniques.
- People must be empowered up to the lowest level.
- People must be involved in development and implementation of TQM plans.
- There must be a reward system in place and a system of appreciation.

07.01.03.04 Continuous Improvement in Business and Production Processes

- Continuous improvement in: Delivery, billing, customer satisfaction, cycle time, process mgt, scrap reduction, supply management, design, engineering etc.
- Techniques: SPC, Bench Marking, ISO 9000 etc…

07.01.03.05 Treating Suppliers as Partners

- Suppliers should be few in numbers for true partnership.
- Emphasis should be on quality and life-cycle cost and not on price.

07.01.03.06 Establish Performance Measures for the Processes

- Performance measures such as percentage of nonconforming, Absenteeism, Customer satisfaction etc must determined for each functional area.
- These measures must be posted at prominent locations, for everyone to see.

07.01.04 New and Old Cultures

Quality element	**Previous State**	**TQM**

Definition	Product Oriented	Customer Oriented
Decisions	Short Term	Long Term
Emphasis	Detection	Prevention
Errors	Operations	System
Responsibility	Quality control dept	Everyone
Problem Solving	Managers	Team Effort
Procurement	Price	Quality and Life-Cycle Cost
Manager's Role	Plan, assign, control	Delegation, Coach, and Mentor

07.01.05 TQM Framework

History and Gurus of TQM:

1. 1924: **W A Shewhart** of bell Telephone laboratories Introduced Statistical Quality Control Techniques.
2. 1946: Formation of American Society for Quality. This organization is involved in Publications, Conferences and Training sessions.
3. 1950: **W Edward Deming** promoted statistical methods.

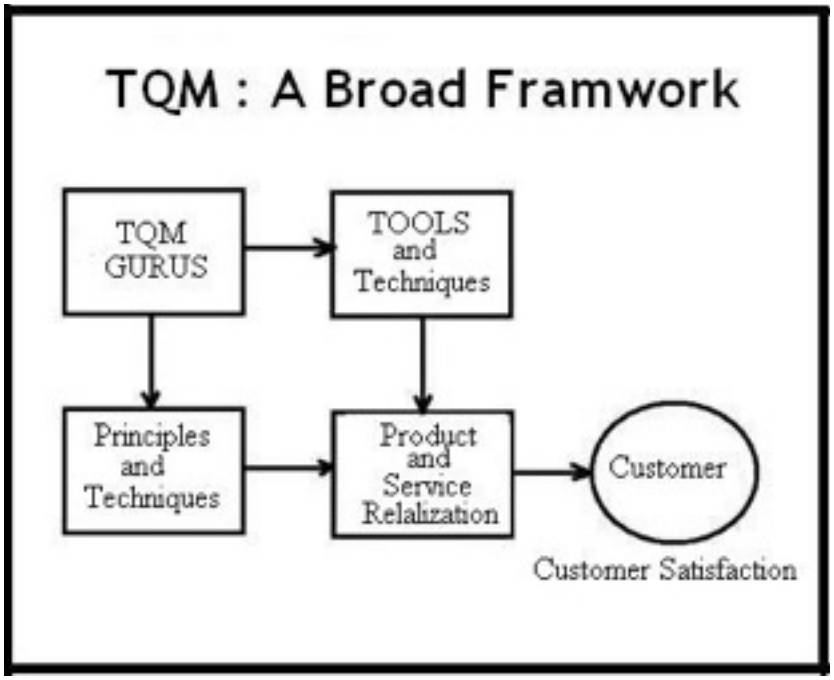
4. 1954: **Joseph M Juran** made his trip to Japan and further emphasized management's responsibility to achieve quality. Japan carried on this concept.
5. 1960: Introduction of Quality Circles at Japan.
6. 1970-1980: A quality renaissance at USA. Visits of American Mangers to Japan.
7. 1980s: Statistical Process Control (SPC) introduced in Automotive Industry. **Genechi Taguchi** introduced his concepts of parameter and tolerance design. Resurgence of Design of experiments (DOE)
8. 1996: Introduction of ISO 9000 standards.

Product and service realization is made possible by using appropriate tools and techniques and applying the basic concepts of TQM.

The following diagram illustrates the broad framework of TQM.

Elements of the Framework:

- Gurus of TQM.
- Principles and Concepts.
- Tools and Techniques.
- Product and Service Realization.
- Customer Satisfaction.



07.01.06 Tools and Techniques

- Bench marking.
- Information Technology.
- Quality Management Systems.
- Environmental Management Systems.
- Quality Function Deployment.
- Quality by Design.
- Failure Mode and Effect Analysis.
- Product and Service Liability.
- Total Productive Maintenance.
- Management Tools.
- Statistical Process Control.
- Experimental Design.
- Taguchi's Quality Engineering.

07.01.07 Principles and Practices

- People and Relationships.
- Leadership.
- Customer Satisfaction.
- Employee Involvement.
- Supplier Partnership.

07.01.08 Product and Service Realization

Requisites:

- Continuous Improvement.
- Customer Feed-back.
- Tools and techniques for measurement.
- Performance Measurement.

07.02.00 Tools for Measurement

In order to achieve ***"Total Quality",*** the managers must:

1. Be aware of the cost of quality and the cost of quality failures.

2. Specify and track the quality parameters. This applies not only to products, but also to services and internal company functions.

3. Be able to apply quantitative techniques in order to isolate and bring under control unacceptable variations in those parameters.

07.02.01 Typical Measurements

Area of Operations	Typical Measurements
Human Resource	Incidence of accidents, Absenteeism, turnover, training hours per employee, Number of grievances, Number of suggestions received / implemented etc…
Customers	Number of field complaints, Number of delayed deliveries, Time for complaint resolution, Response time to customer queries, Customer satisfaction index etc…
Production	Efficiency, Equipment utilization, Scrap percentage, Number of defects, Cost of production, productivity etc…
R & D	Number of new products introduced, R & D spending to sales, Product features vis-à-vis competition, Product improvement measures, State-of the-art technology etc…
Suppliers	Quality performance, Deliver performance, Price level, Lead time for delivery etc…
Marketing / Sales / Service	Sales expense to revenue, Order accuracy, New product sales to total sales, Number of new customers, Number of customers lost, Sales per employee, Time taken to resolve field complaints etc…

Finance / Administration	Accounts receivable past due dates, Accounts payable past due dates, Cost per employee, Revenue per employee, Accuracy of accounts etc…

07.02.02 Tools for Measurement

These tools enable us to take raw data and put it into a form that aids decision-making.

Some of the techniques are listed here:

- **Check Sheet.**
- **Scatter Diagram.**
- **Histogram.**
- **Bar Chart.**
- **Control Chart.**
- **Time Line.**
- **Flow Chart.**
- **Pie-Chart.**

These techniques are enumerated in the following pages.

07.02.02.01 Check Sheet

A sheet that facilitates organized collection of data, and groups data into categories.
A check mark is added for each reading of a category. The checkmarks are then added to determine sub-totals. This can be used to keep track of the parameters of an on-going process.

Example: Monitor the weight of the rice bags.

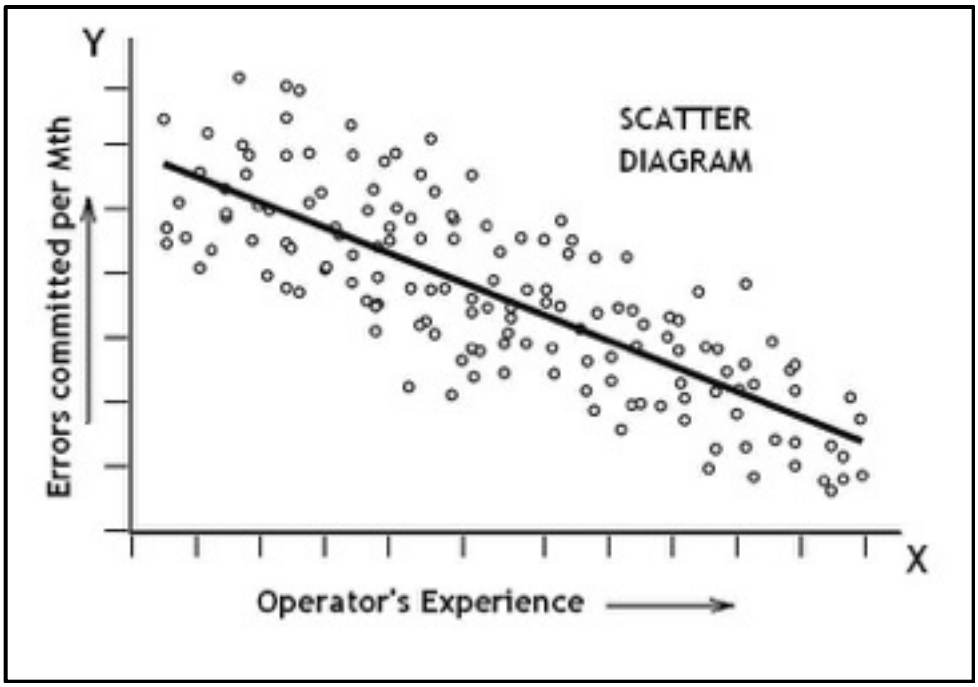
Check Sheet
Weight of a rice bag
Specification=50kg ± 1 kg

Weight Kg	Tally	Total
45-46	I	1
46.1-47	II	2
47.1-48	II	2
48.1-49	IIIII	5
49.1-50	IIIIIIIIIIIIIIIIIII	19
50.1-51	IIIIIIIIIIIIIII	16
51.1-52	III	3
52.1-53	II	2
53.1-54	II	2
54.1-55	I	1

07.02.02.02 Scatter Diagram

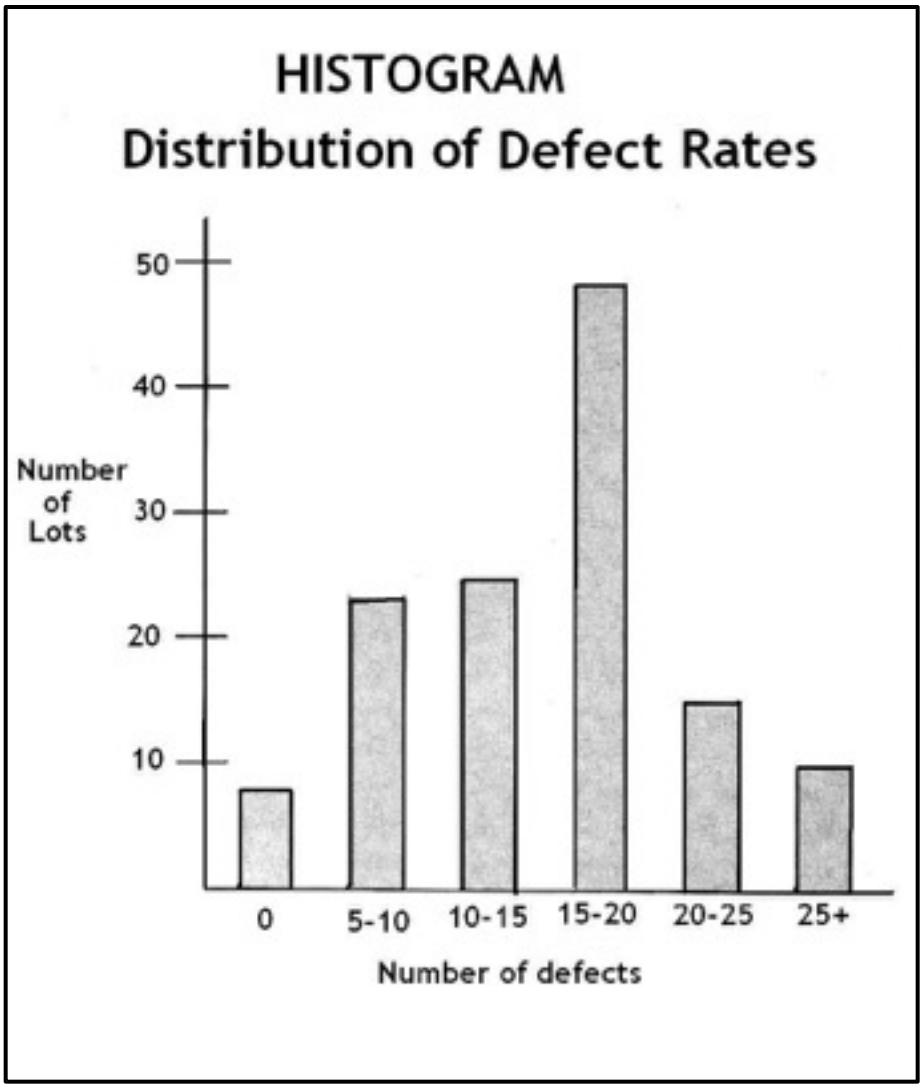
X-axis reflects controllable variable.
Plot the data points **'y'** against variable '**x'.**
Closer the dots are, stronger the correlation.

Example: Plot data points: Operator experience on X-axis vs. error rate on Y-axis.
(E.g. Performance of service Mechanics)



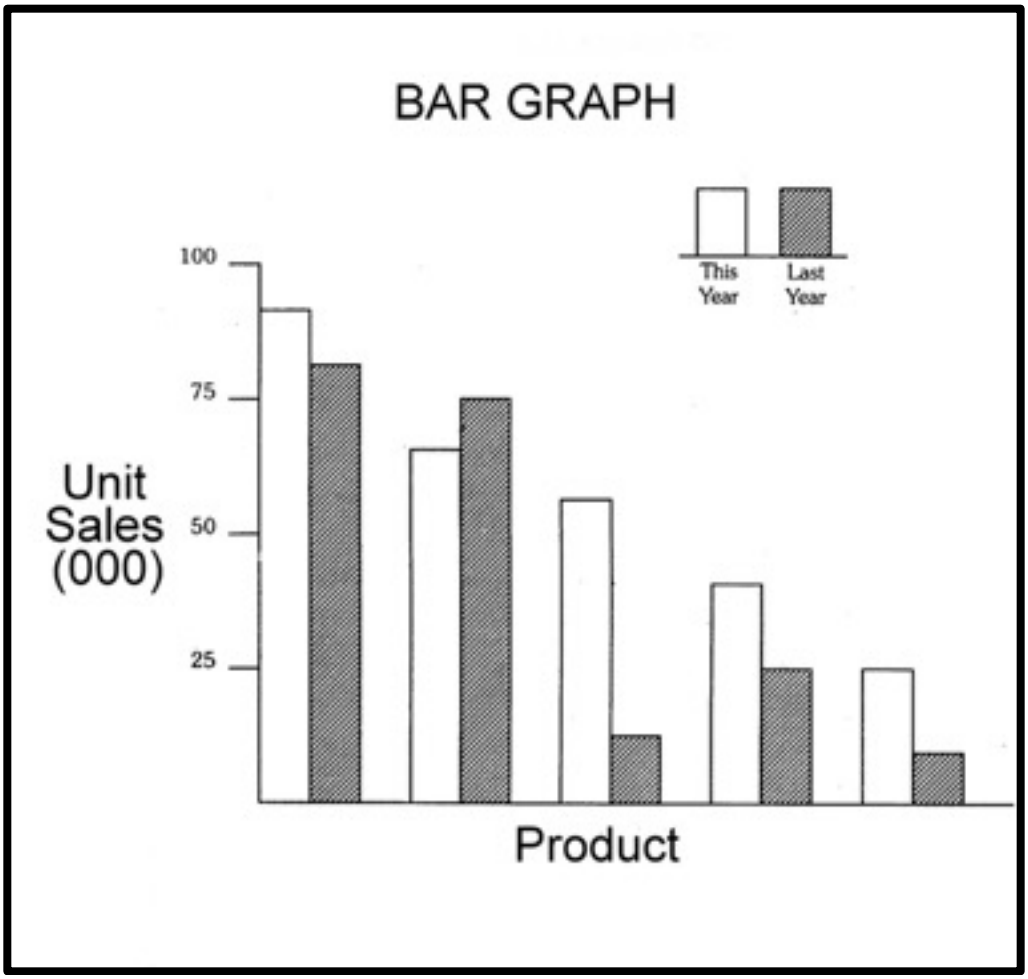
07.02.02.03 Histogram

This is a display of distribution of data by category. It gives visual display and is better than tabulation. Example: No of defects vs. No of Lots.



07.02.02.04 Bar graph

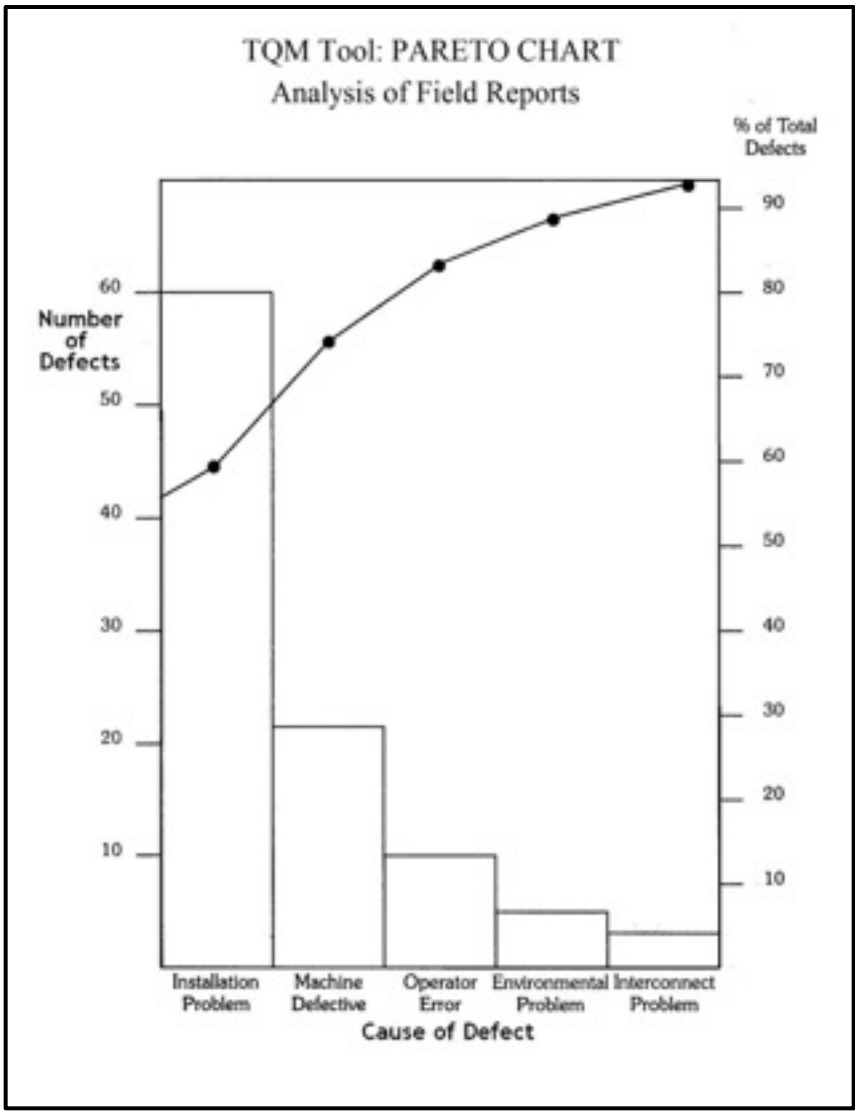
This is a way of displaying data for the purpose of comparison.
The height of the bar indicates the quantity of the category for comparison.
Example: Product type on X-axis and sales on Y-axis.



We get a pictorial view of the Quantity of sales against each product. This enables us take appropriate decisions regarding product-mix, resource allocation, sales strategy etc.

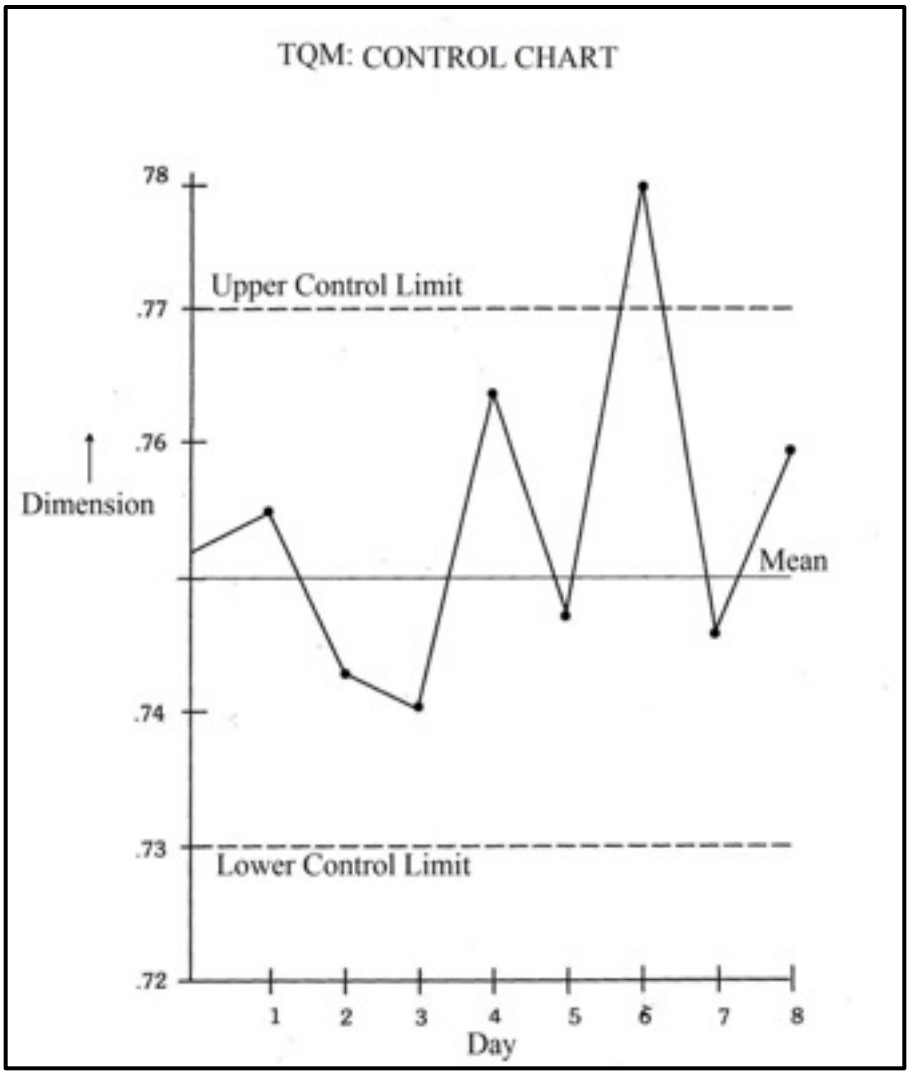
07.02.02.05 Pareto Chart

This is a special form of bar chart, which seeks to determine the most important few factors in a situation.
Example: Data analysis for reduction of field repair visits.
X-Axis: Type of defect & Y-Axis: Number of defects.



07.02.02.06 Control Chart

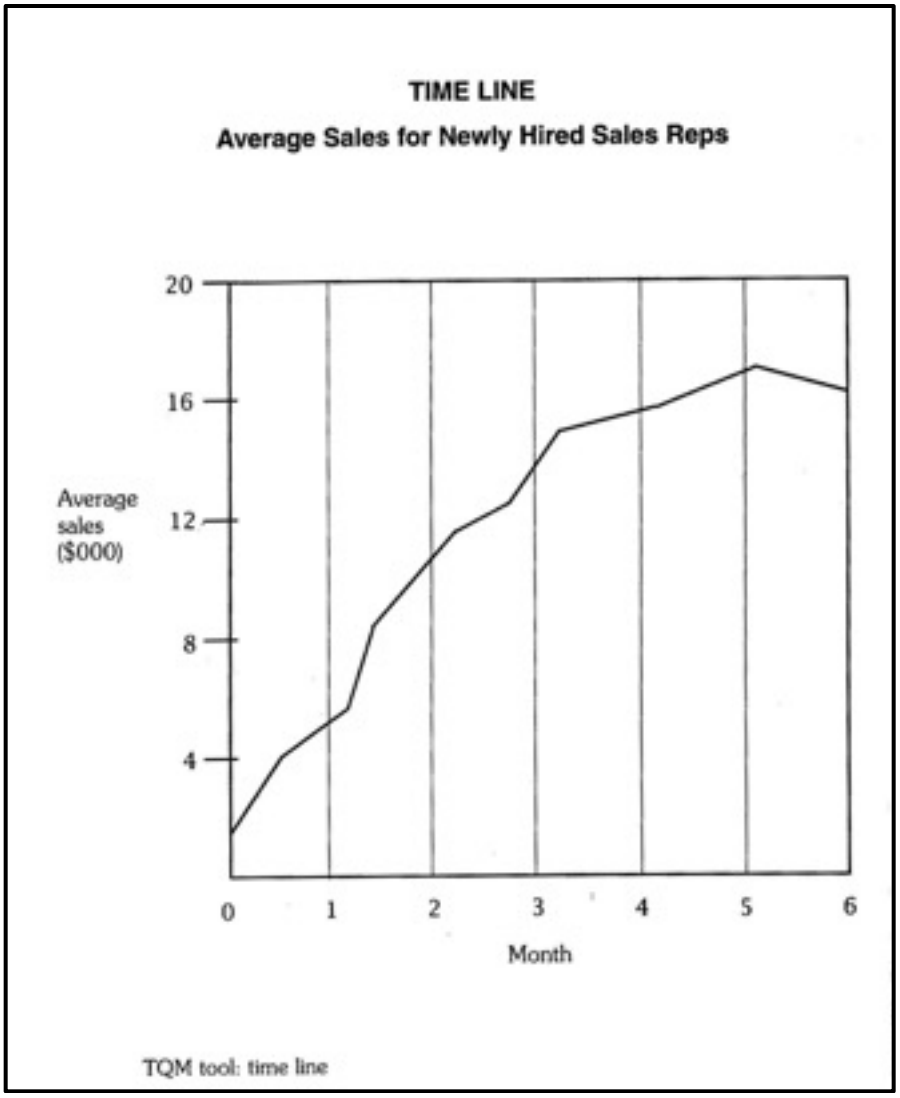
This can be used for monitoring a process according to tolerance limits (Upper control limit & lower control limit). Eg: To monitor the dimension of a product while manufacturing.



07.02.02.07 Time Line (Run Chart / Trend Chart)

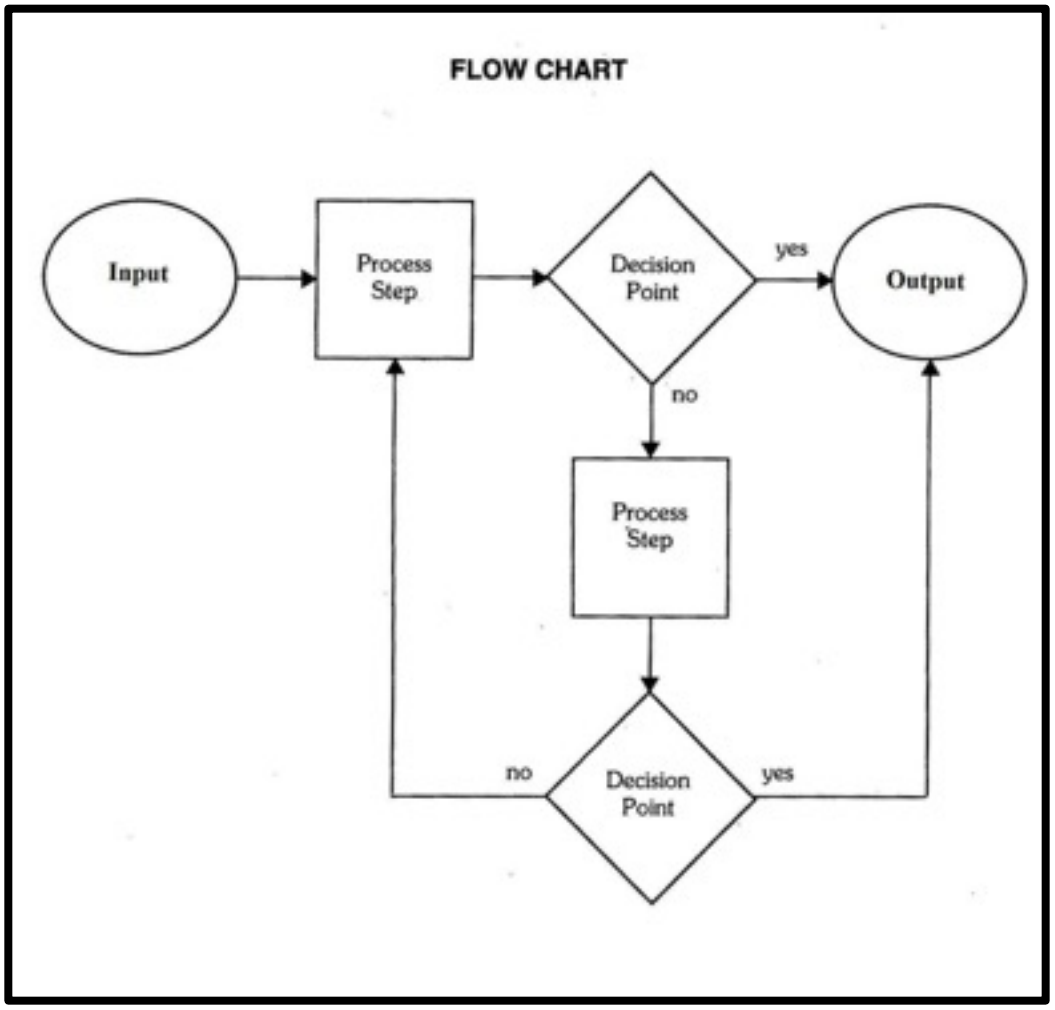
A graphical display of variations in data over time:

Example: Monitoring sales performance of new recruits. X-Axis: Time& Y-axis: Sales value.



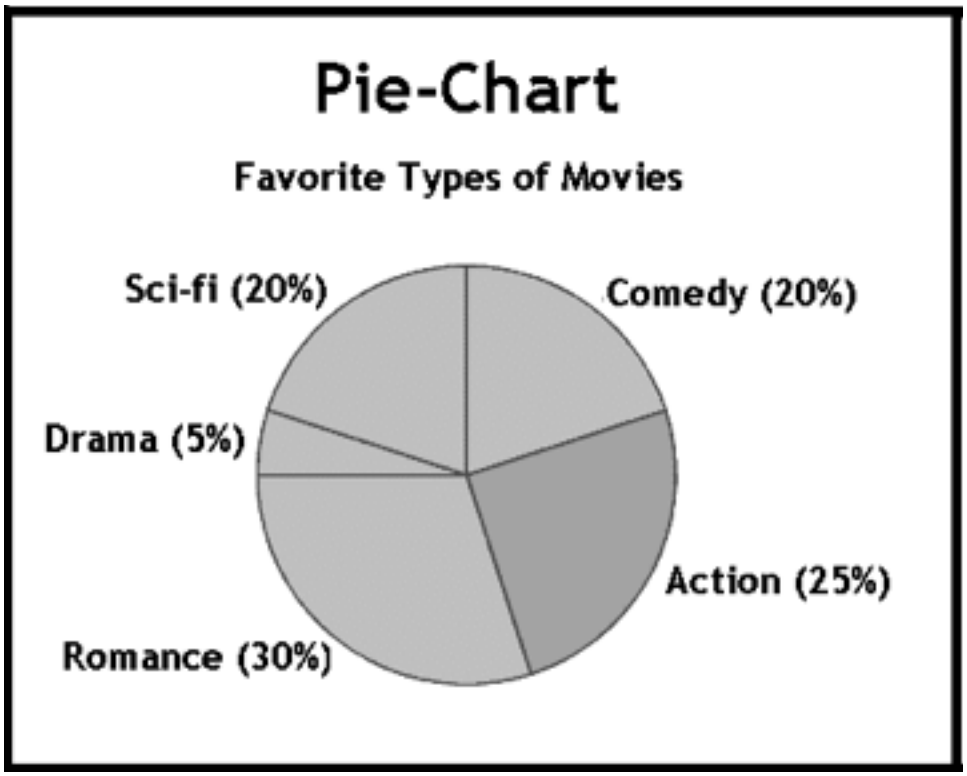
07.02.02.08 Flow Chart

A visual representation of the steps in a complex process:



07.02.02.09 Pie-Chart

In this type of chart, we can visualize the proportion of each element in a total system. Given below is an example of a pie-chart reflecting product-mix of favorite movies.



07.03.00 Implementing TQM

Planning for TQM

It is not always necessary to throw away your current way of doing business.TQM does not require change for the sake of change. Plan to keep the procedures / processes that work well for you and modify / improve the procedures / processes which are holding back in terms of Quality. Keep in mind that there is no single perfect method for establishing TQM program. The best TQM systems are those that are well adapted to the individual company.

Planning for TQM should be customer oriented and goal oriented.

07.03.01 Eight Steps in TQM Implementation

Step 1: Top Management commitment in terms of:

- Allocation of resources.
- Willingness to change the culture in the organization.

Step 2: Learn about TQM concepts and tools:

Step 3: Decide on a quality vision:

A quality vision is a simple statement that summarizes your company's approach to QUALITY.

Points for consideration:

- Consult with all departments and functions.
- Keep it concise.
- Keep it customer oriented.
- Do not make it too general.
- Refer to competition and market.
- Focus on priorities.
- Make it realistic.

Example 1:

For every product or service we provide, we will meet or exceed the customer's requirement with out exception. Our standard performance is:

"Do it right today and better tomorrow."

Example 2 - Xerox Corporation:

Xerox is a quality company. Quality is the basic principle for Xerox.

Quality means providing our customers with innovative products and services that fully satisfy their requirement. Quality improvement is the job of every Xerox employee.

Step 4: Establish a TQM team and name the TQM director:

TQM director could be a senior manager in the Company at the level of a Vice President.

Step 5: Establish quality policies and procedures:

Step 6: Set total quality objectives and provide a yardstick for measuring the performance. Set realistic standards:

Step 7: Focus on priority projects:

Assign priority for such projects that directly address the customer concerns.
Examples: Cycle time reduction etc.
Give priority to solve persistent problems.

Step 8: Set action plans and state the needed steps:

Reference to: who, what, when, where and how?

07.03.02 Checklist of areas needing modifications / improvement

07.03.02.01 Management:

- Involvement of Senior Managers.
- Training of Managers in TQ concepts.
- Reward system.

07.03.02.02 Information:

- Customer data.
- Supplier data.
- Field performance data.
- Tracking systems.

07.03.02.03 Planning:

- Planning for quality leadership.
- Planning for productivity improvement.
- Processes.

07.03.02.04 People:

- Training.
- Rewards.
- Recognition.
- Employee involvement.
- Job redesign.

07.03.02.05 Design and Production:

- Product design to incorporate customer requirement.
- Address quality issues in all phases of production.
- Improve processes and systems.
- Suppliers-Quality indicators.

07.03.02.06 Customer relations

- Mechanism to attend to customer complaints.
- Tracking complaints.
- Measurement of customer satisfaction.
- System to determine customer expectation.

07.03.03 TQM Environment

TQM does not mean overturning your company's traditional business methods. A TQM culture has three elements which are in fact business tactics – ones you are undoubtedly using to a large extent.

1. **Awareness:** The first step is to build awareness among all the employees. This will enable the employees to think of quality and generate ideas for continuous improvement. Organize round table discussions involving all employees and make presentations. Display quality related posters.

2. **Training:** Next step is to train the Managers and all other employees in TQM concepts. E.g. Quality concepts, problem solving, teamwork, process management etc
3. **Environment:** An environment characterized by a TQM culture is the one where all the obstacles to quality are removed.

- Demonstrate commitment.
- Customer orientation.
- Employee participation in problem solving.
- Promote teamwork.
- Reward and recognition.

07.03.04 TQM applications in Business

The principles of TQM apply to every department and function in an organization.
A customer orientation is essential.
TQM thrives on Synergy and cross-functional cooperation.

07.03.04.01 Customer Service

07.03.04.01.01 Application of TQM in Customer Service pays rich and immediate dividends:

- Customer Service is an area of direct contact with customer.
- Service plays a large role in customer satisfaction.
- Mall improvements have big impact on customers.

07.03.0 4.01.02 Here are the four rules that have guided successful application of TQM to customer service

1. Seek out customer expectations:

1. Is it the price?
2. Is it delivery/availability?
3. Is it field service?

2. Quick response to complaints:

- Good tracking system is essential.
- Seek out the problem and fix it. Do not wait for a formal complaint.

3. Know the customer's customer:

Seek out the requirements of customer's customer. E.g. Documentation etc.

4. Recognize that the customer needs are dynamic in nature and update your processes and systems.

07.03.04.01.03 Implementing TQM in Customer Service

It is a step-by-step approach and must be a part of companywide TQM program.

Step 1: Planning:

Set up realistic goals.
Ask:

- Will customer recognize the value of the service?
- Does it add value to the customer?
- Will the customer use the service?

Example: Dispatch of Bank statements to customers: Timeliness.

Step 2: Measure the customer service in terms of:

- Accessibility.
- Amiability.
- Responsiveness.

Step 3: Empower the service staff:

- Training.
- Career growth.
- Job redesign.
- Decision making.

Step 4: continuous improvement in customer service:

- Customer needs are dynamic and demand updating of your processes and systems.
- Trace the root cause of a problem and eliminate it. Example: Delays in courier service may be traced to the system of labeling.

07.03.04.01.04 Questionnaire to Service Personnel

The answers to the questions provide ideas for quality improvement.

A. Which aspects of service are more critical to customer?

- Field service?
- Availability of spares?

B. What improvements would have most positive effect on service as seen by the customer?

- Timely response?
- Price of spare parts?

3. What are the inputs to service staff to do their jobs better?

- Training?
- Empowerment?

4. What is the most important function to measure to gauge effectiveness?

E.g. Time of conflict resolution.

5. What are the ways to obtain customer feedback?

6. How could the reward / compensation system be changed?

07.03.04.02 Marketing

07.03.04.02.01 Key issues in TQM in Marketing

1. Respond to customers: End users are not the only customers for marketing. Marketing services dealers, distributors and not just end-users. Marketing should survey and respond to individual needs of dealers/distributors/end-users. Example: Provide financial assistance to dealers/distributors.

2. Eliminate waste. Example: Is the discount coupon system cost effective?

3. Evaluate Suppliers' quality: Evaluate the performance and effectiveness of Advertisement Agency.

4. Emphasize on teamwork. Involve design and production engineers in service activities.

07.03.04.02.02 TQM at Work; Case Study

One company set up a program to offer financial support to key dealers experiencing cash flow problems. It also provided training to other dealers who were expanding to other territories.

07.03.04.03 Sales

07.03.04.03.01 Key Issues in TQM in Sales

- Customer feedback through sales staff.
- Value added by sales staff, such as providing information to customers.
- Establish sales measurements: Rate of mistakes in order booking, on-time deliveries, profitability of individual sales, and response time to customer complaints.

07.03.04.03.02 Checklist for TQM in Sales

- Change the structure of sales department?
- Involve sales staff in quality planning.
- Empowerment of sales staff.
- Emphasis on customer satisfaction.
- Emphasis on timely service.
- Continuous improvement in sales' process.
- Interaction with other departments.
- Benchmark for sales productivity.

07.03.04.03.03 TQM at Work: Case Study

A company selling Machine Tools wanted to apply TQM for Sales.
Problem faced: Order booking up to Delivery was too slow.

Approach:

1) TQM team is formed comprising Sales Reps, Engineers and shipping Mgr.
2) A flow chart is made to describe the process from order booking up to delivery.
3) A PARETO diagram is made indicating where major delays occurred.
4) Procedural changes are made in computer tracking system.
5) Sales Representatives talk to Factory directly in case of any problem.
6) Review of process and continuous improvement.

07.03.04.04 Manufacturing

The competitive environment in which most companies operate requires a thorough and effective quality program in manufacturing sector. Many of the concepts of TQM, such as Statistical process control are used in manufacturing.

07.03.04.04.01 Key issues in TQM in Manufacturing

- Use TQM Tools such as SPC
- Find the root cause of a quality problem and eliminate it
- Emphasize on Cycle time improvement / Use less no of steps in the process
- Cut buffers- WIP and inventory etc. Buffers cover up and hide inefficiencies.
- Cross Training / Work force becomes more flexible. (Maintenance and self inspection etc…)

07.03.04.04.02 TQM vs. Traditional Approach in Manufacturing

TQM Approach ▼	Traditional Approach ▼
Economical production of small batches	Large batches and profitability
Lean inventory	Buffer stocks
JIT production/deliveries	Long lead times
Involvement of suppliers	Suppliers not involved
Multiple skills	Single skill
Continuous improvement	Look for break through
Customer oriented	Production oriented
Preventive tactics	Reactive tactics
Teamwork	Authoritarian

07.03.04.04.03 TQM at Work- Manufacturing Case Study

A company found that a major source of quality problem was extended cycle times. Approach: As part of TQM, the workers were trained in reading blue prints. Some workers were trained in tooling and setup. As a result, the cycle time came down drastically and the company was better able to respond to customers.

07.04.00 Continuous Improvement

07.04.01 Introduction

Organizations should strive to achieve perfection by continuously improving the business and production processes.

Improvement is made by:

- Viewing all work as a process.
- Making all processes efficient.
- Anticipating customer needs.
- **CEDAC** (**C**ause and **E**ffect **D**iagram by **A**ddition of **C**ards) Also known as Fish-Bone diagram (Ref. Chapter 05.10.00).
- Elimination of waste.
- Eliminate non-value adding activities.
- Bench marking to improve competitive advantage.
- Using technical / management tools : SPC(Statistical process control, QFD. (Quality function deployment, ED (Experimental design, BM (Bench marking), PDCA approach, Kaizen etc…

07.04.02 Planning / Design, Control, Improving Organizational Process

The Juran Trilogy: (developed by Dr Joseph Juran – TQM Guru)

It has three components:

1) Planning / Design.
2) Control.
3) Improvement.

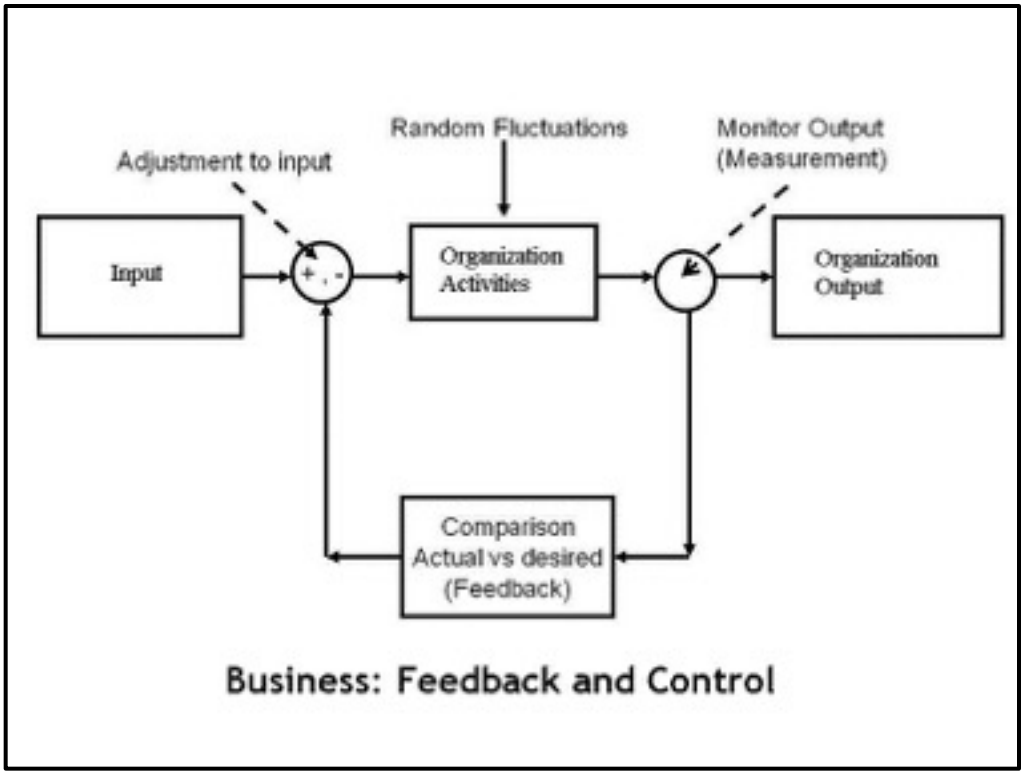
07.04.02.01 Planning / Design (Product / Facilities / Process)

- Find customer needs (Use PARETO DIAGRAM to list vital few features of a product).
- Form a cross functional team in the organization (Comprising Production, Marketing, Design and Finance representatives) to finalize design features in line with customer needs, most economically; Quality function deployment (QFD),

Taguchi's quality engineering, and quality by design are some of the approaches that can be used.

- Next step is to develop the production process able to produce and service the features. Activities include determination of necessary facilities/machines, training, operation, control and maintenance.
- Build a prototype environment to test the process.
- Then transfer the plans to operations.

07.04.02.02 Control



Steps involved are:

1. Determine the items/objects to be controlled and their unit of measure.
2. Set the specifications of output/goals.
3. Arrange for inputs, process the inputs for conversion to a final product/output, and measure the product/output for performance. Use a feedback loop ***(Ref to the Framework of Production and operations Management System)***: measure the

output, compare with standards, and act on the difference ie take corrective action such as changing tools, training, improving the quality of input material etc.

4. Compare the actual performance vis-à-vis standards / goals.

Use of Statistical Process Control (SPC) is an example of quality control /TQM applications.

07.04.02.03 Improvement

Find a remedy for correcting the deviations. Try continuous improvement to be better than competition.

A) Improvement Strategies:

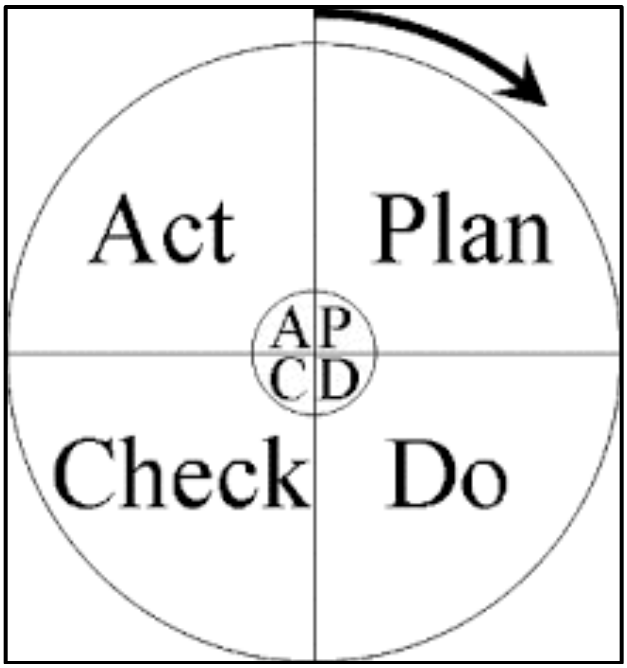
1) Repair: This is a short-term measure, but immediate.
2) Refinement: Refinement improves efficiency and effectiveness. This process is continuous and gradual. This is the concept behind *KAIZEN*.
3) Renovation: Results in major improvements; E.g. Technology improvements/ Use CNC Machines instead of conventional machines.
4) Reinvention: Introduction of a new process, service or product based on the customer needs. E.g. BPR (Business Process Re-engineering).

B) Types of Problems:

1) Compliance .
2) Unstructured.
3) Efficiency.
4) Process Design (E.g. Use Bench Marking for improvement).
5) Product Design (E.g. Use Quality Function Deployment).

07.04.03 The PDCA Cycle: Deming Cycle

PDCA (**"Plan-Do-Check-Act"**) is an iterative four-step problem-solving process typically used in business process improvement. It is also known as the **Deming Cycle**, Shewhart **cycle**, **Deming Wheel**, or **Plan-Do-Study-Act**.



The PDCA Cycle:

1) **PLAN:** Establish the objectives and processes necessary to deliver results in accordance with the expected output. By making the expected output the focus, it differs from other techniques in that the completeness and accuracy of the specification is also part of the improvement.

2) **DO:** Implement the new processes.

3) **CHECK:** Measure the new processes and compare the results against the expected results to ascertain any differences.

4) **ACT:** Analyze the differences to determine their cause. Each will be part of either one or more of the P-D-C-A steps. Determine where to apply changes that will include improvement. When a pass through these four steps does not result in the need to improve, refine the scope to which PDCA is applied until there is a plan that involves improvement.

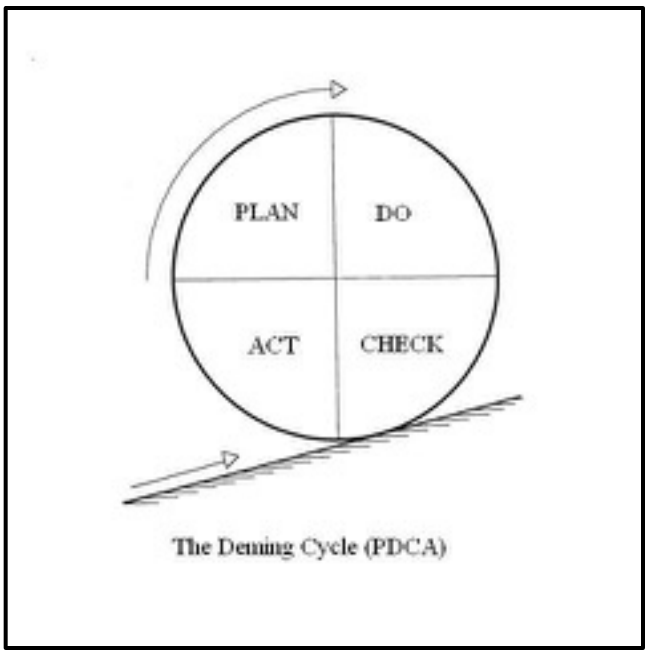
Cycles of Improvement

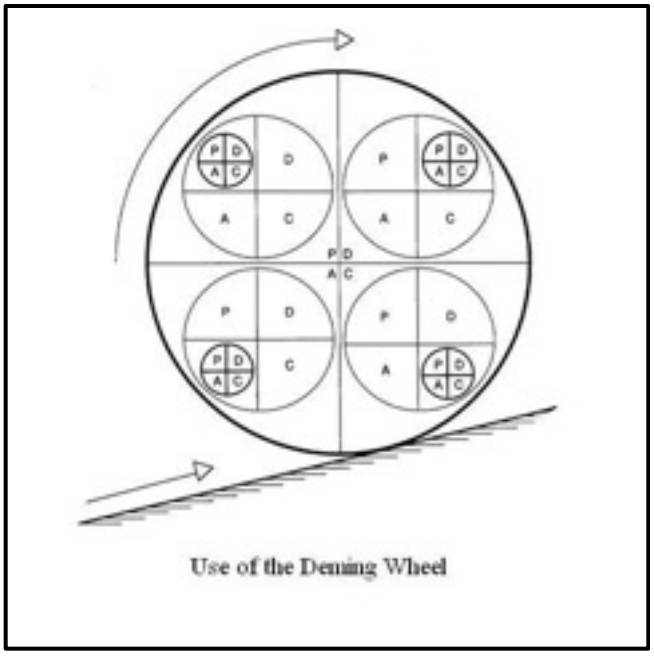
Many times an immediate and dramatic improvement is not possible. There truly is no "quick fix" for many problems. Sometimes, it is not even possible to completely define the problem, much less the fix. PDCA provides a method for improving any process systematically. Used consistently, PDCA delivers improvements.

Practitioners use PDCA as a guide to analyze processes. The goal is to identify errors or omissions that cause the output of the process to fall short of expectations. PDCA is useful anywhere the object is improved performance:

- As a model for continuous improvement.
- When starting a new improvement project.
- When developing a new or improved design of a process, product or service.
- When defining a repetitive work process.
- When planning data collection and analysis in order to verify and prioritize problems or root causes.
- When implementing any change.

Fig : Deming Wheel / PDCA CYCLE(S) ➔ Wheels with in wheels:





Use of the Deming Wheel

The wheel inexorably mounts the rising slope of successive improvements in every area of the company. There is a PDCA wheel in each of these basic activities. In each section of these 4 PDCA wheels there is yet another PDCA wheel, and so on. It means that we can plan the planning.

This is somewhat akin to a planetary gear system.

W. Edwards Deming

Born on October 14, 1900 (Sioux City, Iowa, USA)

Died on December 20, 1993 (Washington DC, USA)

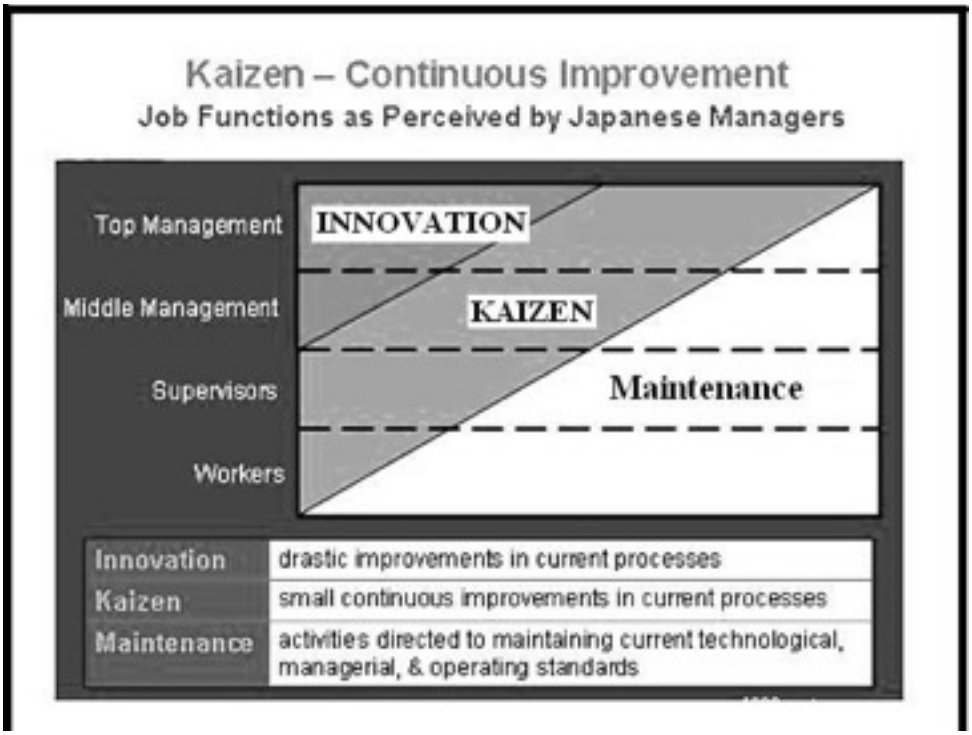
Fields: Statistician

Alma-mater: University of Wyoming, University of Colorado, Yale University

07.04.04: *KAZEN* – Continuous Improvement

Kaizen is a Japanese word for continuous improvement.
Improvement is gradual (not radical)

Kaizen is generally carried out my middle management. Top management is more involved in innovation activities. Maintenance is generally carried out by supervisors and workers; and to some extent by top / middle management.
The following figure illustrates this concept.



The Kaizen improvement focuses on the use of:

1. Value-added work activities.

2. ***Muda***, which refers to the seven causes of waste viz. transportation, over-production, delay, processing, inventory, wasted motion, and defective parts.

3. Principles of motion study and cell technology.

4. Documentation of standard operating procedures.

5. Principles of material handling.

6. Five ***S's***; Japanese words:

- ✓ ***Seiko*** (Proper arrangement).
- ✓ ***Seiton*** (Orderliness).
- ✓ ***Seiketso*** (Personal cleanliness).
- ✓ ***Seiso*** (Clean up).
- ✓ ***Shitsuke*** (Discipline).

7. Visual management / communication (Visual Displays).

8. JIT (Just-in-Time) production.

9. ***Poka-yoke***: Detecting / preventing errors.

10. Team dynamics, which include problem-solving, communication, and conflict-resolution.

Kaizen relies heavily on a culture that encourages suggestions by operators who continually and incrementally try to improve a process. The PDCA cycle described earlier may be used to implement Kaizen concepts. “CEDAC” and “Ishikawa-Diagram (Fishbone Diagram)” techniques enumerated earlier are also very useful in implementation of Kaizen.

07.05.00 Six-Sigma Process Capability

07.05.01 Introduction

Before we delve in to Six-Sigma capabilities, we need to familiarize ourselves with the basic concepts of normal distribution.

In any probabilistic situation each course of action may lead to a number of different possible outcomes. A listing of all the possible outcomes of a random variable with each outcome's associated probability of occurrence is called probability distribution.

We are mainly interested in the normal distribution curve to understand the significance of Six-Sigma concept. The random variable in this type of probability distribution can take any numeric value in a range or an interval. If we measure the sizes (say diameter) of all sand grains on a beach, the size can take any value in a range and it would be a continuous probability distribution.

If we plot the size of sand grains on X-Axis and the associated frequency on Y-Axis, it would be bell-shaped curve with a normal distribution pattern. Likewise, if we plot heights and weights of all students in a college with the associated frequencies, the results would be similar. Same would be the case if we tabulate the income levels of all families in any region.

Nature seems to follow a predictable pattern for many kinds of measurements. The sum of probability to each of these infinitely large number of values is no more than '1' (One).

In probability theory, the **normal** (or **Gaussian**) **distribution** is a very commonly occurring continuous probability distribution - a function that tells the probability that any real observation will fall between any two real limits or real numbers, as the curve approaches zero on either side. It is a bell shaped curve.
Given below are the details of Normal Distribution curves.

The **standard deviation** (**SD**) (represented by the Greek letter sigma, **σ**) measures the amount of variation or dispersion from the average. A low standard deviation indicates that the data points tend to be very close to the mean (also called expected value); a high standard deviation indicates that the data points are spread out over a large range of values.

Following example illustrates the concept of standard deviation

For a finite set of numbers, the standard deviation is found by taking the square root of the average of the squared differences of the values from their average value.

For example, consider a **population** consisting of the following eight values:

$$2,\ 4,\ 4,\ 4,\ 5,\ 5,\ 7,\ 9.$$

These eight data points have the mean (average) of 5:

$$\frac{2+4+4+4+5+5+7+9}{8} = 5.$$

First, calculate the difference of each data point from the mean, and square the result of each:

$$\begin{array}{ll} (2-5)^2 = (-3)^2 = 9 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (7-5)^2 = 2^2 = 4 \\ (4-5)^2 = (-1)^2 = 1 & (9-5)^2 = 4^2 = 16. \end{array}$$

Next, calculate the mean of these values, and take the square root:

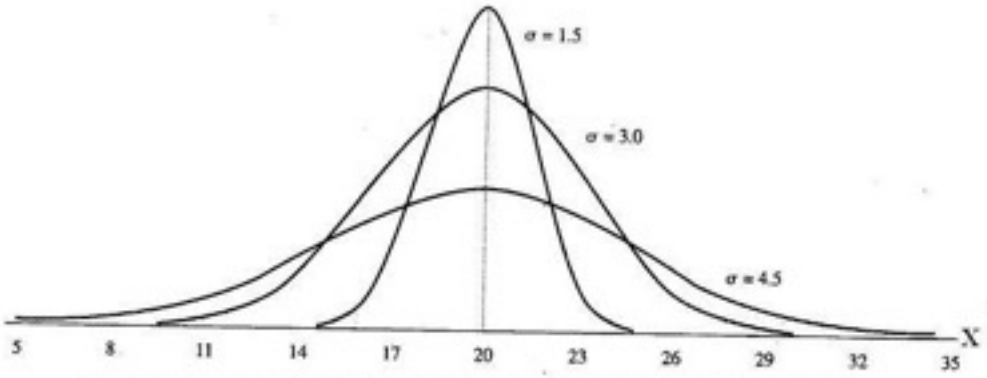
$$\sqrt{\frac{9+1+1+1+0+0+4+16}{8}} = 2.$$

Standard Deviation **σ** = 2 for this population

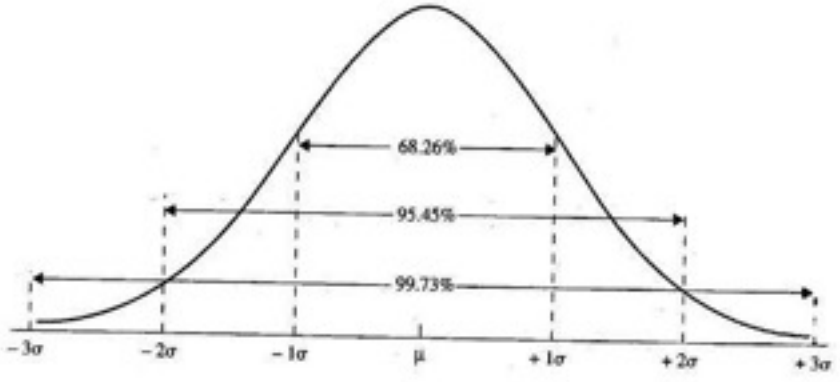
This quantity is the *population* standard deviation, and is equal to the square root of the variance.

It is a measure of the spread of the normal distribution. Smaller the standard deviation is, lesser the spread.

It is the best measurement of process variability, because the smaller deviation-value, the less variability in the process.



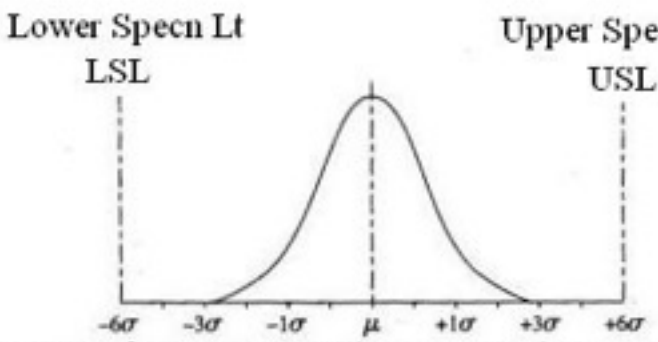
Normal Curves with Different Standard Deviations, but identical Means.
Smaller the standard deviations is, lesser the spread



Percentage of values included between certain values of standard deviation.
These percentages hold good, irrespective of the shape of normal distribution curve.

NORMAL DISTRIBUTION CURVES

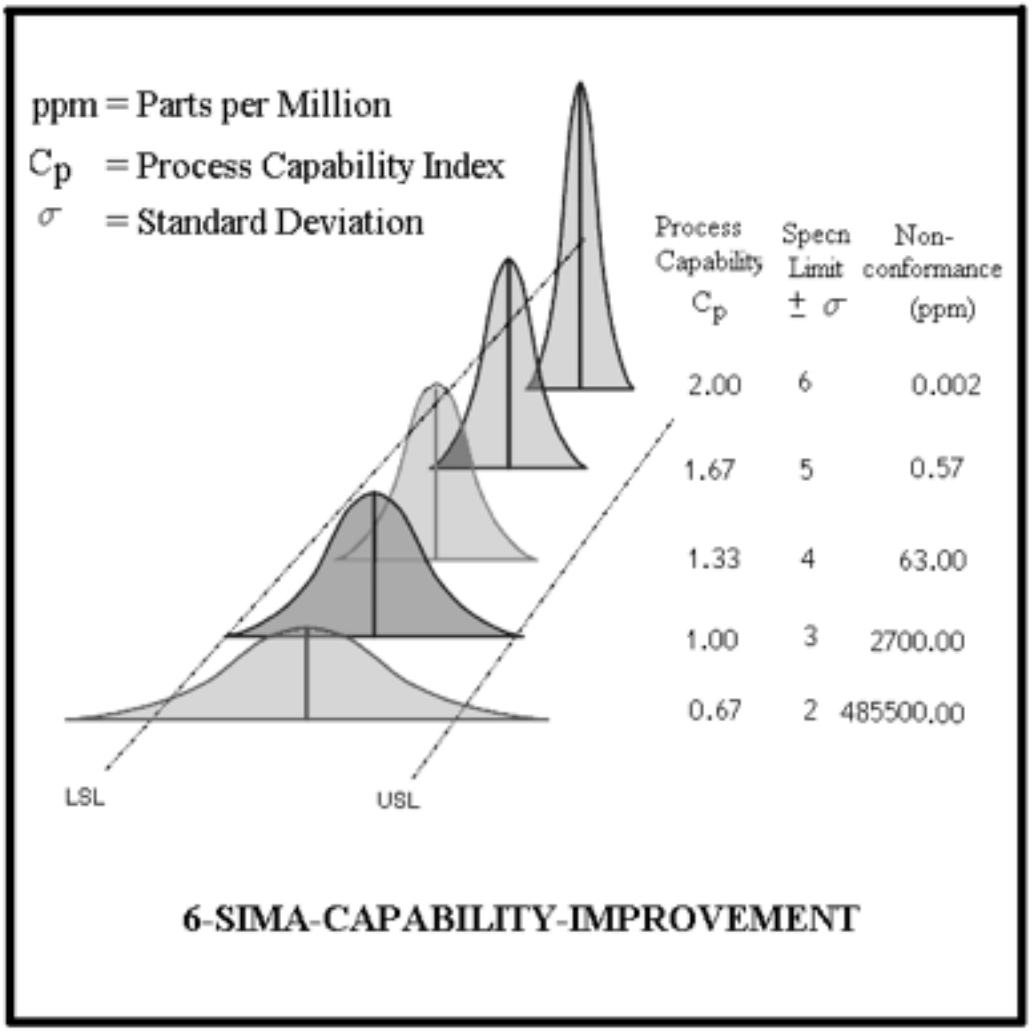
The following figure shows a process that is normally distributed and centered with the upper and lower specification limits (USL and LSL) established at + or – 6 **σ.**
For this situation, 99.9999998 % of the product or service will be between the specifications, and the nonconformance rate will be 0.002 parts per million, or 2.0 per billion. The situation diagrammed represents a process capability index (Cp) of 2.0. A Cp of 1.33 has been a defacto standard. The table below shows the percentage between specifications, the nonconformance rate, and process capability for different specification limit locations.



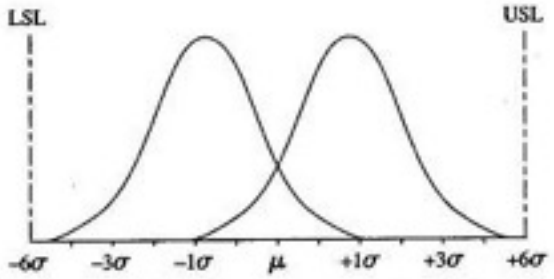
Nonconformance rate when process is centered

Specification Limit	Percent Conformance	Nonconformance Rate (ppm)	Process Capability(C_p)
±1σ	68.7	317300	0.33
±2σ	95.45	485500	0.67
±3σ	99.73	2700	1.00
±4σ	99.9937	63	1.33
±5σ	99.999943	0.57	1.67
±6σ	99.9999998	0.002	2.00

Nonconformance rate and process capability when the process is centered.



According to six-sigma concept, processes rarely stay centered. The center tends to shift above and below the target, mean. The following figure shows a process that is normally distributed, but has shifted within a range of 1.5 **σ** above and 1.5 **σ** below the target. For the diagrammed situation, 99.9996600 % of the product or service will be between specifications and the non conformance rate will be 3.4 ppm. This off-center situation gives a process capability index (Cpk) of 1.5 with 1.0 being the defacto standard. Please note that the index is calculated differently and, therefore, has a different symbol - Cp vs Cpk. Cp = Cpk when the process is centered. The table below shows the percent specifications, the nonconformance rate, and process capability for different specification limit locations.

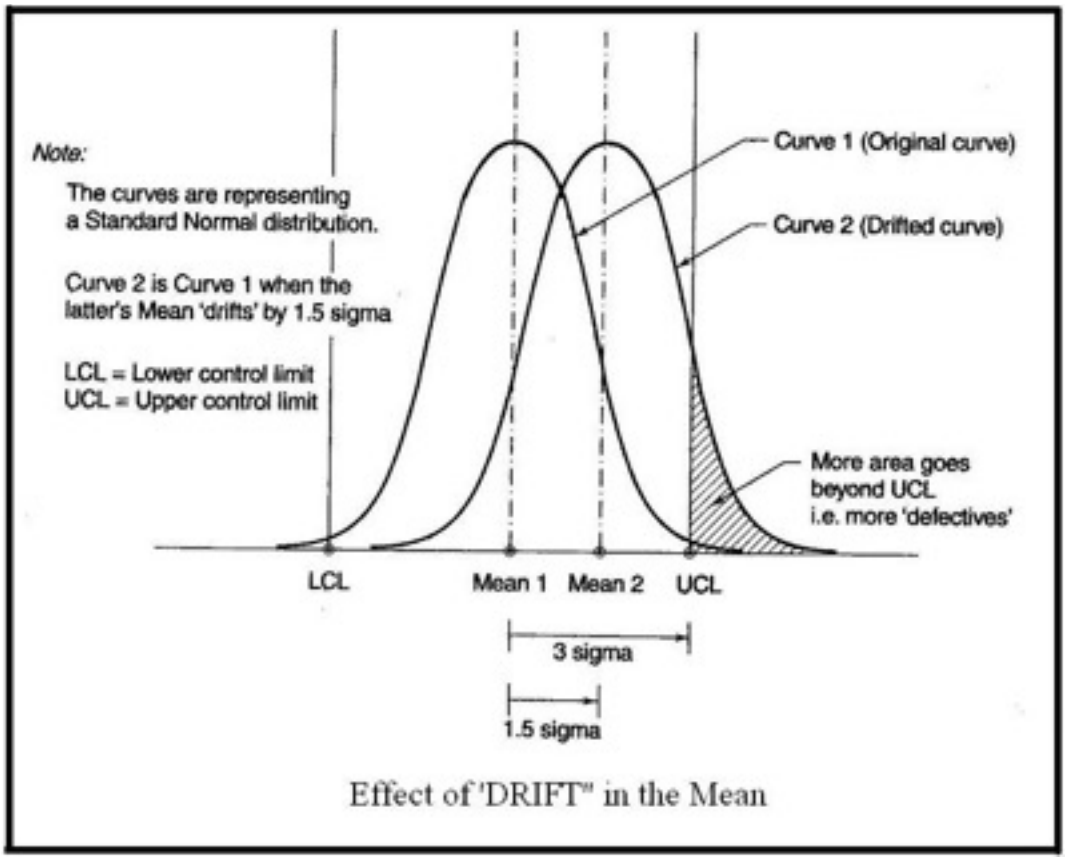


Nonconformance rate when process is off-center $\pm$ 1.5 σ

Specification Limit	Percent Conformance	Nonconformance Rate (ppm)	Process Capability (C_{pk})
±1σ	30.23	697700	− 0.167
±2σ	69.13	308700	0.167
±3σ	93.32	66810	0.500
±4σ	99.3790	6210	0.834
±5σ	99.97670	2330	1.167
±6σ	99.9996600	3.4	1.500

Nonconformance rate and process capability is off-center $\pm$ 1.5 σ

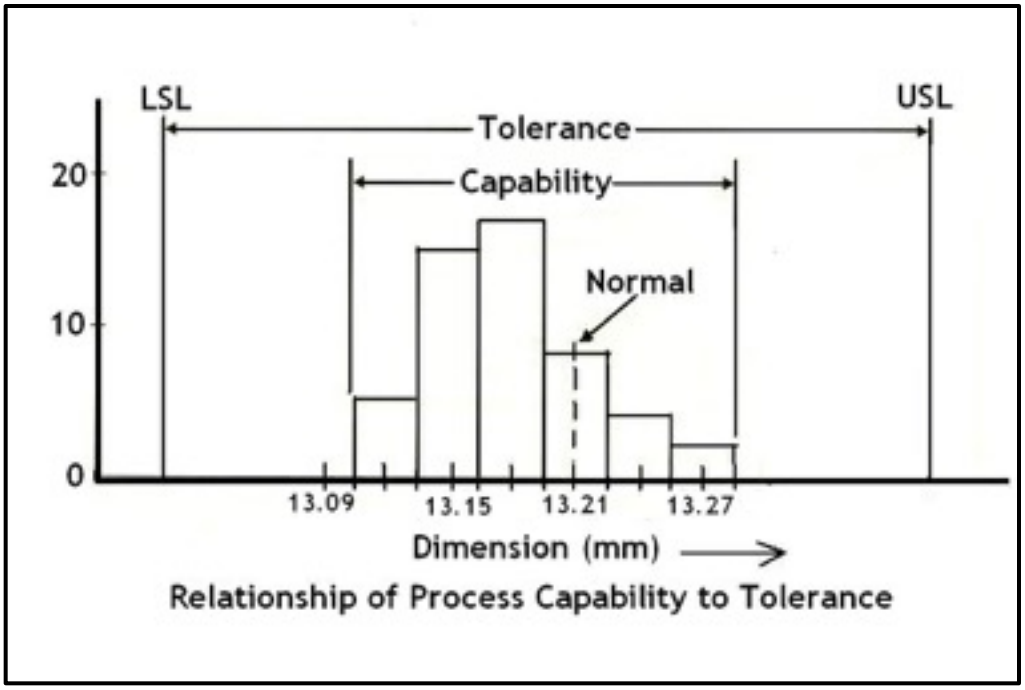
Practically, maximum shift is found to be 1.5 **σ** across the industry.
The effect of a **"1.5 σ drift"** can be seen in the following figure.



Effect of 'DRIFT" in the Mean

07.05.02 Process Capability

The tolerance for a dimension of a part is specified by the designer to meet a particular function. Tolerence = USL – LSL.



Relationship of Process Capability to Tolerance

USL = Upper Specification Limit

LSL = Lower Specification Limit

C_p = Capability Index

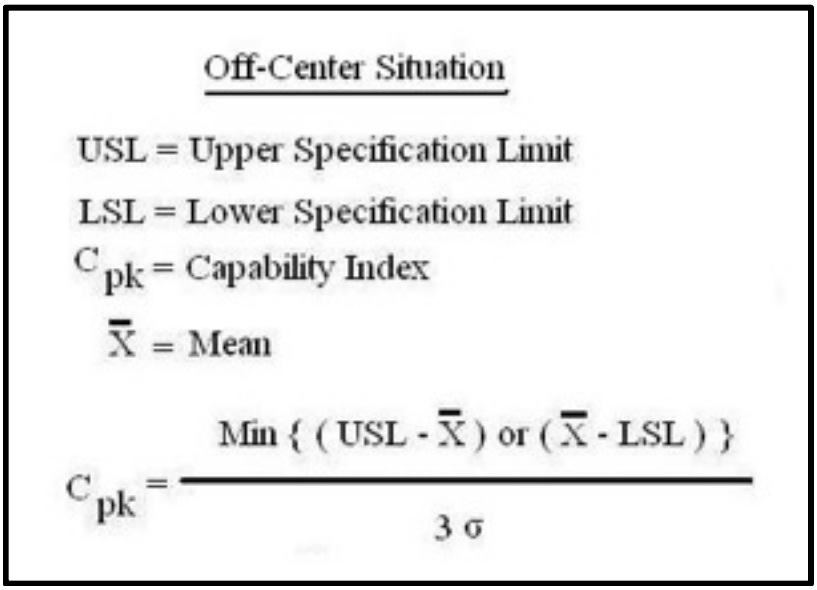
6σ = Process Capability

C_p is defined as :

$$C_p = \frac{USL - LSL}{6\sigma}$$

If the capability index > 1, the process is capable of meeting the specifications; if the index < 1, the process is not capable of meeting specifications.Because the process is shifting back and forth, a Cp value of 1.33 has become a defacto standard, and some organizations are using a figure of 2.00. Using the capability index concept, we can measure quality, provided the process is centered.

In case of off-center situation we use the capability index called Cpk.
Cpk is defined as:



A Cpk value of 1.00 is the defacto standard, with some organizations using a value of 1.33.

Statements concerning Cp and Cpk:

1. The Cp value does not change as the process center changes.
2. Cp = Cpk when the process is centered.
3. Cpk is always equal to or less than Cp.
4. A Cpk value greater than 1.00 indicates that the process conforms to specifications.
5. A Cpk value les than 1.00 indicates that the process does not conform to specifications.
6. A Cp value less than 1.00 indicates that the process is not capable.

7. A Cpk value of zero indicates that the average is equal to one of the specification limits.

8. Negative Cpk value indicates that the average is outside the specifications.

Quality professionals use these 8 items to take corrective action. For example, if a Cp value is less than 1, we need to take corrective action. We either change the tolerance limits or modify the process to reduce the standard deviation or variability.

07.05.03 Need for Six-Sigma

We need to consider the technological complexities and multi-stage processes to understand the need for Six-Sigma. The need for "zero defects" is essential for many items in these days of technology revolution. For instance the computers have to be totally defect-free. To add to the woes, multiple processes are involved in the process of production of physical goods or creation of services. Multi-stage operations would compound the errors.

If 3 Sigma quality levels were to be applied, it would be impossible to produce modern computers or aircraft. Banking system would collapse at 3 Sigma level. It would be virtually impossible to run credit card system at this level, as there would be over a billion errors each year.

What happens if we practice 3 Sigma level of quality control in a multi-stage process?

Let us consider the following example.

We have a yield of 99.72 at 3-Sima level.
If we have just a 3-stage process, the overall yield would be:
0.9973 X 0.9973 X 0.9973 = .09919 (i.e 8,100 defects / failures per million which is quite unacceptable)

For a 8-step process the yield would be:
0.9919 X 0.9919 X 0.9919 = 0.9759 (i.e. 24,100 defects / failures per million which is totally unacceptable)

The imperative of Six-Sigma levels of quality is therefore quite obvious. It is an "absolute- must"

TQM / Six – Sigma Capability

To ensure Six-Sigma application to a process we need to adopt an appropriate technology and suitable tools.

07.06.00 Leadership

07.06.01 Definition of Leader

A leader is one who instills purposes, not one who controls by force.
A leader strengthens and inspires the followers to accomplished shared goals.
An organization's leaders should set directions and create a customer focus, clear and visible values, and high expectations. Leaders should ensure the creation of strategies, systems and methods for achieving excellence, stimulating innovation, and building knowledge and capabilities.
The leaders should inspire and motivate the entire workforce to contribute, to develop and learn, to be innovative, and to be creative.

07.06.02 Characteristics of Quality Leaders

1. They focus on customer needs.
2. They empower the subordinates.
3. They focus more on improvement, rather than maintenance.
4. They emphasize on prevention, rather than on cure.
5. They encourage collaboration, rather than competition.
6. They train the subordinates, rather than direct them.
7. They learn from problems.
8. They improve communication.
9. They demonstrate heir commitment to quality.
10. They choose suppliers for quality, rather than price.
11. They establish systems to support quality.
12. They encourage and recognize team effort.

07.06.03 Leadership Concepts

In order to become successful leaders, one must have intuitive understanding of human nature -- the basic needs, wants, and habits of people.
A leader must understand that

- ➢ People need, paradoxically, security and independence.
- ➢ People are sensitive to reward and punishment.
- ➢ People like to hear kind words.
- ➢ People can handle only few variables at a time; thus, a leader keeps things simple.
- ➢ People trust their gut reaction more than statistics.

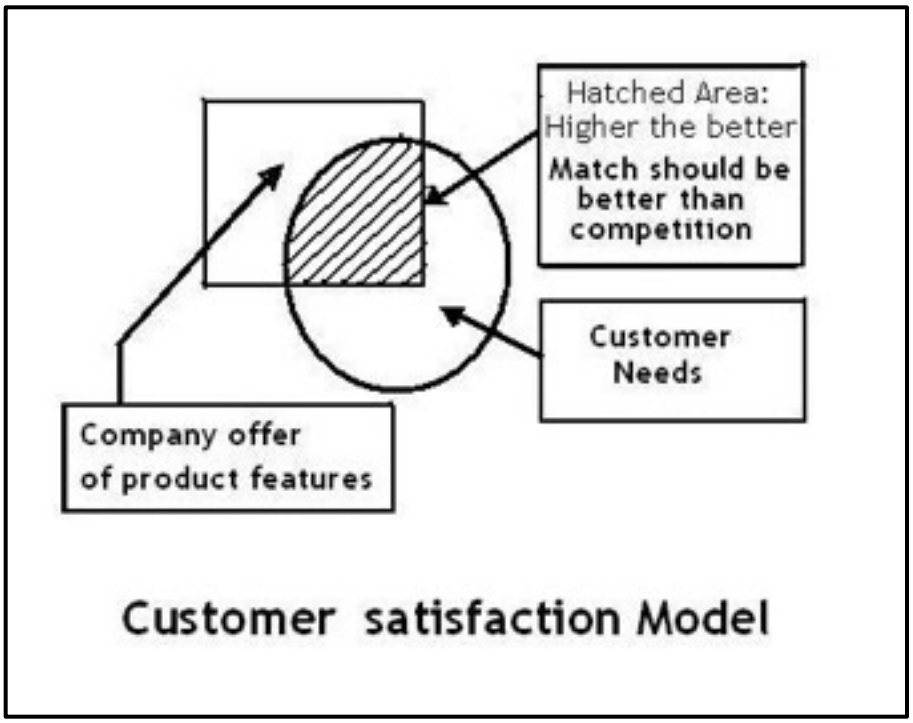
- People distrust variance between rhetoric/ words and actions of a leader.

07.07.00 Customer Satisfaction

07.07.01 Introduction to Customer Satisfaction

The most important asset of an organization is its customers.
Customer satisfaction is a measure of QUALITY which is difficult to measure.
The most successful TQM programs begin by defining quality from customer's perspective.

07.07.02 James Teboul's "Customer Satisfaction Model"



Product features should be in-line with the customer needs. The commonality of the product features and the customer needs is indicated by the hatched area in the above diagram. Hatched area should be maximized and be better than competition for success.

07.07.03 Who is the Customer?

Two types of customers =➔ External and Internal…

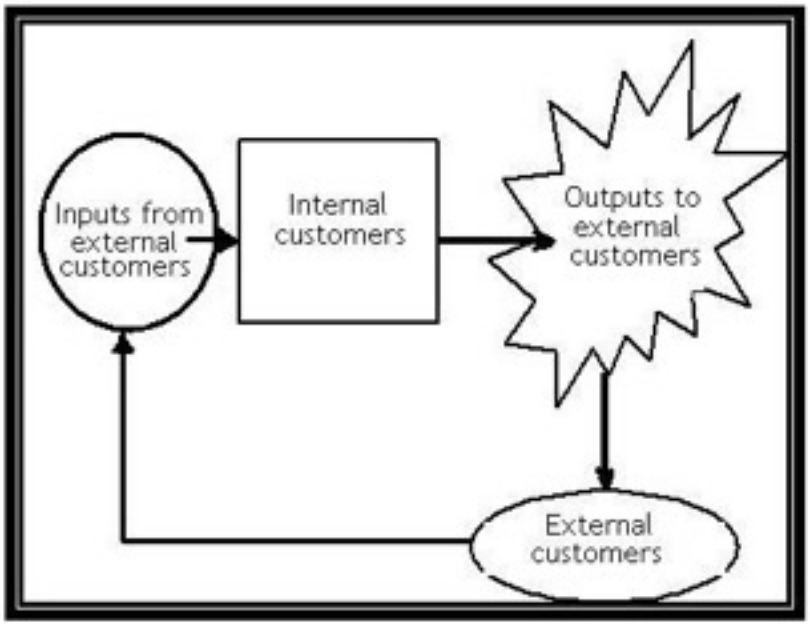
External customers:

- Who uses the product or service?
- Who buys the product or service?
- Who influences the sale of product / service? (E.g. Mechanic, Plumber, Electrician, Consultant etc.)

Internal customers:

Each person in every function of an organization is an internal customer. Each worker has to meet the expectation of the next worker in the chain of processing
a product or service. E.g. Design person ➔ Production person ➔ Marketing person. The next in line is the customer for every worker.

07.07.04 Customer ➔ Supplier Chain



07.07.05 Customer Perception of Quality

One of the basic concepts of TQM philosophy is continuous improvement. There is no fixed quality requirement. The situation is dynamic. Expectations change constantly and customers turn more demanding. We need to be better than competition.

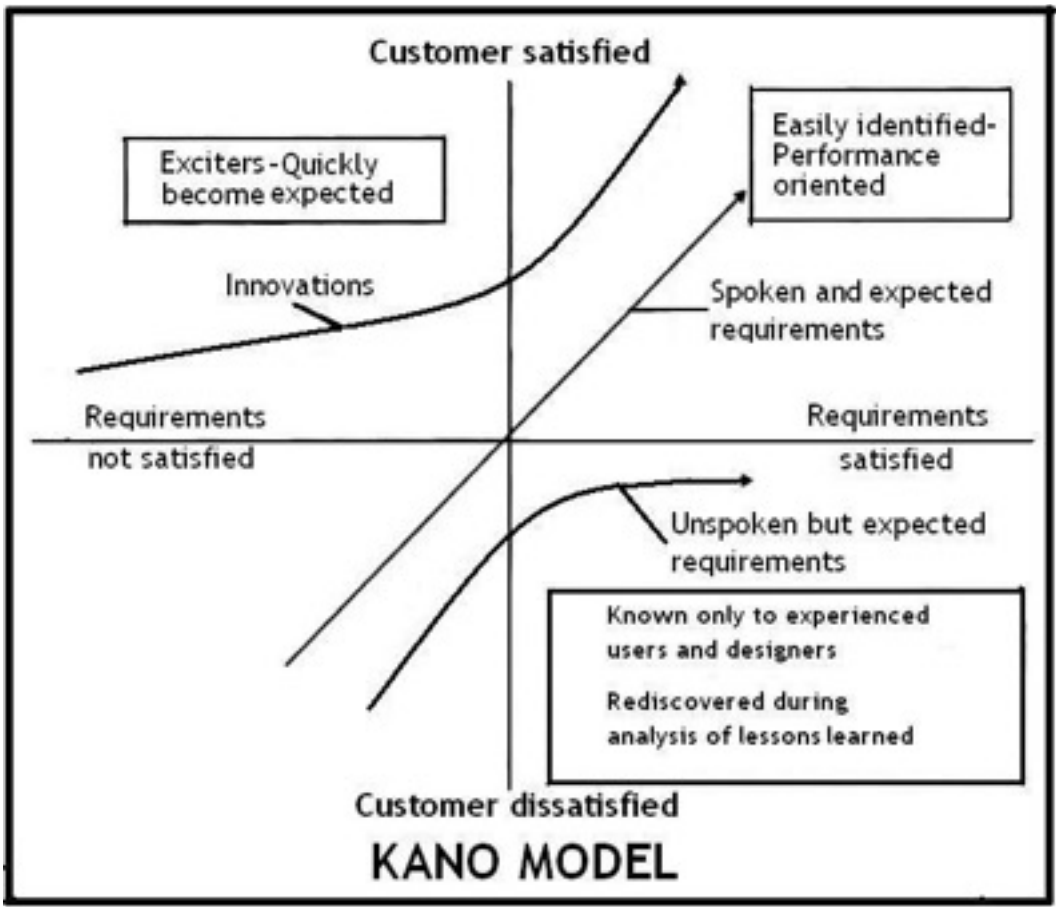
Findings of American Society for quality (AQS): Factors listed in order of importance:

1. Performance.
2. Features.
3. Service.
4. Warranty.
5. Price.
6. Reputation.

07.07.06 KANO MODEL; Customer Satisfaction

The Kano model conceptualizes customer requirements. The model represents 3 major areas of customer satisfaction.
The first area of customer satisfaction, represented by the diagonal line, represents explicit requirements. These include written or verbal requirements and are easily identified, expected to be met, and typically performance related.
The second area of customer satisfaction represents innovations, as shown by the curved line in the upper left corner of the figure. These ideas delight and excite the customer.
The third and most significant area of customer satisfaction represents unstated or unspoken requirements, as shown by the curve in the lower right corner of the figure. The customer may not even be aware of the requirements, or they may assume that such requirements will be automatically supplied.

The Kano's model of customer satisfaction is graphically displayed as under.



07.07.07 Customer Complaints: Measurement of Customer Satisfaction

Actions to be taken to handle customer complaints:

- ➢ Investigate customer's experience by actively soliciting feedback.
- ➢ Develop procedures for complaint resolution.
- ➢ Identify process and material variations and then eliminate the root causes.
- ➢ Communicate details of complaints received and actions taken for complaint resolution; and the details of unresolved issues.
- ➢ Train the front line employees to attend to customer complaints in a systematic manner.

- Improve the response time to customer complaints.

07.08.00 Employee Involvement

07.08.01 Introduction to Employee Involvement

Employee involvement is one approach to improving quality and productivity. It is a means to better meet the organization's goals for quality and productivity at all levels of an organization.

07.08.02 Motivation

07.08.02.01 Theory Developed by Abraham Maslow - Hierarchy of Needs

- ➢ Level 1: Survival means food, shelter and clothing in personal life
- ➢ In factory it means proper lighting, ventilation, phone system, computer information etc…
- ➢ Level 2: Safety and job security.
- ➢ Level 3: Social status cafeteria/conference hall etc; belonging to a group; recognition etc…
- ➢ Level 4: Self-esteem; pride; self-worth; freedom etc…
- ➢ Level 5: Self-actualization: Promotions.

A person's satisfaction could be at any level, depending individual preferences.

07.08.02.02 Frederick Herzberd's Two-Factor Theory

He extended Maslow's theory by adding to the above-mentioned ***"motivators".***
He labeled some additional factors as ***"dissatisfiers or hygiene factors".*** These factors are low salary, lack of fringe-benefits, poor working environment, ill-defined management policies etc. We need to minimize dissatisfiers to motivate the staff.

07.08.02.03 Employee Wants

Some Managers' perceptions of motivators are different fro those of employees. Some Managers tend to rate good remuneration very high, which is not really the case. Employees want interesting work, recognition and involvement first.
Here are the motivating factors listed in order of priority as perceived by employees. Managers' ratings are inside the parenthesis as per some survey.

1. Appreciation (8)

2. Involvement (10)
3. Job security (2)
4. Good pay (1)
5. Promotional growth (3)
6. Good working conditions (4)
7. Loyalty to employees (7)
8. Help with personal problems (9)
9. Discipline (6)
10. Interesting work (5)

07.08.03 Employee Surveys

Employee surveys help managers to assess the current status of employee relations. Some examples of survey:

- Personal characters: such as anxiety level, self-esteem etc…
- Management styles: such as commitment to quality, consideration for subordinates etc…
- Job attitudes: Such as Job satisfaction, social support.
- Nature of work: such as task variety, autonomy and importance.

07.08.04 Empowerment

Empowerment is an environment in which people have the ability, the confidence, and commitment to take responsibility and ownership to improve the process to satisfy the customer needs. Empowerment is not delegation of authority.
Conditions of empowerment:

- Everyone must understand the need for change with out fear of change.
- The system needs to change to the new paradigm.
- The organization must enable the employees, by providing information, training, tools etc…

07.08.05 Teams

A team is defined as a group of people working together to achieve a common objective. A team is better than an individual is. Two heads are better than one. Members pool their individual special abilities to achieve results. Cross functional participation is beneficial e.g. Quality Circles.

Types of teams:

- Process improvement team.
- Cross functional team.
- Self-directed teams.
- Departmental teams.

Characteristics of successful teams:

- Appropriate sponsor.
- Clear Team Charter.
- Good team composition.
- Proper Training.
- Formulation of ground rules and terms of reference.
- Clear objectives.
- Adequate resources.
- Trust.
- Open communication.
- Leadership.
- Cohesiveness
- Balanced participation.

07.08.06 Training

Examples:

- Training in quality awareness.
- Statistical quality control techniques.
- Safety.
- Technology.
- Team building.
- Communication skills etc…

07.08.07 Suggestion System

- Define the system. E.g. suggestion box, clear terms of reference.
- Remove fear.
- Respond quickly.
- Recognize contribution.

- Reward the contributions.

07.08.08 Recognition and Reward

- Monetary rewards.
- Non-monetary reward (Certificates and celebrations).
- Career progression etc…

07.08.09 Gain Sharing

Gain sharing is a financial reward system that results from improved organization's performance e.g. Incentive schemes.

07.08.10 Performance Appraisal

The purpose is to evaluate the employee's performance to provide a basis for promotions, salary increases, training needs, counseling etc…

07.08.11 Union Involvement

This is to remove unions' apprehensions that they are loosing control on workers.
This facilitates the process of collective bargaining.

07.08.12 Benefits of Employee Involvement

- ➢ Employees have detailed knowledge of the process as they are closer to work-places and have hands-on experience.
- ➢ The employees are more likely to implement the decisions taken, as they were part of the decision making process.
- ➢ Employees are in a better position to pinpoint the problem areas.
- ➢ Employees are in a position to take immediate and corrective action.
- ➢ Employees are motivated to improve performance, by empowerment.
- ➢ Increase morale.
- ➢ Reduced friction between employees and managers.
- ➢ Better employee commitment.
- ➢ Open communication.
- ➢ Improved Teamwork.

07.09.00 Supplier Partnership:

07.09.01 Introduction to Supplier Partnership

The major element in the cost of a product is material.
Material content is generally 66 % (two-thirds) in Engineering Industries.
Customers and suppliers have the same goal- to satisfy the end user.
Purchase should not be only price-based. Primary focus needs to be on **QUALITY**.

07.09.02 Forces promoting the Supplier-Partnership

- J-I-T production system is the major force in promoting the Supplier-Partnership.
- Next is the demand for continuous improvement.
- Anther force is mandating of implementation of IO-9000 standards.

07.09.03 Principles of Customer-Supplier Relationship

Dr Ishikawa has suggested ten principles to ensure quality products and eliminate unsatisfactory conditions between the customers and suppliers.

1. Both customer and supplier are responsible for quality control.
2. Both customers and suppliers must respect each other's independence.
3. Customer is responsible for providing clear and sufficient requirements / specifications.
4. The contracts between customer and suppliers should be non-adversarial.
5. The supplier is responsible for providing quality that will satisfy the customer.
6. Both customer and supplier should work out mutually acceptable quality evaluation methods.
7. There should be a clear procedure to resolve disputes between customer and supplier.
8. There must be frequent exchange of information between customer and supplier.

9. Both customer and supplier should perform business activities in a cordial manner.

10. Both customer and supplier should act in the best interest of the end-user of the product.

07.09.04 Partnering

Partnering is a long-term commitment between two or more organizations for the purpose of achieving specific business goals and objectives by maximizing the effectiveness of each participant's resources.
The key issues in partnering:

- Long-term commitment for mutual advantage.
- Trust.
- Shared profits.
- Hared vision.

07.09.05 Sourcing

Three types of sources:

A. Sole source (Patented items).
B. Multiple sourcing (Two are more suppliers); Especially for J-I-T Production.
C. Single source (A planned decision).

07.09.06 Supplier Selection

First, take a strategic decision to *Make or Buy*; based on the following factors.

1. Criticality of the item (Consequences of shortage).
2. Economics.
3. Technical Competence of the organization.
4. Technical competence of the Supplier.
5. Reliability of supplier in terms of quality, delivery, safety.

Criteria for selection for suppliers**:**

1. The supplier must have a stable management system.

2. Supplier must have high technical standards and has the ability for innovation.
3. Supplier should be able to meet the specifications as per customer needs.
4. Supplier should have adequate production capacity.
5. Suppler has to maintain confidentiality of know-how and protect company secrets.
6. Supplier must adopt appropriate processes to control costs and supply material at right prices.
7. Supplier should be able to meet the delivery requirements.
8. The supplier should have a good track record of customer satisfaction.

07.09.07 Supplier Rating

The customer rates the suppliers in order to:

- Measure overall supplier's performance.
- Assess performance in terms of quality, delivery and service.
- Provide record of problems and corrective action.
- Enhance the relationship between the customer and supplier.

Key success factors in supplier rating system.

- An internal structure to implement and sustain the system.
- A regular and formal review.
- A standard measurement system for all suppliers.

07.09.08 Relationship Development

Key issues:

- Inspection procedures to be standardized.
- Training to be imparted.

TQM / Supplier Partnership

- Team approach: Frequent meetings, Participation in development activity etc…
- Recognition / incentives to suppliers. Mention in newsletters, Letter of appreciation etc…
- Transparency of the system.
- Timely payments.

07.10.00 Tools and Techniques for TQM:

INDEX

07.10.01 Bench Marking

07.10.01. 01 Introduction / Definition

It is a tool for continuous improvement.
Benchmarking is a systematic method by which organizations can measure themselves against the best industrial practices.
Benchmarking is the systematic search for the best practices, innovative ideas, and highly effective operating procedures.
Benchmarking learns from experiences of other people.
The essence of benchmarking is the process of borrowing ideas and adopting them to gain competitive advantage.

07.10.01. 02 Types of Bench Marking

1) **Internal Bench Marking:** Following the best practice of another efficient department, in the same organization.
2) **Competitive Benchmarking**: Following the best practice of a successful competition.
3) **Functional Benchmarking**: Following the best and relevant practices, within the same broad Industry, not necessarily in direct competition.
4) **Generic benchmarking**: Some practices are same regardless of type of business, such as billing and collections. We could emulate any successful organization in the relevant aspect of business, not necessarily in the same type Industry.

07.10.01.03 Process / Steps:

1. Decide what to benchmark.
2. Assess/understand current performance.
3. Plan (Choose a benchmarking team, Identify the industries with best practices, Make a time-table for action, and desired output from the team).
4. Study others. Collect data/ systems followed by best industries.
5. Learn from the data. Assess the gap between own practice/performance and the best practice/performance in the industry.
6. Adopt/use the findings to competitive advantage. (Make a plan of action, choose a team for implementation, establish a schedule, determine the expected results, implement the new system, and Monitor the progress against the plan of action.
7. Measure the output/performance vis-à-vis expected goals and control the process of improvement/new system.

8. Continue with further improvements.

07.10.01.04 Pitfalls / Criticism

- Benchmarking cannot replace innovation.
- Copying blindly may not give results.
- Benchmarking is not a one-time process. Situation changes dynamically.
- Copying itself is not a flattering idea.

07.10.02 Information Technology

Computers play an essential function in quality function.
The quality function needs served by computers are:

1. Data collection.
2. Data analysis and reporting.
3. Statistical analysis.
4. Process control (e.g. CNC machines / FMS).
5. Testing/Inspection.
6. System design: Integration of quality functions with other activities require sophisticated computer systems (E.g. CAD, CAM, MRP, MRP II, ERP, MIS).

Quality by Design through use of computers: CAD/CAM, FMS, rapid prototyping, finite elemental analysis software, solid modeling software, enhance the quality of a product.

The integration of the various quality functions requires sophisticated systems design.

Components of a total system are available in:

CADD	Computer-Aided Drafting and Design
CAE	Computer-Aided Engineering
CAM	Computer-Aided Manufacturing
CAPP	Computer-Aided process Planning
CIM	Computer-Integrated Manufacturing
ERP	Enterprise Resource Planning
HRIS	Human Resources Information System
MES	Manufacturing Execution System
MIS	Management Information System
MRP	Material Requirement Planning
MRP II	Manufacturing Resources Planning

Integration of these components requires the use of ***expert systems***, ***relational data bases***, and ***adaptive systems***.

Expert systems are computer programs that capture knowledge of experts.

The relational data bases create linkages among various data elements for consistent application across the entire organization.
Adaptive systems permit a system to learn from data patterns or repetitive situations. Data flow is monitored to detect, characterize, and record events that describe the actions to be taken in similar situations.

When computers are used effectively, it becomes a powerful tool to aid in improvement of quality. The ubiquitous computer has played an important role in TQM.

The role of Information technology is enumerated in various chapters in this book, particularly in the chapters titled “Production and Operations Management”, “Computer Management / Management Information System”, “Knowledge Management”, “Internet and Cloud Computing”.

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07.10.03 Quality Management Systems; ISO 9000 standards:

07.10.03.01 Introduction to Quality Management System

ISO 9000 refers to a group of quality assurance standards established by the **I**nternational **O**rganization for **S**tandardization.
This group, which is made up of representatives from 91 countries, adopted the standards in 1987.
IO 9000 standards are aimed at quality systems, not at the quality of goods and services. ISO certification means that a company has detailed, documented approach to achieving consistency of output. We need to choose a Registrar for certification, like we choose any other service.
ISO 9000 standards are mainly concerned with quality assurance; TQM focuses on quality management. ISO 9000 can be an integral part of TQM. ISO 9000 can serve as a foundation for TQM.

07.10.03.02 Benefits / Advantages of Implementation of ISO 9000 standards

- ✓ Quality consciousness within the organization
- ✓ Elimination of multiple quality audits by variety of customers
- ✓ Enhancement of credibility/image of the organization
- ✓ Opening of new markets / Exports

07.10.03.03 ISO 9000 Standards - Definition and concepts

The ISO 9000 consists of categories. A company has to choose an appropriate ISO standard to suit the type of business.

A) ISO 9001: Summary

This is the most comprehensive standard. It assures all aspects of quality from the design stage through production and service. Summary of ISO 9001 as under:

1) Management Responsibility.
2) Quality System.
3) Contract review.
4) Design Control.
5) Document Control.

6) Purchasing.
7) Purchaser supplied product.
8) Product identification and traceability.
9) Process Control.
10) Inspection and Testing.
11) Inspection, measuring and Testing Equipment.
12) Inspection and test status.
13) Control of nonconforming product.
14) Corrective action.
15) Handling, Storage, Packaging and Delivery.
16) Quality Records.
17) Internal Quality Audits.
18) Training.
19) Servicing.
20) Statistical Techniques.

B) ISO 9002

This standard leaves out design phase of ISO 9001.
It focuses on production and delivery.
It is used mainly by commodity companies, such as chemicals and paint companies.

C) ISO 9003

This standard is less detailed than the two above. It does not include a comprehensive quality system, but focuses on Testing and Inspection. It is useful for distributors of equipment.

D) ISO 9004

This is not a standard that applies to relations with outside customers, but suggests internal methods for meeting the quality measurements in the other standards.
It describes methods for approaching areas such as procurement, corrective action, and the use of statistical process controls.
All the SO standards are generic. They can be applied to any Industry, and to both product and service firms.

E) Tips for ISO 9000 documentation

1. Be specific.
2. Document important variations/situations.
3. Break up complex procedures.
4. Use visual aids.
5. Do what you say AND say what you do.
6. Seek involvement of employees at all levels.
7. Use Information Technology/computerizations.
8. Keep documents up-to-date.

F) The Registration Process:

1. Choose a Registrar.
2. Develop a quality manual.
3. Questionnaire by the Registrar - Clarifications by the Organization.
4. Review of documents by the Registrar.
5. Quality audit by the Registrar.
6. Correction.
7. Registration.
8. Follow-up, periodic audit and updating.

07.10.04 Quality function deployment (QFD)

07.10.04.01 Introduction to QFD

Dr Mizuno, Tokyo Institute of technology initiated the technique:

QFD (**Q**uality **F**unction **D**eployment)

The first application of QFD was carried out at Mitsubishi Ship Industries Ltd in 1972.
Toyota implemented QFD successfully at mini-vans plant in 1977.
QFD is a planning tool used to fulfill customer expectations. It is a disciplined approach to product design, engineering, and production and provides in-depth evaluation of a product.

QFD focuses on customer expectations/requirements, often referred to as "***THE VOICE OF THE CUSTOMER".***

QFD is employed to translate customer expectations/requirements, into technical characteristics / features of a product; to match the product inline with customer requirement.

QFD is deployed trough:

1. Product planning.
2. Part development.
3. Process planning.
4. Production planning.
5. Service industries.

QFD is primarily a set of graphically oriented planning matrices that are used as a basis for development of product/features.

QFD ensures that the voice of the customer prevails over the voice of the organization (Company officials may have some personal perceptions, which may not be relevant to customer requirements. The may work at something the customer is not interested in)

07.10.04.02 THE QFD Team

- ➢ QFD may be applied to develop a new product or improve an existing product.
- ➢ QFD Team must be cross-functional; to draw the expertise/talent from personnel different functions/departments.
- ➢ The QFD meetings should be structured and scheduled.
- ➢ The terms of reference must be clearly stated.

07.10.04.03 Benefits of QFD

07.10.04.03.01 Improves Customer Satisfaction

- Focus is on customer expectations/requirements.
- Surveys are conducted to assess customer requirements as also to assess competitor's product.
- The information is prioritized using Pareto chart, affinity diagram etc…

07.10.04.03.02 Reduces Implementation Time

- All aspects of customer requirements are systematically analyzed and are considered at every stage of development.
- Cross functional team approach reduces the chances of too many modifications / errors in the course of product development and production.
- Post-design / post-production disputes are eliminated as all functional mangers are involved though out development period.

07.10.04.03.03 Promotes Team-Work

- Participatory approach.
- Consensus approach.
- System is transparent.

07.10.04.03.04 Provides Documentation

- QFD provides data base for future development of a product.
- QFD Adds structure to the data.
- QFD matrices are flexible to adopt new points.

07.10.04.04 VOICE of the Customer

The driving force behind QFD is that the customer dictates the attributes of a product. Sources for determining customer expectations are:

- ➢ Surveys.
- ➢ Complaints.
- ➢ Consultants.
- ➢ Standards.
- ➢ Statutory requirements.
- ➢ Competitor information.

07.10.04.05 Organization of Information

Once the customer requirements are identified, we need to organize the information.

Use tools such as

- Affinity diagram (Info is classified under different heads; Most suited for QFD applications).
- Pareto Chart (Charting ---Vital few and trivial many factors).
- Cause and effect diagram.
- Tree diagram (E.g. Decision trees).
- Matrix.

07.10.04.06 HOUSE OF Quality

07.10.04.06.01 Concept

The primary planning tool used in QFD is the ***"house of quality".*** The house of quality translates the voice of the customer into design requirements that meet specific target values and matches those against how an organization will meet those requirements. House of quality is the primary chart in quality planning. It is a tool for balancing the customer requirement (voice of customer) and technical capabilities of the organization (voice of the organization) to arrive at an optimal solution to meet the customer requirement.

The mechanics of giving weights to various factors/criteria for arriving at an optimal solution for a given project is quite involved and is beyond the scope of this book. However, we shall illustrate the concept with a few examples and deal with the subject qualitatively.

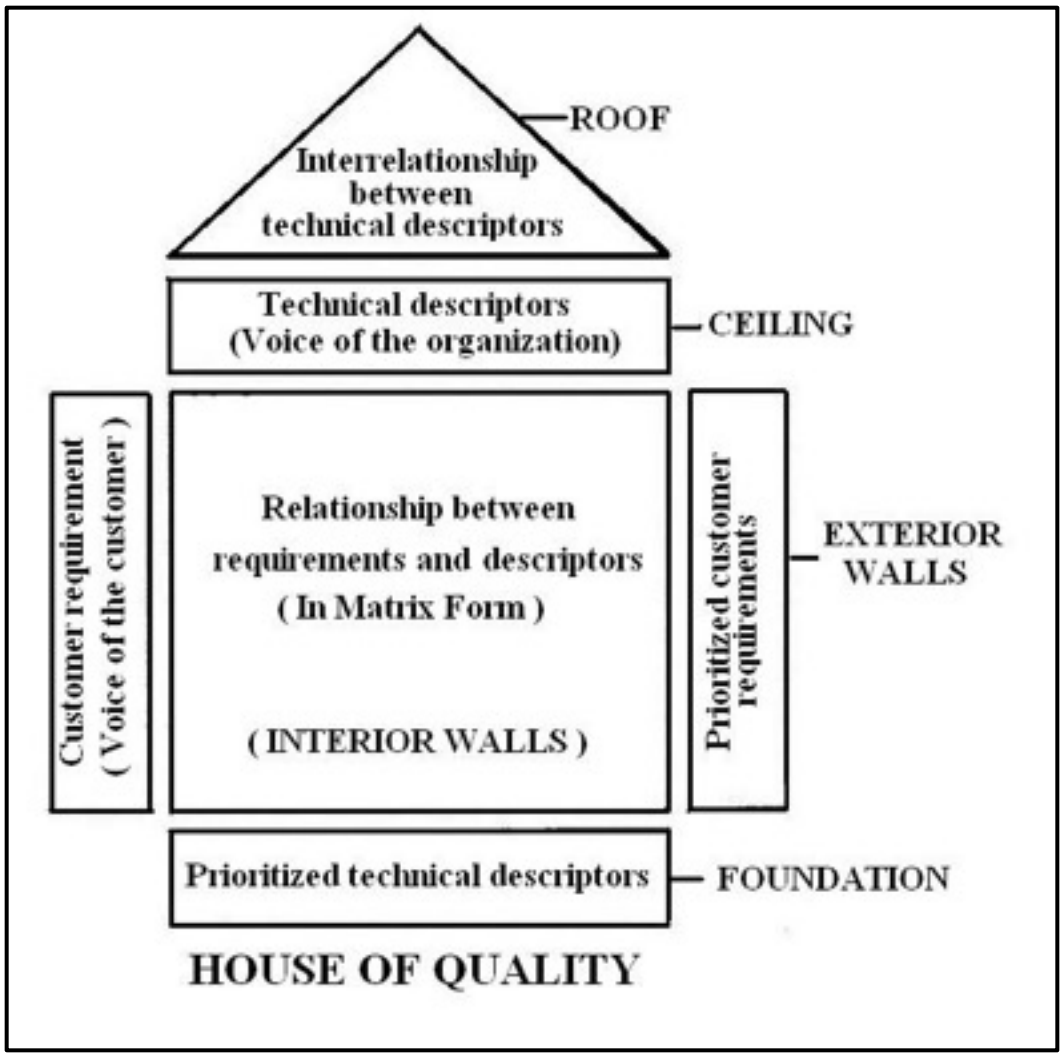
The structure of the house of quality can be thought of as a framework of a house, as shown in the following figure.

Please note the contents in parentheses:

- The exterior walls ("Customer requirements" and "Prioritized customer requirements").
- The ceiling (Technical descriptors).
- The interior walls (Relationship between requirements and descriptors).
- The roof (Interrelationship between technical descriptors).
- The foundation (Prioritized technical descriptors).

This is the basic structure for the house of quality which facilitates formulation of QFD matrices that point to an optimal design solution.

The following figure illustrates the concept of "The House of Quality"



07.10.04.06.02 Building a House of Quality

Let us consider a situation where in, we need to finalize design criteria for manufacture of a break pedal for a Fork Lift Truck.

Step 1: List customer requirement criteria in the HOQ matrix (WHATs**):**

- Low cost.
- Nice finish.
- High strength.
- Durability.
- Good shape.

These points are listed in the left exterior wall of the house of quality.

Step 2: List the technical descriptors / parameters in the HOQ matrix **(**HOWs**):**

- Material options: Cast Steel, Aluminum, Steel Plates.
- Manufacturing process options: Welding, Die casting, Sand casting, Forging, Investment casting.

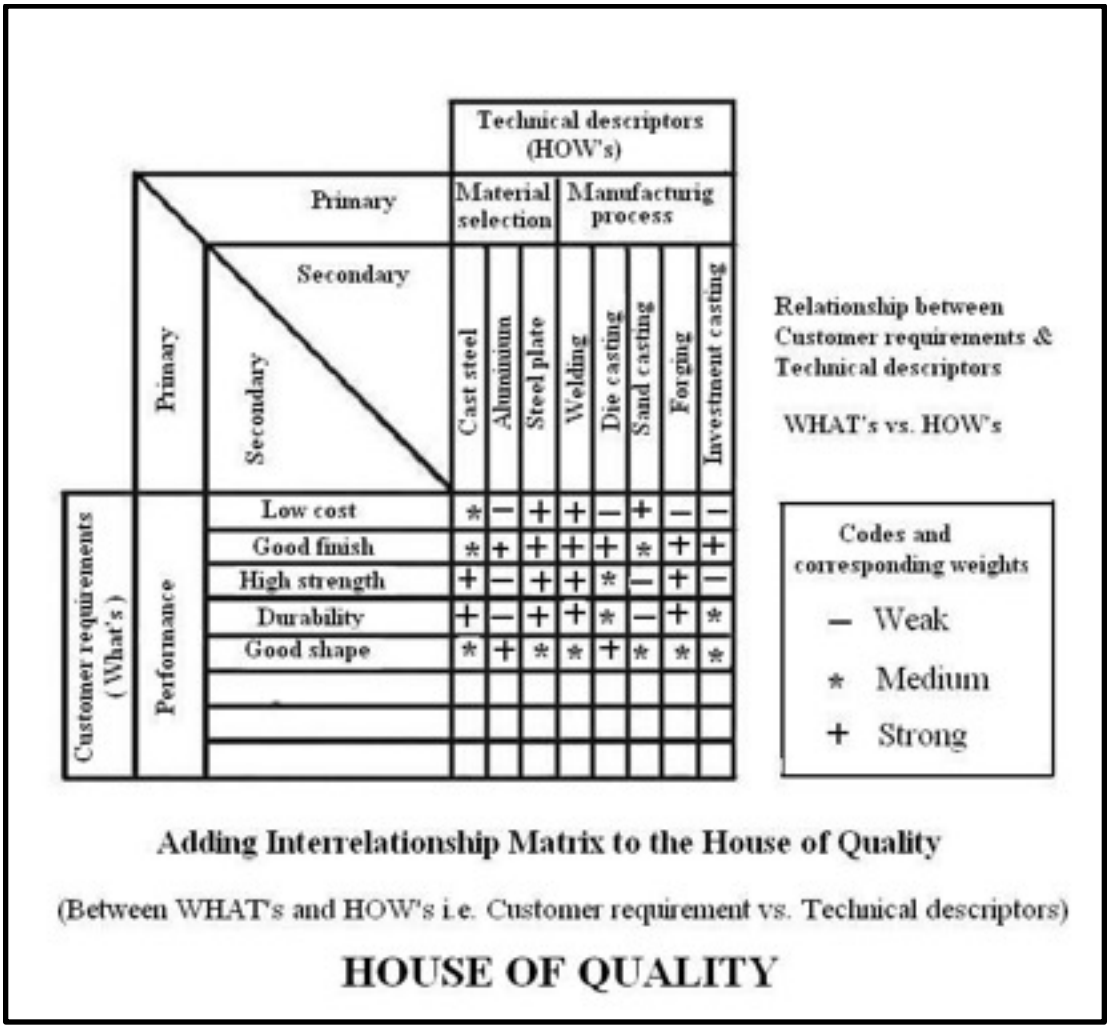
These options are listed in the ceiling of the house of quality.

Step 3: Develop the inter-relationship matrix between WHATs and HOWs.
The inter-relationship is codified as:

- Strong.
- Medium.
- Weak.

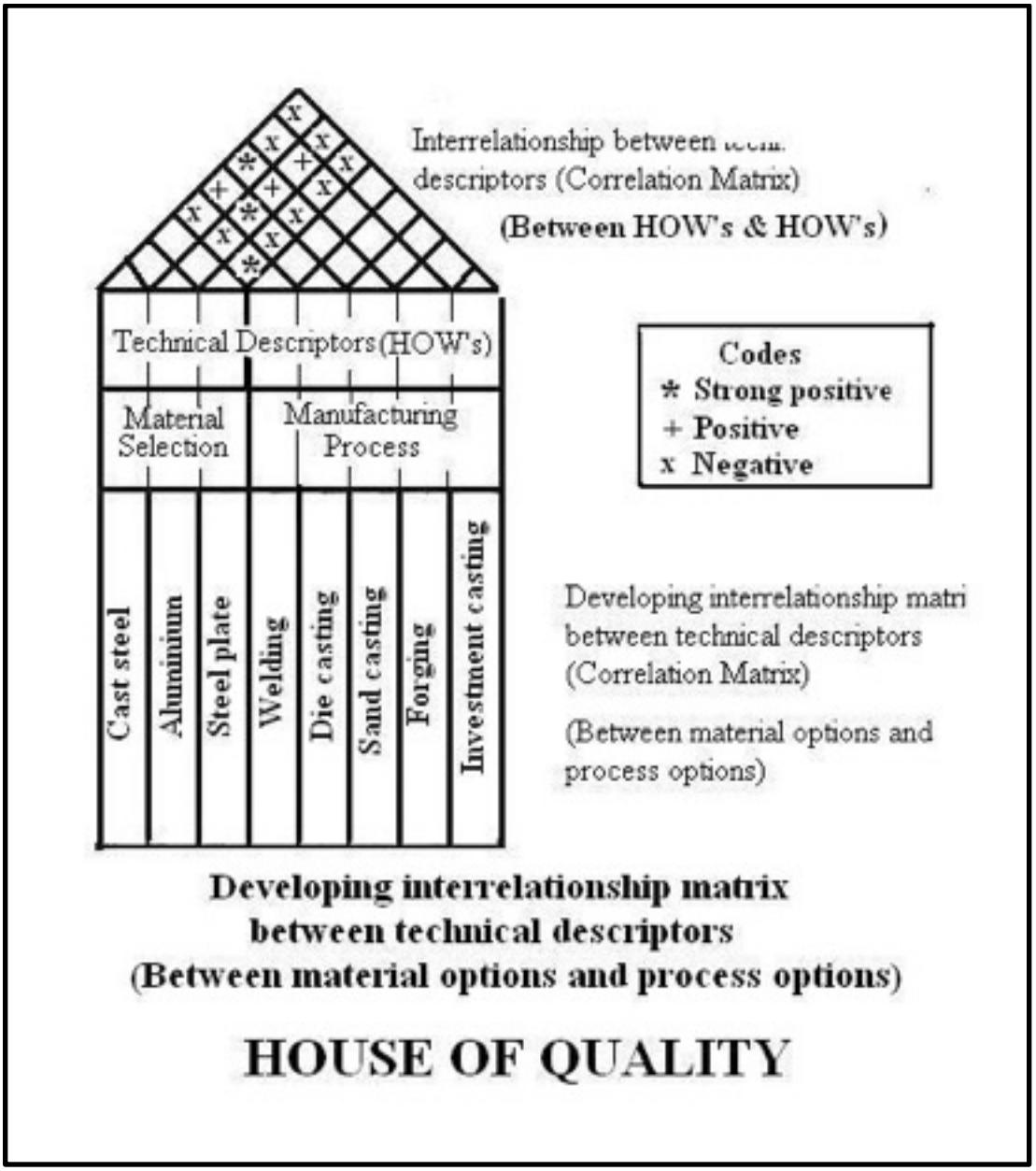
We also can give weights to these codes for ease of calculations, as an alternative.

The resultant matrix is generated in the interior wall as follows:



Step 4: Develop interrelationship matrix between HOWs.

Likewise, a matrix is generated in the roof of the house of quality as follows:



Step 5: Incorporate competitive assessments.
Study the features of the product manufactured by competitors.

Step 6: Develop prioritized customer requirements.
This data is reflected in the right exterior wall of the house of quality.

Step 7: Develop prioritized technical descriptors/parameters. This data is reflected in the foundation of the house of quality.

Step 8: Determine the design criteria based on the information collected as above. The mathematical aspects of the calculations are not enumerated here. It is to be understood that the final decision on design aspects has to be taken by balancing the voice of the customer (Customer Requirement) vis-à-vis voice of the organization (Organization's Manufacturing Capabilities), while considering the features of competitive products and economics.

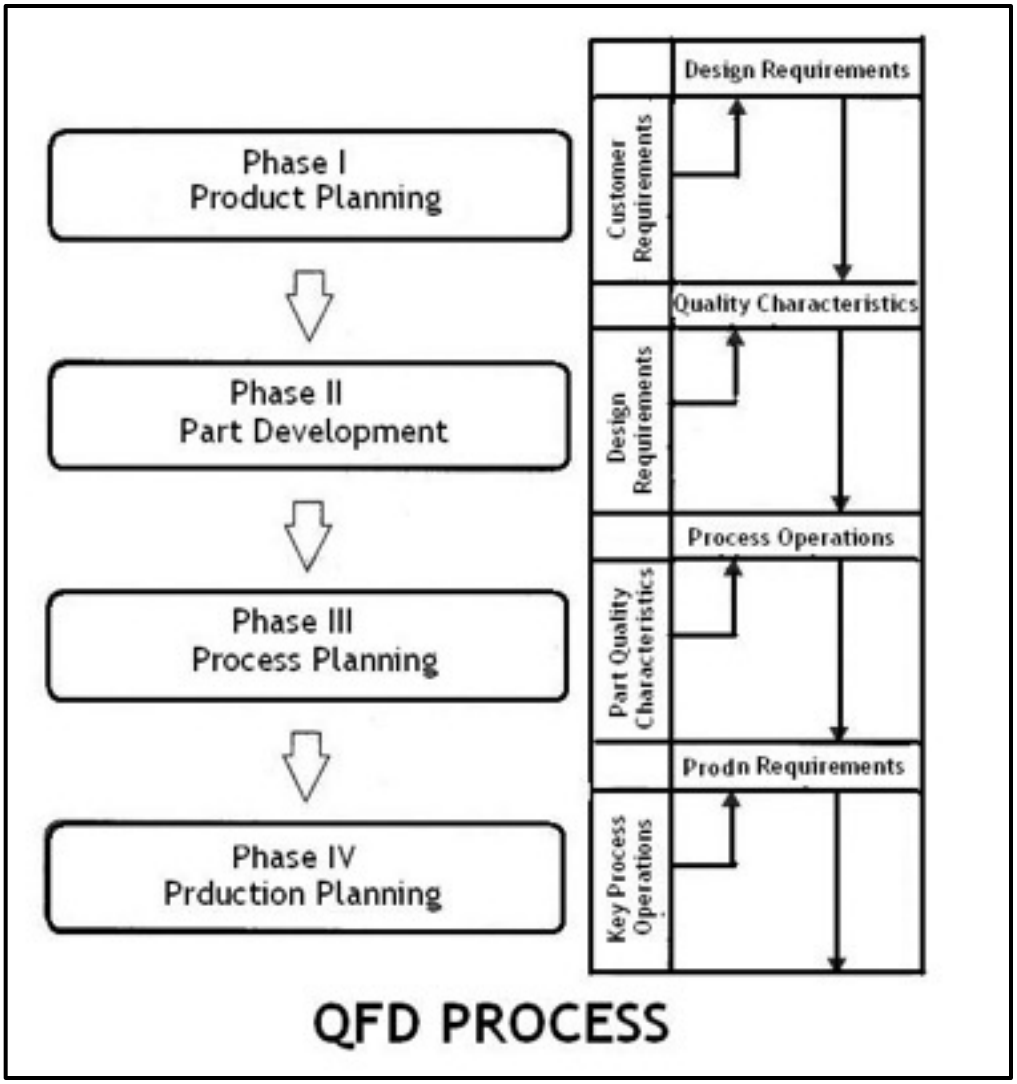
In this case, the optimal design is found to be use of steel plate (welding process) for manufacture of brake pedal for fork lift trucks.

The above exercise is carried out using qualitative method to demonstrate the concept.

We may also give weightage to the codes and make calculations to arrive at the optimal solution analytically.

07.10.04.07 QFD Process

The QFD matrix (House of Quality) is the basis for all the future matrices needed for the QFD methods. An example of the complete QFD process from beginning to end is shown in the following flow diagram.



The design requirements from the first chart are carried over to the next chart to establish part-quality characteristics. The part-quality characteristics from send chart are carried over to the next chart to establish key process operations. The key process operations are then carried over to next chart to establish production requirements. Finally, production requirements are determined from the key process operations

07.10.05 Quality by Design

07.10.05.01 Concept / Definition

A broad definition of “QUALITY BY DESIGN” is a team of specialists who simultaneously design and develop a product to ensure ease of producibility and logistics and customer satisfaction.

07.10.05.02 Concurrent Design

We replace the system of sequential deign process (Traditional way where there is not much interaction between various departments in the organization) with concurrent design/engineering process.

In the concurrent design process representatives from all the departments in the organization are involved in the design process right from the beginning. Even the suppliers are involved.

Since all the experts are working as a team, all the factors concerning customer requirements are incorporated in the initial stages design activities.

QFD technique is used by “Quality by Design – Team”, comprising representatives from Marketing, Design, Production, Quality control, Materials Mgt, Suppliers, Finance etc. Result: No revisions in drawings/specifications, no “post-design” disputes, and no “post-production” disputes and minimal “post- marketing” problems/customer complaints.

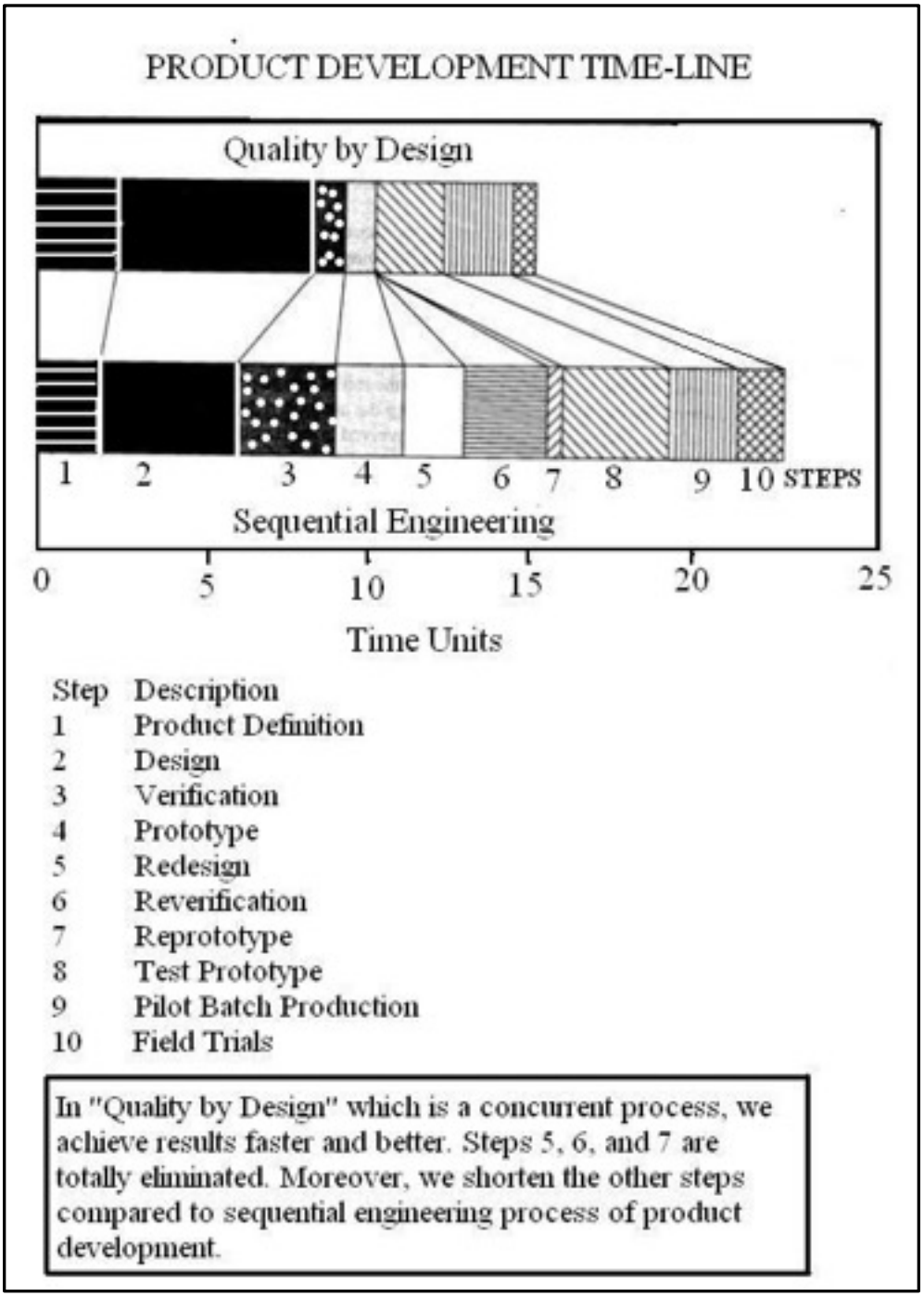
Since all the concerned departments are associated with the project, there would not be any objections or back tracking at any stage of design process.

By this process we have the prior assurances from various functional heads:

- Production manager confirms manufacturing capability.
- Finance manager confirms investment capability.
- Marketing manager confirms customer requirements.
- Sales manager confirms salability / distribution of the product.
- Suppliers confirm that material can be supplied as per design specifications.
- Quality control manager confirms inspection procedures.
- Service manager confirms the ability to manage after-sales-service / repairs.

No disputes later!
This concurrent design process cuts short the developmental lead time(s).

All the problems are preempted because of the coordinated effort by various specialists and their collective knowledge and wisdom.



Step	Description
1	Product Definition
2	Design
3	Verification
4	Prototype
5	Redesign
6	Reverification
7	Reprototype
8	Test Prototype
9	Pilot Batch Production
10	Field Trials

In "Quality by Design" which is a concurrent process, we achieve results faster and better. Steps 5, 6, and 7 are totally eliminated. Moreover, we shorten the other steps compared to sequential engineering process of product development.

07.10.05.03 Production Tools

Improving the quality of manufactured parts and decreasing the production cycle time requires the use of high-powered software and computer controlled machines.
Primary “Quality by Design” tools for production are:

- ➢ Robotics.
- ➢ Computer aided manufacturing.
- ➢ CNC machines / FMS (Flexible Manufacturing Systems).
- ➢ Continuous process improvement.
- ➢ JIT (Just-in-Time) production.
- ➢ Advanced measurement and verification techniques.

07.10.05.04 Benefits of Quality by Design / Concurrent Design

- ✓ Faster product development.
- ✓ Better quality.
- ✓ Less work-in-progress.
- ✓ Fewer engineering changes.
- ✓ Better team-work.
- ✓ Increased productivity.

07.10.06 Failure Mode and Effect Analysis (FMEA)

07.10.06.01 Introduction to FEMA

Failure Mode and Effect Analysis (FMEA) is an analytical technique (a paper test) that combines the technology and experience of people in identifying foreseeable failure modes of a product or process and planning for its elimination.
FEMA is a group of activities intended to:

- Recognize and evaluate the potential failure of a product or process and its effects.
- Identify actions that could eliminate or reduce the chance of potential failures.
- Document the process.

FEMA is a “before-the-event” action requiring a team effort to easily and inexpensively alleviate any problems in future.
The potential failures are ranked according to their relative impact on a product performance. FEMA helps establish priorities based on expected failures and severity of those failures and helps uncover oversights, misjudgments, and errors that may have been made.
FEMA reduces development time and cost of manufacturing process by eliminating many potential failure modes, prior to operation of the process and by specifying the appropriate tests to prove the designed product. Furthermore, design and process FEMA document the results of design and production processes respectively.

007.10.06.2 Objectives of FMEA

1. Design FEMA or process FMEA can provide the following benefits.
2. Anticipate modes of failures concerning the components in a product.
3. Minimize the adverse effects of a component failure on other components in the product.
4. Ensure that a failure causes minimal damage to the product.
5. Identify the components which are critical to the product function.

6. Calculate probability of failures.
7. Improve reliability of the product and parts there of.
8. Establish Testing procedures.
9. Uncover oversights, misjudgments, and errors that may have been made.
10. Reduce development cost and time.
11. Track the progress of a product.
12. Provide training to employees.
13. Encourage tem-work.

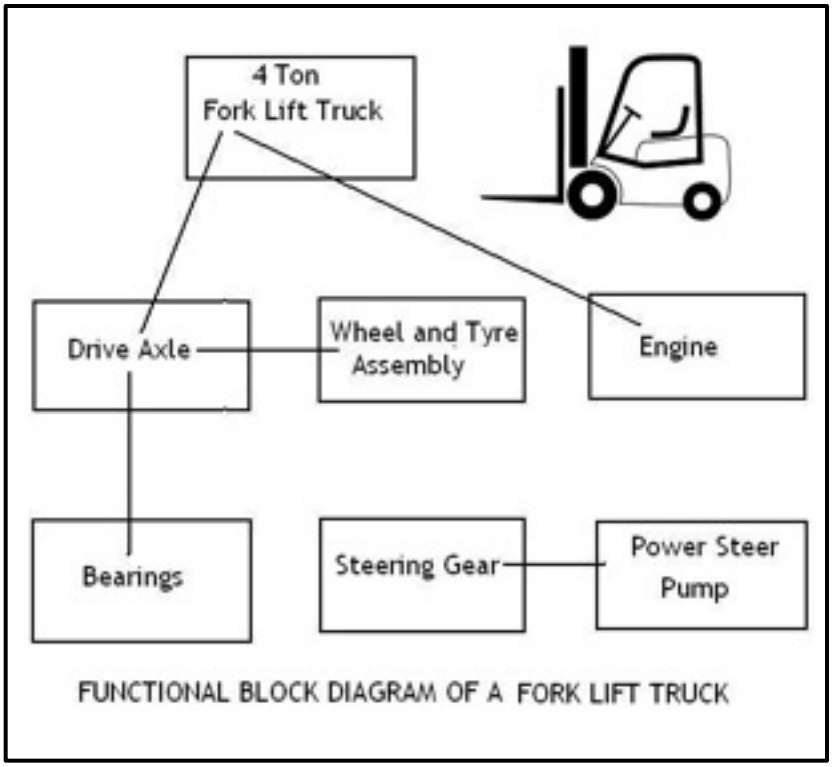
07.10.06.03 Stages of FMEA

The four stages of MEA are:

1) Specify possibilities (Functions, Possible failure modes, Root causes, Effects, Detection / Prevention.
2) Quantifying risk (Probability of cause, Severity of effect, Effectiveness of the controls systems, Risk priority ranking).
3) Correcting high risk causes (Prioritizing work, Detailing action, Assigning action responsibility, Check-list on completion).
4) Re-evaluation of risk (Recalculation of risk priority number).

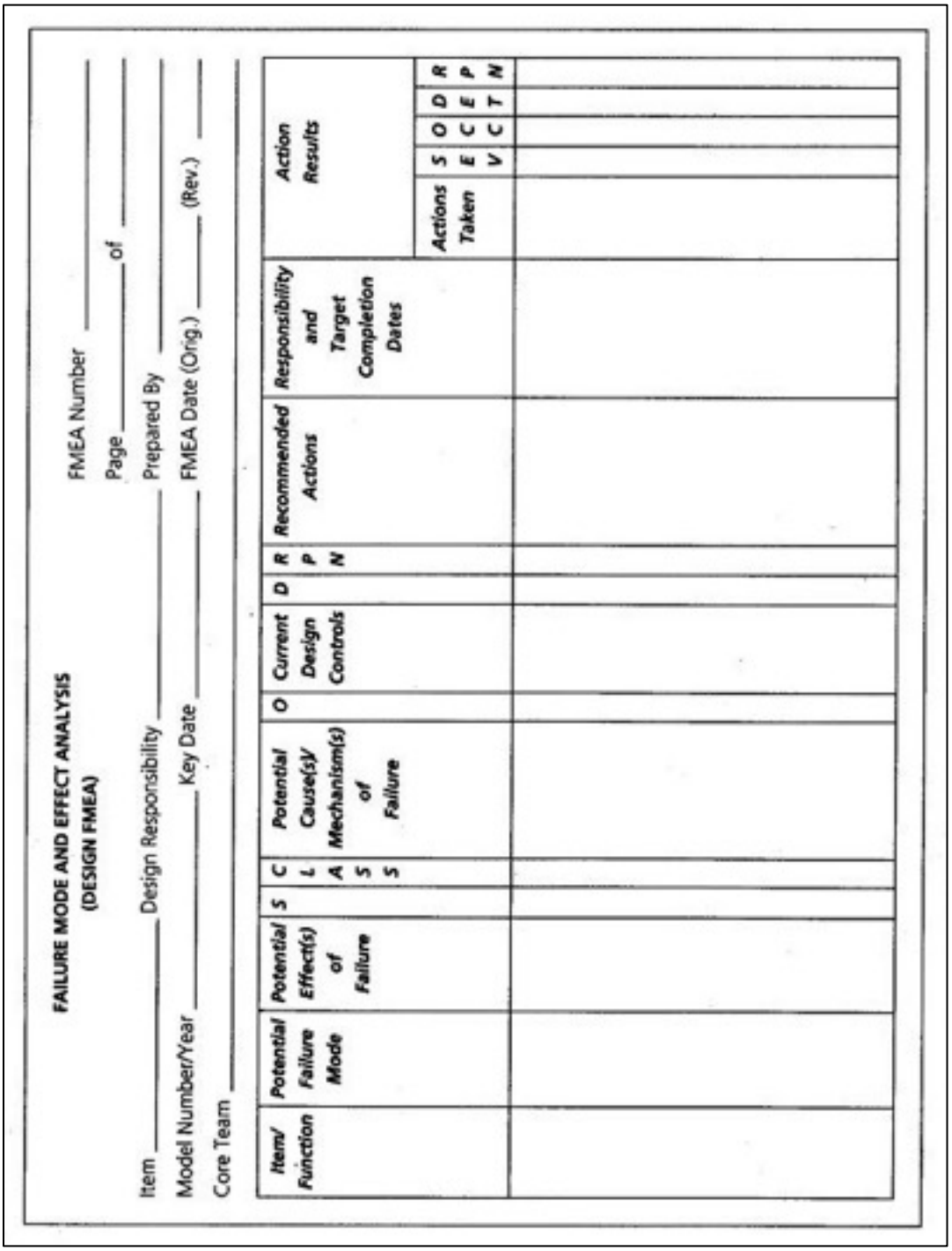
07.10.06.04 FMEA Documentation

The purpose of the FMEA document is to allow all involved engineers to have access to others' thoughts and to design and manufacture using this collective group of thoughts. Design FMEA should always start with a block diagram. A block diagram is started by first listing all components of the system, their function, and the means of connection or attachment between components. Then the components of the system are placed in the blocks and their functional relationships are represented by lines connecting the blocks.



FUNCTIONAL BLOCK DIAGRAM OF A FORK LIFT TRUCK

A typical Design FMEA Form is given below.



FAILURE MODE AND EFFECT ANALYSIS
(DESIGN FMEA)

FMEA Number _____
Page _____ of _____

Item _____ Design Responsibility _____ Prepared By _____
Model Number/Year _____ Key Date _____ FMEA Date (Orig.) _____ (Rev.) _____
Core Team _____

Item/ Function	Potential Failure Mode	Potential Effect(s) of Failure	S E V	C L A S S	Potential Cause(s)/ Mechanism(s) of Failure	O C C U R	Current Design Controls	D E T	R P N	Recommended Actions	Responsibility and Target Completion Dates	Action Results				
												Actions Taken	S E V	O C C U R	D E T	R P N

07.10.07 Experimental Design

07.10.07.01 Introduction/Concept/definition

Experimental design is one of the most powerful techniques for improving quality and productivity.
Through experimentation, changes are intentionally introduced into the process or system in order to observe their effect on the performance characters or response to the system or process.
An engineer can use his experience and experiment on a system using heuristic (Logical rule of thumb) methods. He may also use ad-hoc methods. He can still do a better job if he is equipped with statistical tools.
Any experiment that has the flexibility to make desired changes in the input variables of a process to observe the output response is known as experimental design.
Experimental design is a systematic manipulation of a set of variables in which the effect of these manipulations is determined, conclusions made, and results are implemented.

The primary goals of a designed experiment are:

- Determine the variables and their magnitude that influence the response.
- Determine the levels of these variables.
- Determine how to manipulate these variables to control response.

We may use SPC (Statistical Process Control) technique for experimental design. They are more efficient than one-variable-at-a-time kind of experiment. Experimental design must necessarily precede SPC.

Experimental design can be used to:

- Improve a process and its performance.
- Establish statistical control of a process variable.
- Improve an existing product or develop a new product.

07.10.07.02 Terminology

- Factor: An input variable (E.g. Temperature, pressure, time, speed etc…)
- Level: A value that is assigned to the factor (100 degrees C, 120 degrees C etc…)
- Treatment condition: The set of conditions for testing (Factors and their levels).
- Replicate: A repeat of treatment condition.

- Repetition: Multiple results of a treatment condition.
- Randomization: Run the test in a random order to prevent any build-up in the results.
- Interaction: Two or more factors that, together, produce a result other than separate effects.

07.10.07.03 Example

Let us consider a product where the following variables affect the final performance of the product.

1. Pressure.
2. Time.
3. Speed.

We may conduct the experiment at two levels of these variables and see their effect on final performance of the product.

Variable	**Level 2**	**Level 2**
Pressure	75 psi	100 psi
Time	5 Min	10 Min
Speed	25 M/Sec	35 M/Sec

We may also try different combinations of these variables to see their effect on the product performance.

07.10.07.04 Proactive nature of Experimental Design Process

In SPC (Statistical Process Control), the process gives information that leads to a useful change in process. This is passive statistical method. SPC assumes that the right variable is being controlled, the right target is known, and that the tolerance is correct. Experimental design is known as a proactive statistical method. It takes the initiative by acting rather than reacting to events. Information is extracted for process improvement based on tests done on the process, changes made in the input, and observations of the output.

Experimental design can be used to:

- Improve process by increasing its performance and eliminate trouble.
- Establish statistical control of a process variable i.e. identify variables to control the process.
- Improve an existing product or develop a new product.

07.10.08 Taguchi’s Quality Engineering

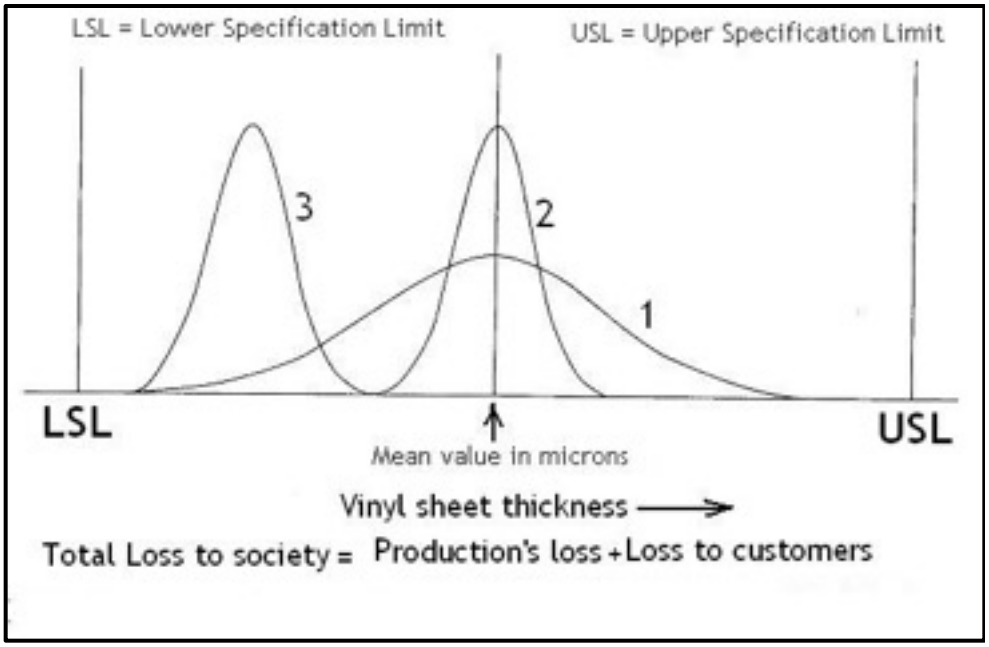
07.10.08.01 Introduction to Taguchi’s Quality Engineering

Dr Taguchi introduced “The Loss of Function” concept, which combines cost, target, and variation into one metric with specification being of secondary importance. Taguchi has defined quality as the loss imparted to society from the time a product is shipped. Loss to society occurs on account of:

- Failure to meet desired performance.
- Harmful side effects.
- Resources such as material, energy, and labor consumed on production of unused / unusable products.
- Toxic by-products etc…

07.10.08.02 Loss of Function

The loss-to-society concept can best be illustrated by an example connected with production of vinyl sheet to protect material from the elements. The thickness of the sheet has to be controlled between LSL (Lower specified limit) and USL (Upper specified limit). There can be three scenarios that can be visualized, as indicated in the following figure plotting the results of production in terms of thickness of the vinyl sheets.



Possible outcomes of production:

1. The spread of the dimension (thickness) is maintained between LSL and USL (Large variability).
2. The spread has a narrow range around the target / mean value (Reduced variability).
3. The spread is shifted towards LSL (Reduced variability).

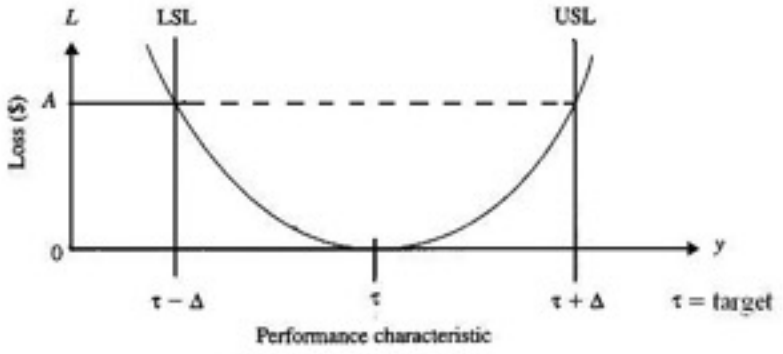
Assuming that actual production is as per specification - as in scenario 1- there can be a failure to meet a critical function. For instance, if these sheets are used to protect food grains exposed to elements and if some of the vinyl sheets tear off, there can be a huge loss to the users such as Farmers in the field, Ware houses etc.

The situation improves if the vinyl sheets are manufactured as in scenario 2.

The situation improves dramatically if the sheets are manufactured - with range/spread closer to LSL - as in scenario 3.

07.10.08.03 Quadratic Loss Function

Dr Taguchi developed a number o loss functions such as quadratic function.



Quadratic Function

Loss is said to occur as soon as the performance characteristic 'y' devetaes from target τ

The quadratic loss function is described by the equation $L = k(y - \tau)^2$

where L = cost incurred as quality deviates from the target
y = performance characteristic
τ = target
k = quality loss coefficient

The loss coefficient is determined by setting $\Delta = (y - \tau)$, the deviation from the target. When Δ is at the USL or LSL, the loss to the customer of repairing or discarding the product is $\$A$. Thus,

$$k = A/(y - \tau)^2 = A/\Delta^2$$

Taguchi concepts result in substantial improvements at lower cost.

07.11.00 SQC (Statistical Quality Control) / SPC (Statistical Process Control):

07.11.01 Introduction to SQC

A product may be designed for high quality, but the desired quality can be achieved only through compatible processes which are controlled. The production processes determine the degree of conformance to quality. Mere inspection can not ensure quality. Only correct and "in-control" processes can ensure quality first time and every time. There are many products which are mass produced and it is virtually impossible to inspect the parts under manufacture going through several processes in large numbers. We need to continually monitor the quality of the parts under manufacture and make adjustments in the process variables and keep the process under control. In essence quality can be achieved by controlling processes and not by inspection.

Statistical Quality Control (SQC) or Statistical Process Control (SPC) aims at addressing the above issues and providing means to check whether the process is capable of delivering the requisite quality, determining whether the process is in control or not, and specifying actions to be taken when the process is out of control. SQ techniques are applicable to both manufacturing processes and service processes. In SQC, we inspect a sample lot of specified size -number of pieces- to conclude if the main batch of production is in order.

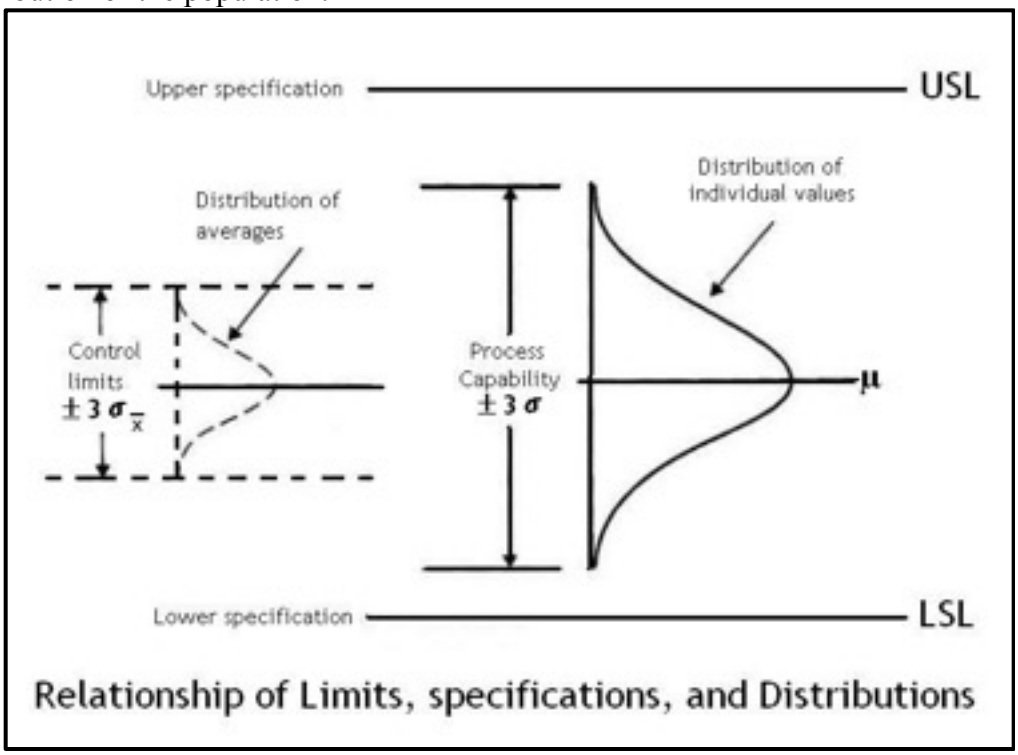
07.11.02 Central Limit Theorem

The Central Limit Theorem forms the basis of sampling theory. The basic concepts are:

1. The distribution of sample means (called the sampling distribution of mean). follows a normal distribution pattern irrespective of the distribution of population.
2. The mean of the sample means is the same as the population mean.
3. The standard error of the mean –that is, the standard deviation of the sample mean distribution- is equal to the standard deviation of the population divided by square root of the sample size.

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

The following figure shows the relationship between distribution of means and the distribution of the population.



Relationship of Limits, specifications, and Distributions

Please recall the contents of the earlier chapter titled “Six-Sigma Capability” where in we have enumerated on the characteristics of normal distribution. We need to understand the concept of normal distribution to appreciate the merits of SQC techniques.

07.11.03 Process Control Charts

Let us consider the example of manufacture of components for wrist watches. The parts are so tiny that they are not amenable for conventional measurement of dimensions. We need to control the quality (esp. dimensions) by only a manufacturing process. If the process is right we get the right quality. Since the components are mass produced, it is not practically possible to conduct 100% inspection. We can only inspect a few samples to ensure quality. This has been made possible by SQC techniques. For instance a wrist watch component such as a tiny gear can be inspected by optical projection of the component on to a screen by a thousand fold magnification and matching the same with a template. Obviously we can carry out such inspection only for a small batch of components. In such a situation we adopt SQC technique – control charts – enumerated as follows.

Major types of Control Charts:

1. $\bar{X}$ and $\bar{R}$ Charts
2. p Charts
3. c Charts

07.11.03.01 Process Control for Variables - $\bar{X}$ and $\bar{R}$ Charts

Let us look at an array of numbers and illustrate the concepts of
X, $\bar{X}$,**R**, $\bar{R}$, and $\bar{\bar{X}}$.

Array of numbers (readings): 10, 12, 16, 10

X= Actual reading viz. 10, 12, 16, or 10 in the array

$\bar{\bar{X}}$ = Mean value = [10+12+16+10] / 4 = 48/4 = 12

R = Range = 16-10 = 6

$\bar{\bar{\bar{X}}}$ = Mean of mean values (For several of such arrays)

$\bar{R}$ = Mean of Range Values (For several of such arrays)

$\bar{\bar{X}}$ Chart and $\bar{R}$ Charts:

Depending on the confidence levels required, we specify values for UCL and LCL. We usually set control limits at ± 3 level, which implies that 99.7% of the sample means are expected to be within the limits. For very critical applications such as banking, aircraft manufacture etc, Six-Sigma standards are applied. This subject had been dealt with in detail in the earlier chapter titled Six-Sigma Capability.

Control Limits for $\bar{\bar{X}}$ Chart:

$\bar{\bar{X}}$ ("Read X bar") = Average of a subgroup.

$\bar{\bar{\bar{X}}}$ ("Read X double bar") = Target Value = Average of the subgroup averages.

We need to collect a minimum of 25 subgroups' data for accuracy.

$\bar{\bar{\bar{X}}} = \sum \bar{\bar{X}}$ **/ Number of subgroups**

UCL $\bar{\bar{X}}$ = $\bar{\bar{\bar{X}}}$ +3 $\bar{\bar{X}}$

LCL $\bar{\bar{X}}$ = $\bar{\bar{\bar{X}}}$ - 3 $\bar{\bar{X}}$

Control Limits for $\bar{R}$ Chart:

$\bar{R} = \Sigma R$ / **Number of subgroups**

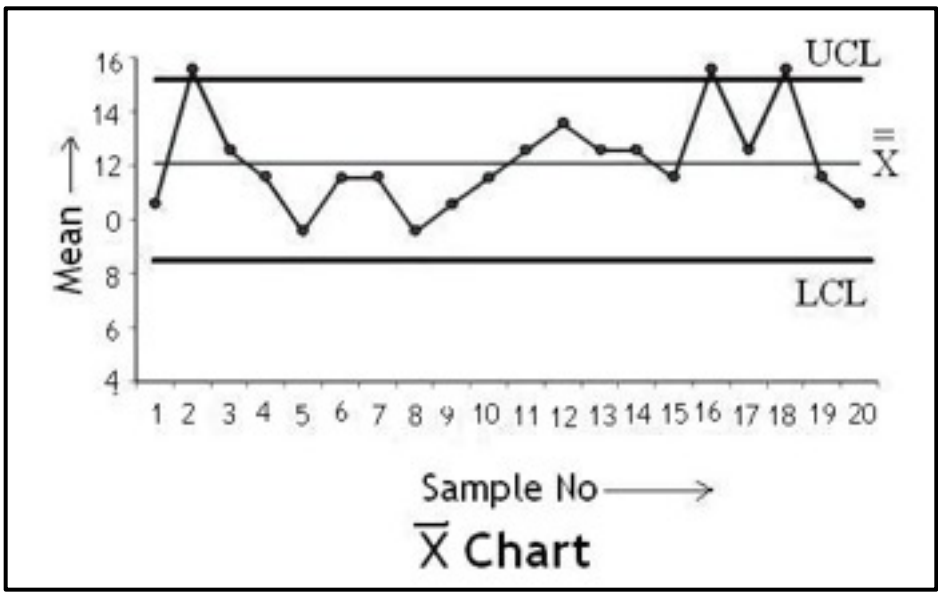
$$UCL_R = \bar{R} + 3\sigma_R$$

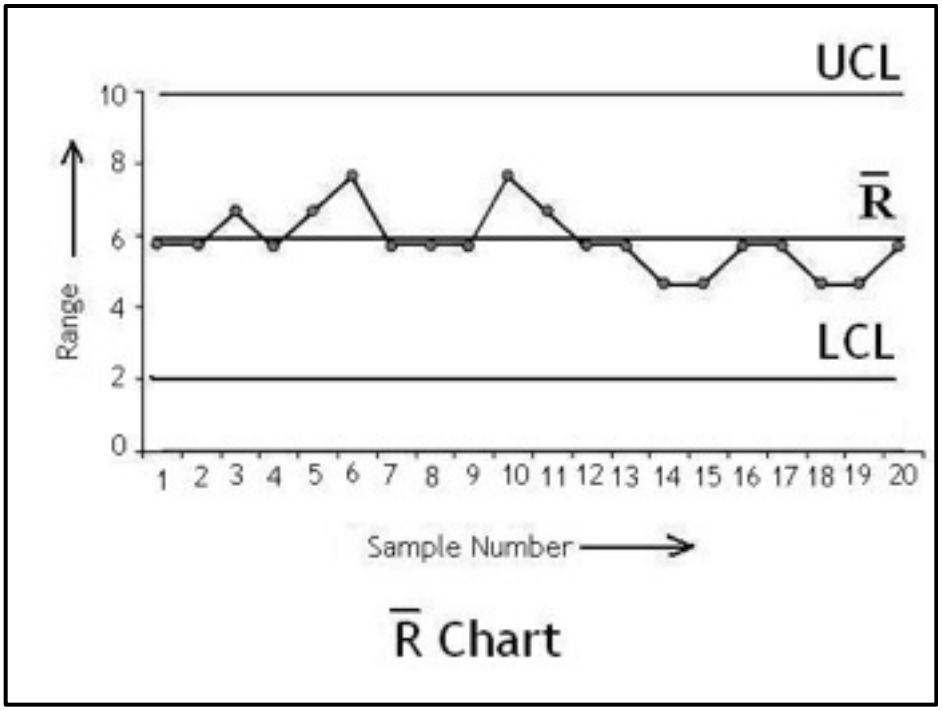
$$LCL_R = \bar{R} - 3\sigma_R$$

Using statistical sampling theory we can determine UCL and LCL in both $\bar{\bar{X}}$ and $\bar{R}$ Charts .

There are some ready reckoner methods (charts / tabulations) available to work out UCL and LCL values without elaborate calculations. The variables in the process are continually monitored and corrective action is taken by changes in process parameters, the moment the process goes out of control i.e. the readings go above UCL or below LCL.

Sample $\bar{\bar{X}}$ and $\bar{R}$ Charts are given below.





07.11.03.02 Process Control for Attributes – p Charts

Measurement by attributes that follow binomial distribution involves taking samples and using a single decision; the item is good or bad. The proportion of defectives can be found from the samples and upper and lower control limits are established. This chart may be applied in case of mass produced items such as nuts and bolts. The percentage defectives are noted in each batch of specified quantity and a decision is taken to accept or reject the lot.

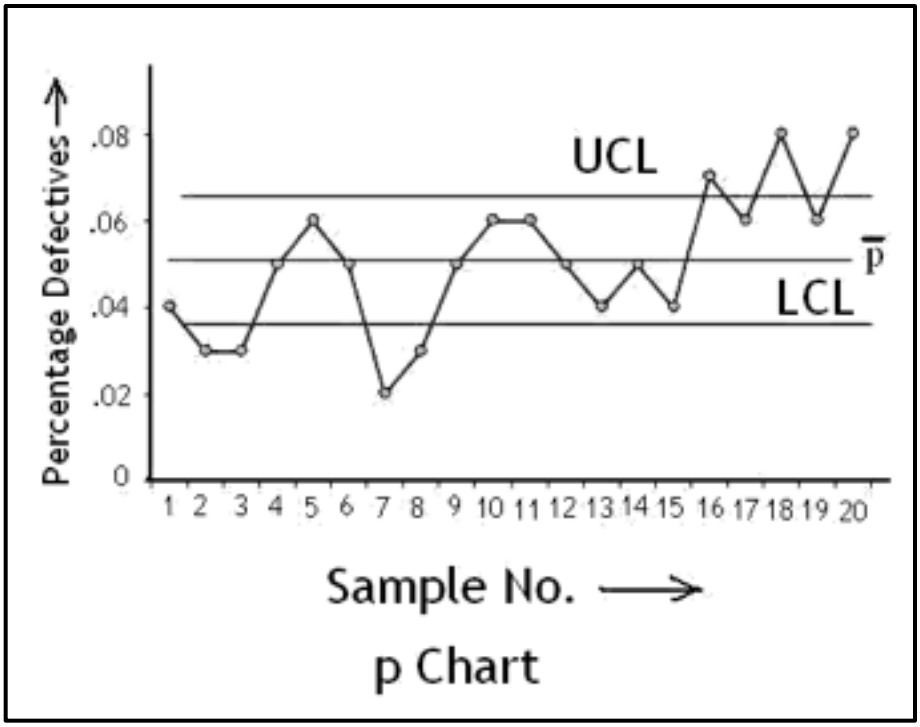
Let us apply $\pm 3\,\sigma_{\bar{p}}$ standards.

$$\sigma_{\bar{p}} = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

The control limits for this chart type are:

$$\left[\ \bar{p} \pm 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}\ \right]$$

where $\bar{p}$ is the estimate of the long-term process mean established during control chart set up.

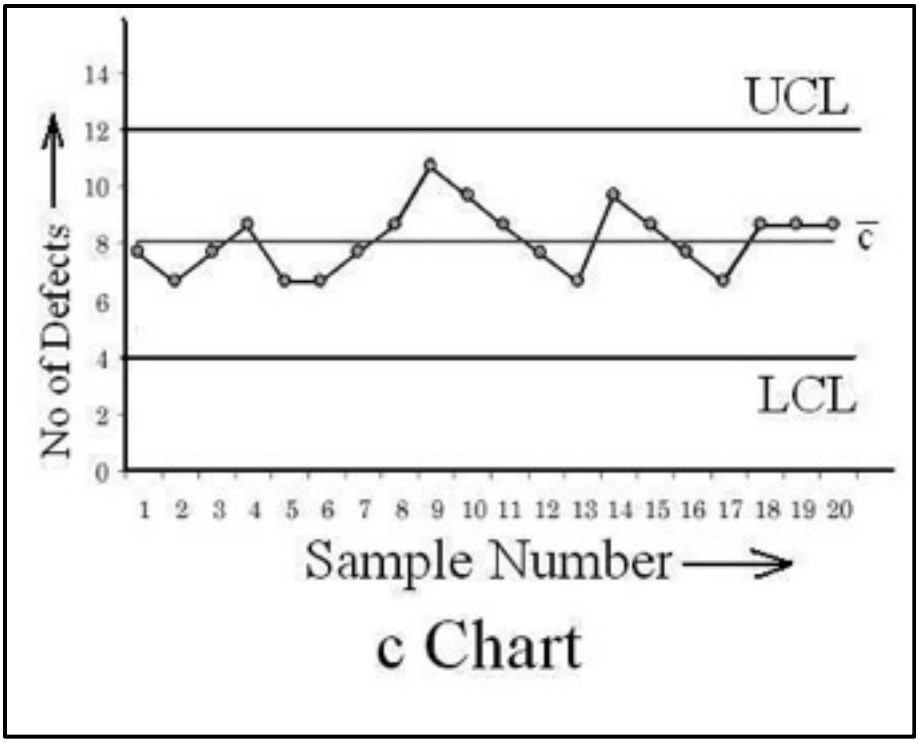


03.03 Process Control for attributes – c Charts:

Some attributes follow a Poisson distribution, for example number of defects in a polished surface or the number of defects in a textile product.

$\bar{c}$ = Total number of defects / Total nuber of pieces sampled.

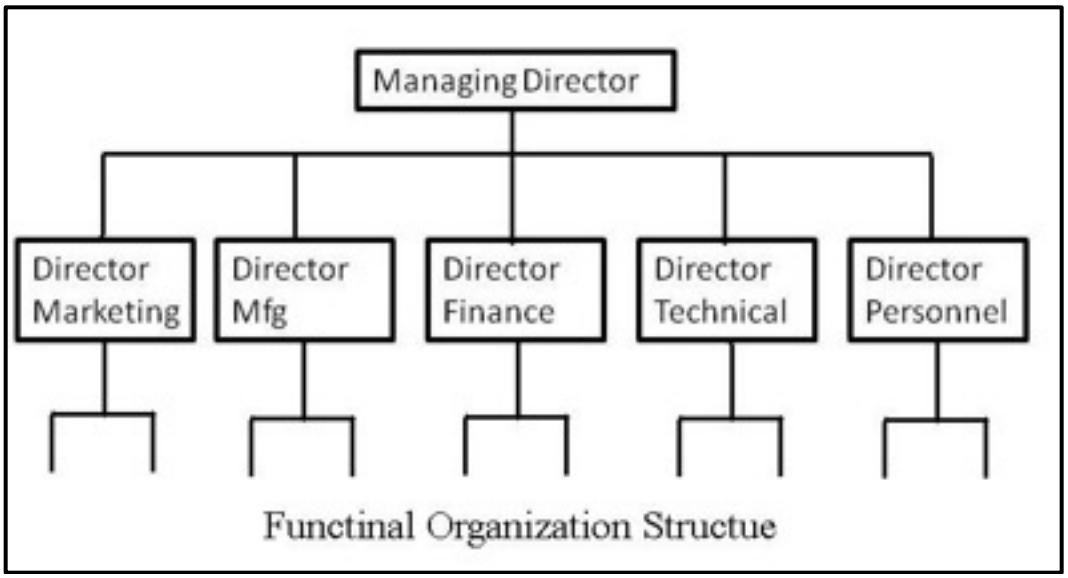
The control limits for this chart type are $\left[\bar{c} \pm 3\sqrt{\bar{c}} \right]$ where $\bar{c}$is the estimate of the long-term process mean established during control-chart setup.


UCL
LCL
$\bar{c}$
No of Defects
0
2
4
6
8
10
12
14
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Sample Number
c Chart

07.12.00 Designing Organization for Quality

07.12.01 The Functional Structure

A typical functional organization structure:



Functional structures provide organizations with clear chain of command and allow people to specialize in various functional areas.

Draw Backs:

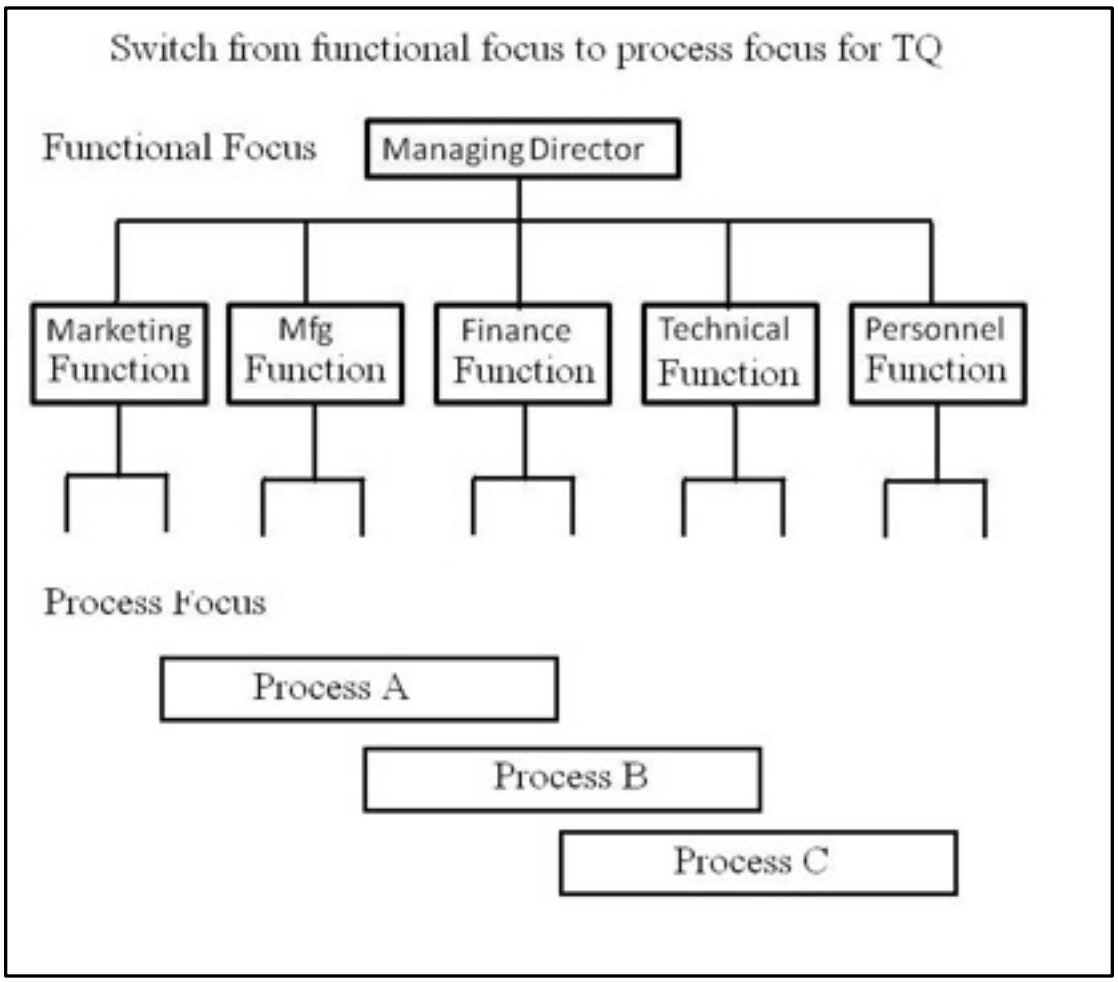
- ➢ Most employees have little or no contact with customers.
- ➢ People work in water tight compartments; e.g. The designer may not inter act with production.
- ➢ All employees are not involved in quality function. Only quality control department is concerned about quality aspects.
- ➢ This structure Inhibits process improvements due to inter departmental conflicts.

07.12.02 Redesigning Organizations for Quality

The key success factor: The aim is to “break down the barriers between departments in order to encourage team work among the employees in various functions”
This is the basic TQ philosophy for organizational design to ensure customer satisfaction through continuous improvement.

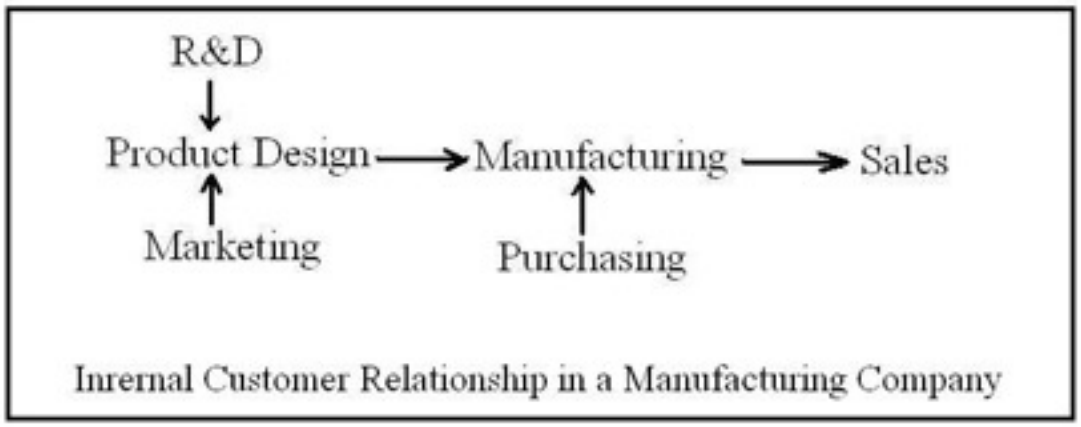
07.12.02.01 Focus on Processes

Process management involves designing processes to develop and deliver products and services that meet the customer needs and continually improving the processes.
We need to switch from functional focus to process focus.



07.12.02.02 Recognize Internal Customers

An internal customer is another person or group who depends on one's work.;
e.g. production group is a '***customer'*** to maintenance group.
Production person is a customer to a marketing or sales person.

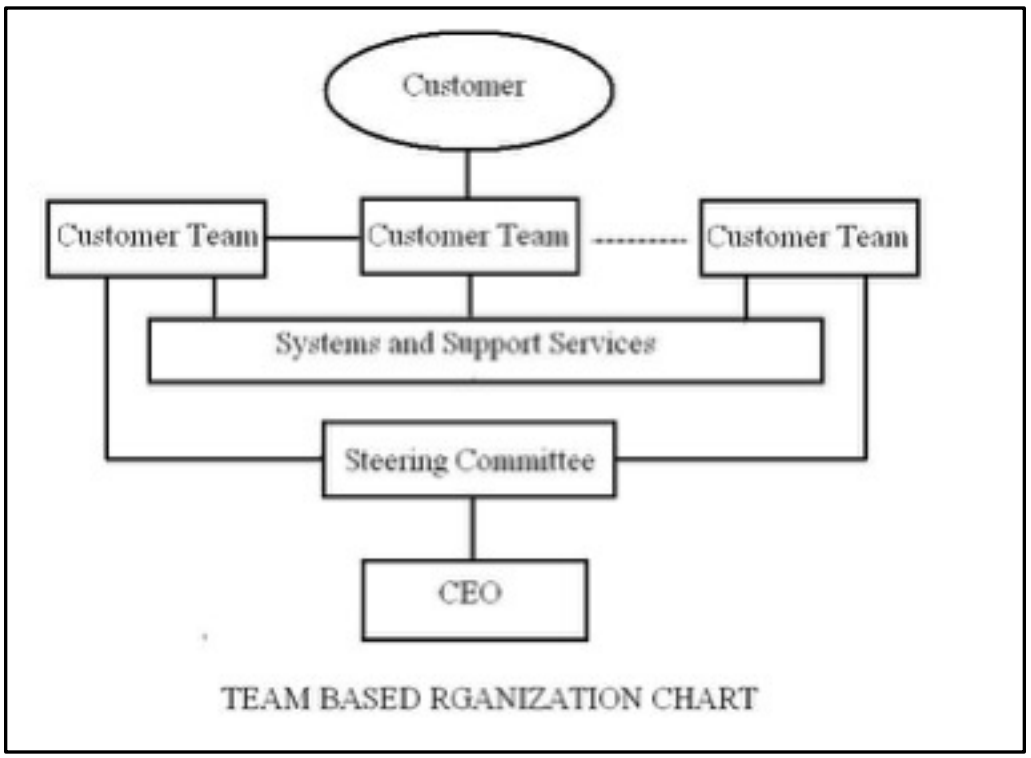


Inrernal Customer Relationship in a Manufacturing Company

The idea of internal customer does not change the organization structure. It only changes the way people work at the structure. Everyone in he organization has to satisfy his customer and not necessarily the 'Boss'. One person helps another in a horizontal process and everyone is one step closer to the customer.

07.12.02.03 Create a Team Based Organization

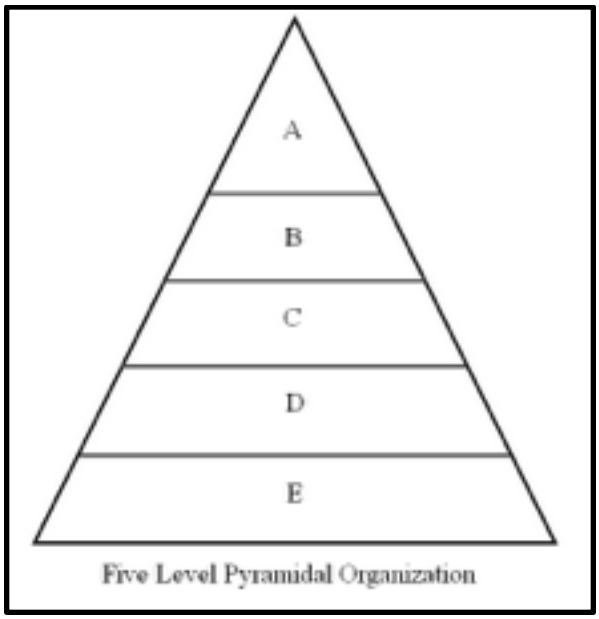
One way is to create cross functional teams for product design, process design etc.
For example: A design team may comprise representatives from all the departments and functions. If all the departments are involved in design process, there will be lesser re-designs / revisions. Post-production and post-sales problems would be minimized.



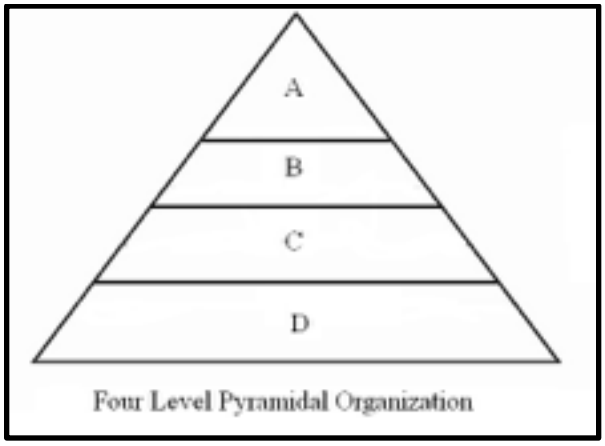
TEAM BASED RGANIZATION CHART

07.12.02.04 Reduce Hierarchy

Several levels of middle management are eliminated leading to a flat pyramidal structure of an organization. When front line workers are empowered, managers have less of supervision work and more of coordination and innovation work flat pyramid is more conducive to better and faster communication.



Five Level Pyramidal Organization



07.12.02.05 Use Steering Committees

Another type of structural change associated with TQ is creation of a high level planning group responsible for guiding the organization's quality efforts. Such steering committees, quality councils, or quality improvement teams are a key part of a firm's quality improvement efforts. Such groups provide a means of demonstrating the organization's commitment to quality, as well as a mechanism for coordinating the efforts of various organizational units.

A quality council is characterized by four essential elements:

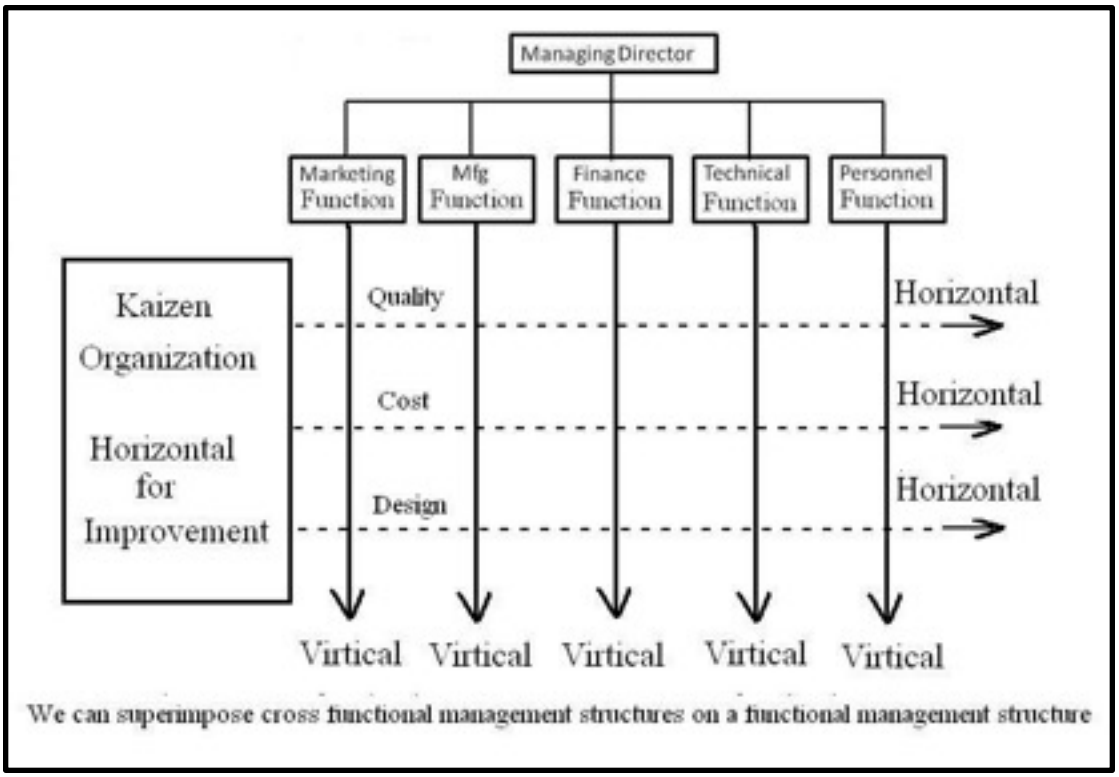
1. Leadership.
2. Planning.
3. Implementation.
4. Review (Tracking Progress).

07.12.03 Organization for quality in action

We can superimpose cross functional organization on a functional management structure.

Cross functional goals would be:

- Quality.
- Cost
- Design etc….



07.12.04 Organic Structure of an Organization

There are two principal types of organization structures.

1. Mechanistic Organization.
2. Organic Organization.

Mechanistic Organization	Organic Organization

Centralized	Decentralized
Strict Rules	Few and Liberalized Rules
Strict Division of Labour	Loose Division of Labor
Formal Coordination	Informal Coordination

TQM organizations tend to move in the direction of organic structure, as bureaucratic structures interfere with rapid progress and freeze processes.

07.12.05 Summary of TQM and Net Effect

A) TQM Culture and Organizational Behavior:

- ➢ Leadership.
- ➢ Motivation.
- ➢ Teamwork.

B) Design of Organization for TQM:

- ➢ Focus on customers & processes.
- ➢ Team based & cross functional teams.

C) Competitive Strategy - Differentiation Strategy:

- ➢ Product superiority.
- ➢ Cost leadership.
- ➢ Product range.
- ➢ Flexibility.

TQM / Designing Organization for Quality

- ➢ Rapid response to customer needs.
- ➢ Service motto.

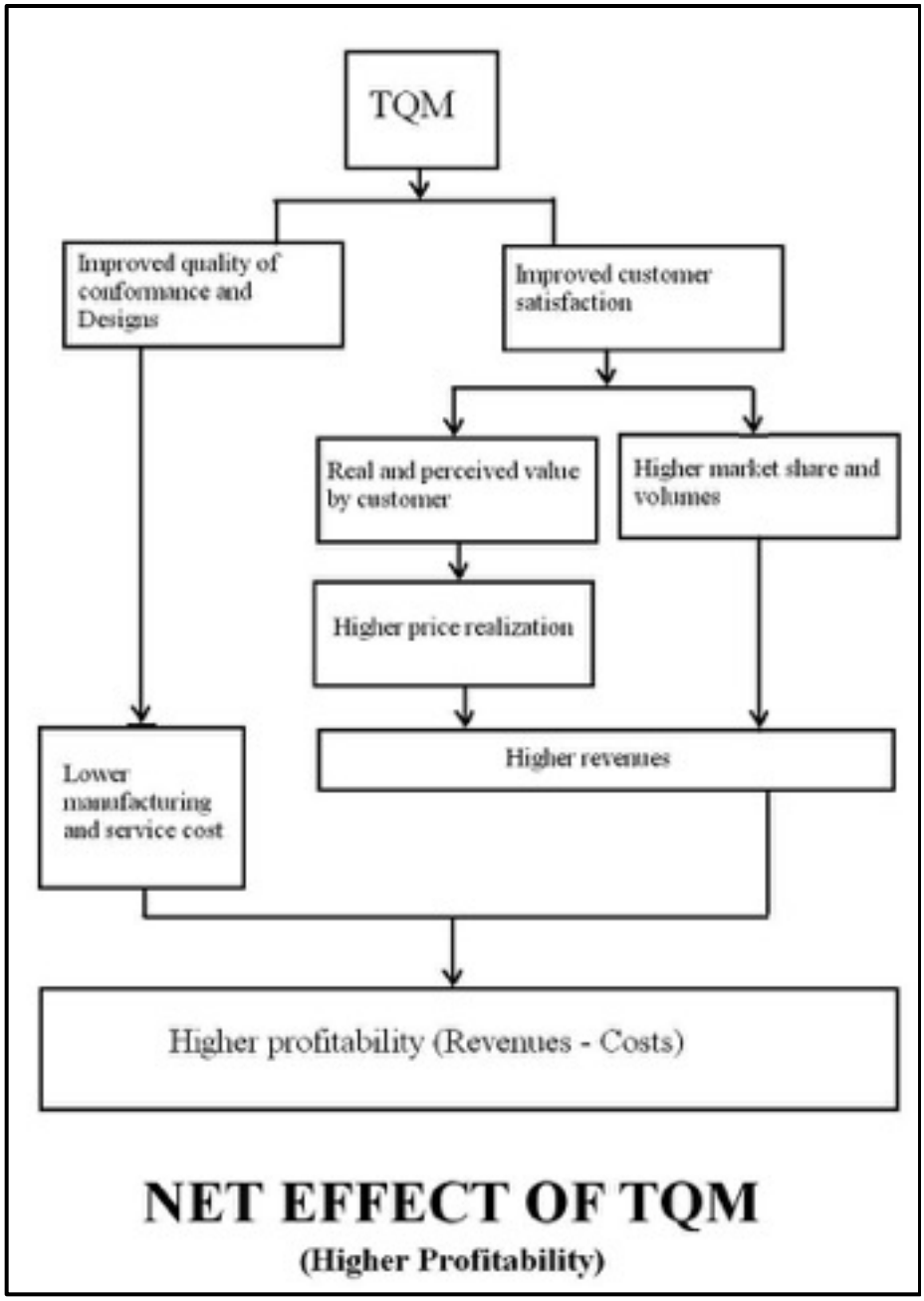
D) Superior Product / Service Design & Continuous Improvement:

Use of Tools and Techniques:

- ➢ Benchmarking.
- ➢ Information Technology.
- ➢ Quality Management Systems (ISO 9000 …)
- ➢ Environmental Management Systems (ISO 14000 …)
- ➢ QFD: Quality Function Deployment.
- ➢ QBD: Quality by Design.
- ➢ FMEA: Failure Mode and Effect Analysis.
- ➢ TPM: Total Productive Maintenance.
- ➢ MT: Measurement Tools.
- ➢ SQC: Statistical Quality Control.
- ➢ ED: Experimental Design.
- ➢ Taguchi's Quality Engineering.

07.12 06 Net Effect of TQM

Net effect of TQM is higher profitability. The process is diagrammed as under.


TQM
Improved quality of conformance and Designs
Improved customer satisfaction
Real and perceived value by customer
Higher market share and volumes
Higher price realization
Lower manufacturing and service cost
Higher revenues
Higher profitability (Revenues - Costs)
NET EFFECT OF TQM
(Higher Profitability)

Chapter 08
Organizational behavior and Human Resources Development
(OB and HRD)

08 Organizational Behavior (OB) / Human Resources Development (HRD)

So long as you have food in your mouth, you have solved all the questions for the time being.

... Franz Kafka

Index

08.02.01	Definition of HRD
08.02.02	Significance of HRD
08.02.03	Characteristics of Human Resources
08.02.04	Concept of HRD
08.02.05	Features of HRD
08.02.06	Scope of HRD
08.02.07	Need for HRD
08.02.08	Objectives of HRD
08.02.09	Functions of HRD
08.02.10	Techniques of HRD
08.02.11	Attributes of an HRD Manager

08.01.00 Organizational Behavior (OB)

08.01.01 Introduction to Organizational Behavior (OB)

Organizational behavior (**OB**) is "the study of human behavior in organizational settings, the interface between human behavior and the organization, and the organization itself." OB can be divided into three levels: the study of (a) individuals in organizations (micro-level), (b) work groups (meso-level), and (c) how organizations behave (macro-level)

Definition of “Organizational Behavior – OB” by Investopedia:

The study of the way people interact within groups. Normally this study is applied in an attempt to create more efficient business organizations. The central idea of the study of organizational behavior is that a scientific approach can be applied to the management of workers. Organizational behavior theories are used for human resource purposes to maximize the output from individual group members.

There are a variety of different models and philosophies of organizational behavior. Areas of research include improving job performance, increasing job satisfaction, promoting innovation and encouraging leadership. In order to achieve the desired results, managers may adopt different tactics, including reorganizing groups, modifying compensation structures and changing the way performance is evaluated.

08.01.02 Nature of OB

1. OB has assumed the status of a distinct field of study. It is a part of general management.
2. OB has an Inter-disciplinary approach; OB is influenced by Psychology, Sociology, and Anthropology.
3. OB is a normative science. A normative science prescribes how the various findings of researches can be applied get organizational results which are acceptable to society.
4. OB is both Art and Science.
5. OB focuses attention on people from humanistic point of view. It is based on the belief that needs and motivations of people are of high concern.
6. OB is oriented toward organizational objectives.
7. OB adopts a total systems approach. An individual's behavior can be analyzed keeping in view his psychological framework, interpersonal-orientation, group influence, and social / cultural factors. An individual's nature is quite complex. By applying systems approach, OB tries to find out solutions to its complexity.

08.01.03 Contributing Fields to OB

1. Psychology.
2. Sociology.
3. Political Science.
4. Social Psychology.
5. Anthropology.

08.01.04 Significance of OB

1. OB attempts to manage work place diversity in terms of gender, language, religion, social background, level of education etc...

2. OB involves in improving ethical behavior of the employees.
3. The behaviors can be controlled and directed by the use of power and sanctions which are formally defined by the organization for achieving organizational and individual objectives simultaneously.
4. Communication helps employees to come into contact with each other. Communication must be effective to achieve organizational objectives.
5. OB involves in improvement of quality and productivity.

08.01.05 Approaches to OB

Various Schools of Management Thought

1. Classical school.
2. Behavioral School.
3. Modeling School.
4. Contingency Approach.

08.01.05.01 Classical Management Thought

This encompasses “Scientific Mgt” and “Process theories”.

08.01.05.01.01 Scientific Management

- Suggested by Frederick W Taylor, Father of scientific management.
- Focus is only on economic efficiency.
- Assumes a world of certainty.
- This is a closed system of engineering and economics.
- Assumes men are motivated by money alone.

08.01.05.01.02 Process School of Management

Developed by Henri Fayol (France) and Ralph C Davis (US).
Focus is on Functional approach to Mgt.
Mgt is viewed as a process involving Planning, organizing, direction and control.

08.01.05.02 Behavioral School of Management

Output is not always dependent upon physical environment.
Workers respond favorably to individual care and attention.
Subordinate – Supervisor relationships directly affect production.
Human relations school recognizes that a person is complex and has multiple needs.
People cannot be treated as machines.
Behavioral scientists, psychologists, sociologists and cultural anthropologists have provided the answer to human relations question.
Human relations mattered.
Care for employees, freedom, participation/consultation etc were considered important to enhance performance.
The focus shifted to human relations.

08.01.05.03 Modeling School of management

The modeling school is concerned with decision-making, systems theory, and mathematical modeling of systems and decision-making process.

08.01.05.03.01 Decision-Making

The decision-making orientation considers making decisions to be the central purpose of Mgt. Managers make use of studies dealing with human relations, information processing, assessing risk, and generating decision alternatives to help them make final choices.

The decision theory can be expanded to include decision process through out the organization.

08.01.05.03.02 Systems Theory

Stress is on the importance of **"total systems"** in the organization.
All sub systems are inter related. Eg : A policy change in Marketing can affect finance or production.

According to this school, identifying sub-system relationships, predicting the effects of a change, and implementing a system change appropriately are the part of managing an organization.

08.01.05.03.03 Mathematical Modeling

Focus is on mathematical representations of Mgt problems.
A formula has certain variables and the result of a decision can be predicted.
E.g. Break even analysis, inventory control / Economic batch qty, physical distribution (transportation model) and resource allocation (Operations research) etc.
This is applicable only to certain management situations amenable to logical analysis.
Fitting people in mathematical models has not been possible.
This school can not assure a total approach to Mgt.

08.01.05.03.04 The Contingency Approach; An Integrated Approach

It is not possible to apply any single/particular school of thought in all Mgt situations.
Existing ideas must be applied selectively depending upon the circumstances.
No single idea is universal. As the famous philosopher, Confucius opined that "The Golden Rule is that there is no Golden Rule."

The ***contingency approach*** is integrative, focusing on fitting together the ideas of different schools of thought.

Classical / process approach is helpful in structuring our Mgt thinking, since it examines separate activities in detail viz. Planning, Organizing, Direction and Control.
As we plan, organize, direct and control; we must take into account the behavioral implications. The process and behavioral approaches interact in a complex way.
Many planning, organizing, directing and control activities can be modeled; but behavioral aspects are difficult to integrate.

Modeling approach is best applied to routine aspects in an organization.
We need integration of the 3 schools of thought as framework for analysis in Management.

08.02.00 Human Resources Development

08.02.01 Definition of HRD

Human resources are the set of individuals with knowledge, who make up the workforce of an organization, business sector, or economy. Other terms sometimes used include "manpower", "talent", "labour", or simply "people".

08.02.02 Significance of Human Resources Development

The term refers to the knowledge, skills, creative abilities, talents, aptitudes, values and beliefs of an organization's workforce. Human resources development improves the utilization value of an organization. The efficiency of production process and various areas of management depend to a greater extent on the level of human resources development.

08.02.03 Characteristics of Human Resources

Human resources is complete human being i.e., economic, social and psychological. HRD attempts to manage work place diversity in terms of gender, language, religion, social background, level of education etc. The competencies of human resources are developed through HRD programs. The value of human resources increases over the time due to continuous learning process unlike other resources.

08.02.04 Concept of Human Resources Development

HRD is mainly concerned with developing the skills, knowledge and competencies of people and it is people-oriented concept. Many personnel managers and organizations view HRD as synonymous to training and development.

08.02.05 Features of HRD

- HRD is a systematic and planned approach for the development of individuals in order to achieve organizational, group and individual goals. HRD is a continuous process for the development of technical, managerial, behavioral and conceptual skills and knowledge.
- HRD is multi-disciplinary. It draws inputs from Engineering, Technology, Psychology, Anthropology, Management, Commerce, Economics etc…
- HRD is embodied with techniques and processes.

08.02.06 Scope of HRD

HRD is involved in selecting, recruiting, and training of employees having potentialities for development to meet the present and future organizational needs. Other functions are:

analyzing, appraising and developing performance of employees with a view to develop them by identifying the gaps in skills and knowledge.

08.02.07 Need for HRD

- Changes in Economic Policies.
- Changing job requirements.
- Need for Multi-skilled Human Resources.
- Technological Advances.
- Organizational complexity.
- Human Relations.

08.02.08 Objectives of HRD

- To enhance organizational capabilities.
- To aid total quality management.
- To prevent employee obsolescence.
- To develop creative ability and talents.
- To prepare employee for higher level jobs.
- To promote individual and collective morale, a sense of responsibility, co-operative attitudes and good relationships.

08.02.09 Functions of HRD

- Performance appraisal of employees.
- Employee training.
- Executive development.
- Career Planning and Development.
- Succession Planning.
- Organization Development.
- Involvement in welfare activities, compliance with legal provisions, disciplinary measures, quality circles, safety, and workers' participation in management.

08.02.10 Techniques of HRD

- Performance Appraisal.
- Potential Appraisal.
- Employee Training.

- Executive Development.
- Career Planning and Development.
- Organizational Development.
- Workers' participation in management.
- Grievance settlement.
- Employee counseling.

08.02.11 Attributes of an HRD Manager

- Knowledge and skill in counseling.
- Knowledge of behavioral sciences.
- Leadership.
- Organizing ability.
- Systems development skill.
- Knowledge of labour laws.
- Positive attitude towards others.
- Concern for excellence.
- Concern for people and their development.
- Ability to work as a team member.

Chapter 09
Sales and Distribution Management

09 Sales and Distribution Management

So long as new ideas are created, sales will continue to reach new heights.

... Dorothea Brande

Index (Contents)

09.01.00 Sales Management

Sales management is a business discipline which is focused on the practical application of sales techniques and the management of a firm's sales operations.

At this juncture we need to distinguish between “SALES’ and ‘MARKETING’.

The American Marketing Association defines marketing as:
“Marketing is an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stake holders. Marketing is the art and science of choosing markets and getting, keeping, and growing customers through creating, delivering, and communicating superior customer value.”

09.02.00 Distribution management

Companies aim at providing the right product at the right place at the right time through a mix of 4 Ps:

- **P**roduct.
- **P**rice.
- **P**romotion.
- **P**lace.

Sales / Distribution organization structure varies from company to company and product to product.

A company could be in any one or more of the following businesses:

- Engineering Projects (e.g. Turn-key Projects: Power Plant, Airportsetc…)
- Engineering Products (e.g. Forklift Trucks etc…).
- White goods (e.g. Refrigerators, washing machines etc…)
- Consumables (e.g. Soaps, detergents etc…).
- Commodity (e.g. Synthetic fiber / Yarn etc…).
- Electronics (e.g. Computers, TVs, cameras etc…)
- Specialized Products (e.g. Satellites, Planes, weapons etc…)

Each of the above product lines requires different type of sales and distribution organization. Even for the same type of product lines, there could be differences in the

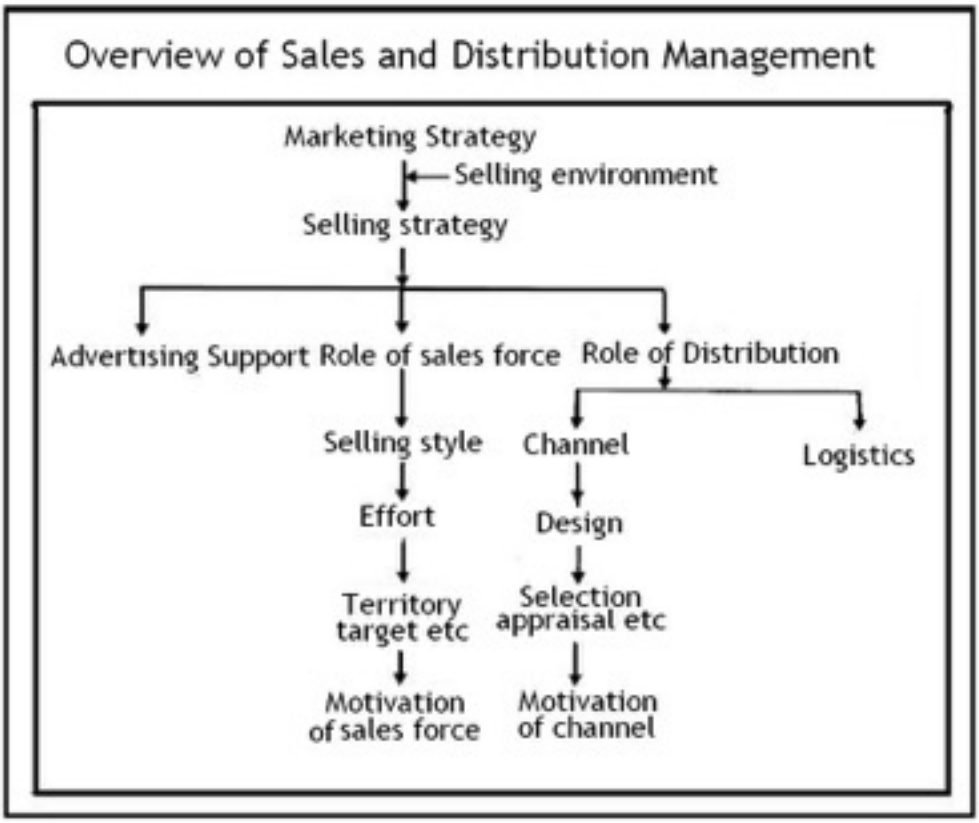
ways of sales and distribution, depending on company policies, environment,\ and customer profiles.

Distribution refers to the marketing channels that come together to bring products and services from the point of origin to the point of consumption. Thus the originator of goods or services gains access to a market through marketing channels. A marketing channel is a set of interdependent organizations involved in the process of making a product or service available for use or consumption

Sales and distribution activities have to be closely coordinated for success in business. These functions overlap and can not be carried out in isolation.

The functions of ‘Sales’ and ‘Distribution’ are overlapping and can not be segregated strictly; and often these are somewhat used synonymously.

The following diagram broadly outlines the activities concerning sales and distribution of a product or services.



The details of sales and distribution functions are enumerated in the following two chapters

Chapter 09.01
Sales Management

09.01.00 Sales Management:

INDEX

09.01.01 Introduction to Sales Management

Sales management is a business discipline which is focused on the practical application of sales techniques and the management of a firm's sales operations.

The type of selling could be through:

1. Direct selling by company staff.
2. Company outlets.
3. Distributors/Retailers.
4. Franchisees etc.

We shall deal with this subject of distribution in detail later in this chapter.
There are a number of ingredients to marketing. The Chartered Institute of Marketing definition includes:

- *Identifying* – What are the customers' requirements?
- *Anticipating* – What do people want in future?
- *Satisfying* – Satisfying the customers by providing the right goods and services, at the right price, at the right time and at the right place.
- *Profitability* – A business must make profits for survival.

To be sustainable, marketing would require an understanding of the consumer.

09.01.02 Consumer Decision Process

Consumers adopt different decision processes for different products and at different situations. The various decision processes are as under.
Details of the decision process along with examples based on some studies are also given below.

1. Picking: involves random choice. The buyer is indifferent to a brand; due to "little uncertainty with unbranded products" as also due to "few differences between brands "Example: Mineral water.

2. Impulse buying: Impulse buying occurs when a consumer experiences a sudden urge to buy something immediately; often leading to regret later. Example: Chocolates.

3. Variety seeking: Purchases are made for variety, not necessarily used immediately. Example: Fashion garments.
4. Legalistic behavior: Buyer seeks approval from an external source (Legal or societal norms). Example: gas cylinder supplied by a public sector undertaking and stove with ISI marking.

5. Subcontracted decision-making: Buyer obtains brand recommendation from a personal source. Example: Drugs prescribed by a doctor, Buying Anti-virus software etc.

6. Heuristics: Buyer follows some intelligent thumb rules acquired through experience and practice. Example: The *"Intel Inside"* sticker on a computer, A TATA product etc.

7. Extended problem solving: This occurs when the purchase is of very much importance to the buyer. The buyer evaluates:

- Technical parameters.
- Economic aspects.
- Performance guarantee.
- Snob-value.

Example: Consumer durables, Automobiles etc…

8. Habitual behavior: occurs if the buyer is satisfied with previous purchases; and also in the absence of search for better alternatives. Example: Cosmetics.

9. Reciprocity: reciprocal dealings involving two parties doing business with each other.
Example: Chemical Industries.

10. No alternative syndrome: Decision when there is no alternative to what is available.

09.01.03 Marketing Strategy

Marketing strategy to present products in the market, considering customer decision processes:

Marketing strategy is the business activity of presenting products or services to potential customers in such a way as to make them eager to buy them. This outlines the specific actions a company intends to carry out to interest the potential customers and clients in the product / services and persuade them to by the product / service.

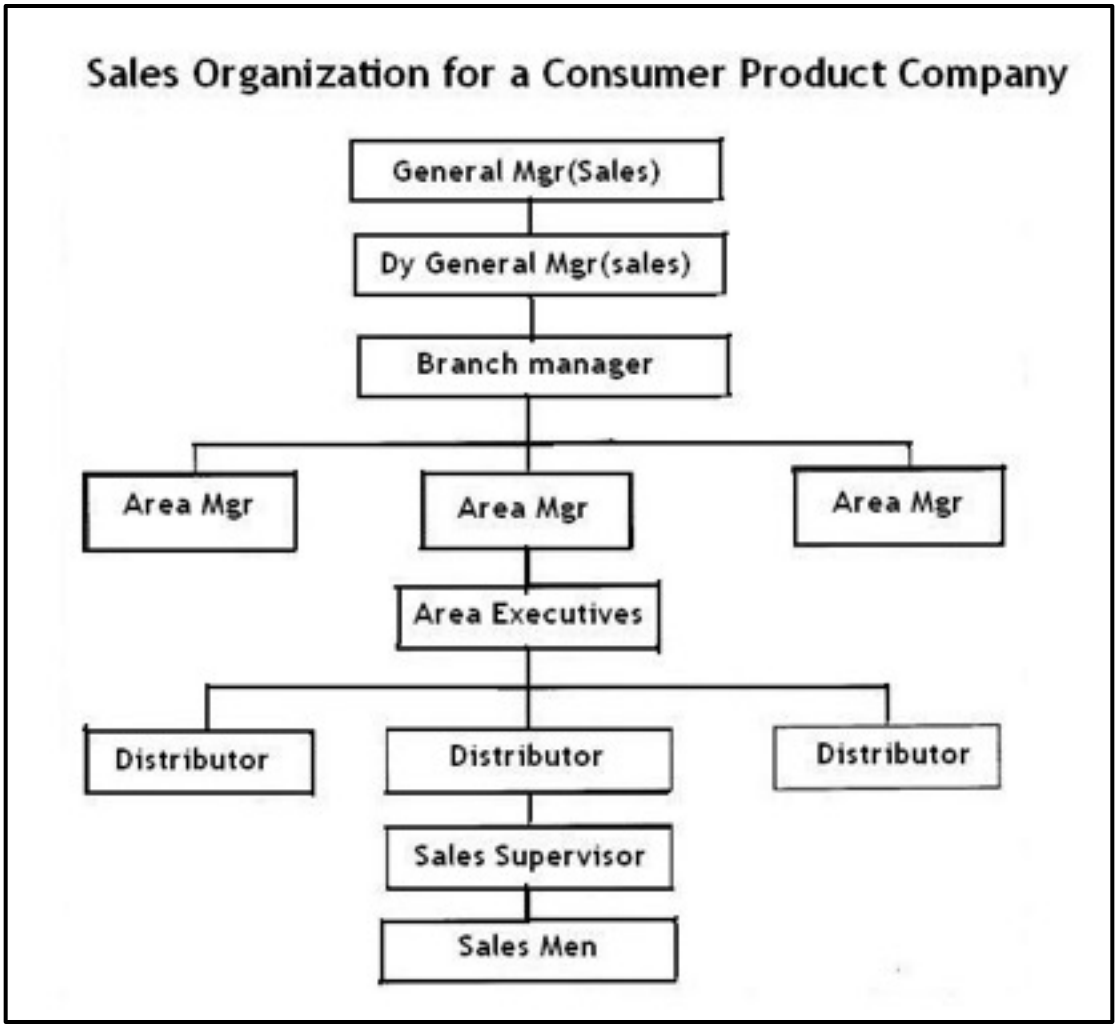
The basic strategy is one of *"Product differentiation";* in what way is our product superior to competition?
A company has to do adequate job on various fronts, providing flexibility in terms of:

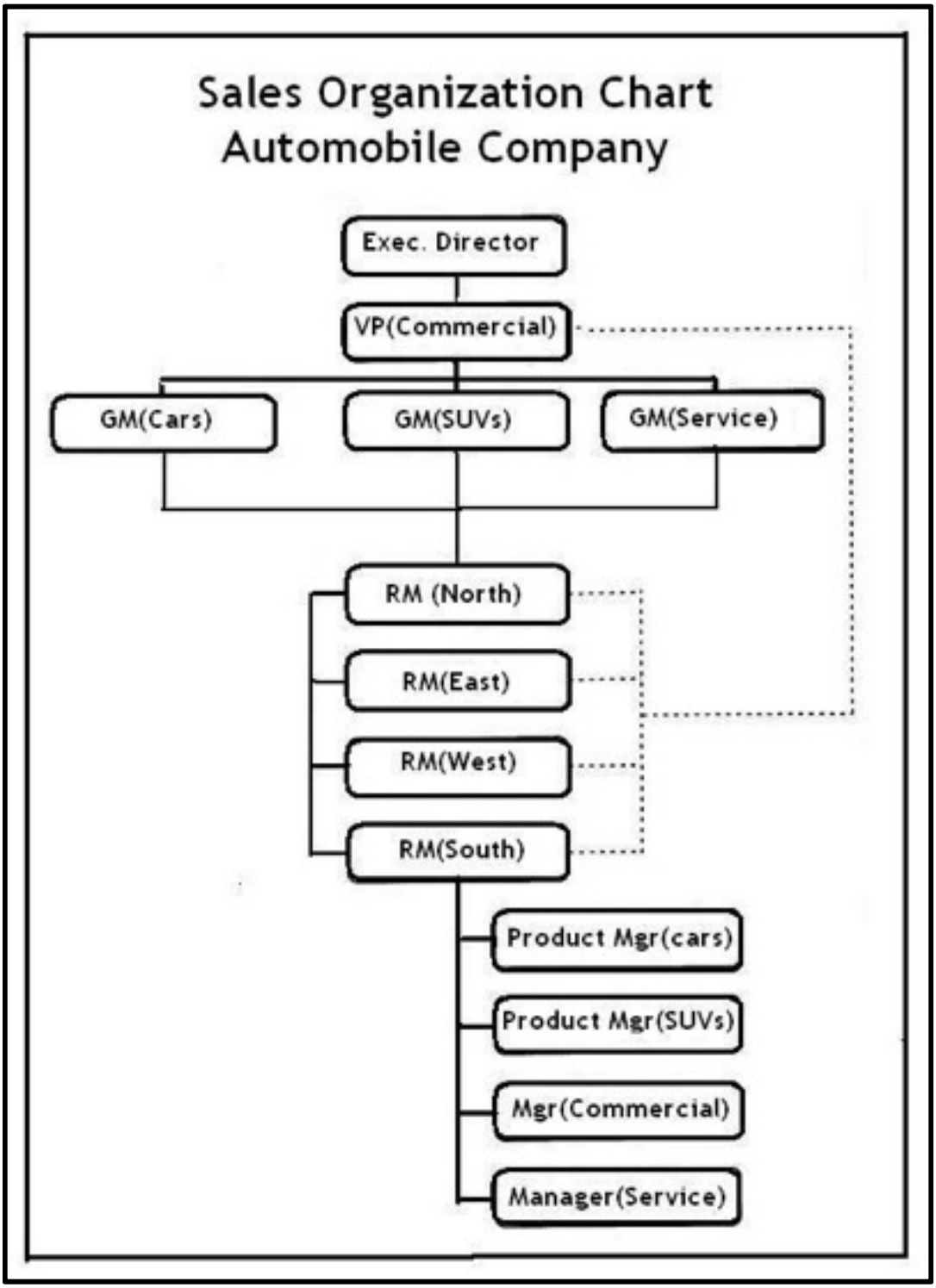
- Product design.
- Product range / mix.
- Volumes.
- Fast delivery.
- Quick introduction of new products.
- Quick response to customer needs.
- Appropriate pricing.
- Customer convenience etc…

A good marketing strategy involves, changing the behavior of a buyer from low involvement purchase to a high involvement purchase.
The process of changing consumers from low involvement purchase to high involvement purchase would require an understanding of the factors differentiating the low involvement and high involvement purchase

09.01.04 Sales Organization

Typical sales organization charts for a consumer product organization and an automobile manufacturing company are as follows. Sales organization structure depends on nature and volume of the product.


Sales Organization for a Consumer Product Company
General Mgr(Sales)
Dy General Mgr(sales)
Branch manager
Area Mgr
Area Mgr
Area Mgr
Area Executives
Distributor
Distributor
Distributor
Sales Supervisor
Sales Men

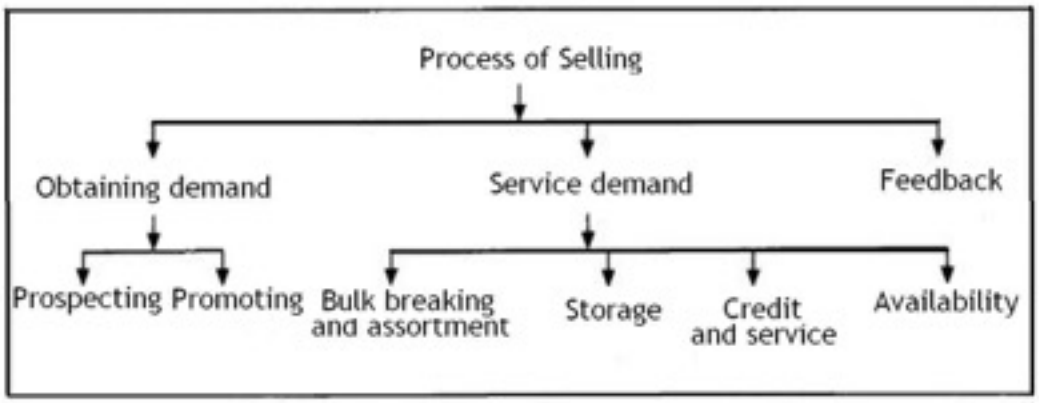

Sales Organization Chart
Automobile Company
Exec. Director
VP(Commercial)
GM(Cars)
GM(SUVs)
GM(Service)
RM (North)
RM(East)
RM(West)
RM(South)
Product Mgr(cars)
Product Mgr(SUVs)
Mgr(Commercial)
Manager(Service)

09.01.05 Selling Strategy

This section develops a framework to identify the selling strategy for a product. Characteristics of customer oriented selling:

1. The desire to help customers make satisfactory purchase decisions.
2. Helping customers assess their needs.
3. Offering products that will satisfy those needs.
4. Describing a product accurately.
5. Avoiding deceptive or manipulative influence tactics.
6. Avoiding the use of high pressure.

Companies adopting customer-oriented selling need to understand the process of selling from consumer perspective.



Process of selling	Consumer decision process and Criteria
Prospecting	Consideration set: Creating awareness of the brand by point-of-purchase display, advertisement etc…
Promoting	Information search: Providing information on packs, Displays / Brochures, Sales man's presentation. Evaluation: e.g. Comparison between competitive product such as TV sets.
Bulk breaking and assortment	Form utility: Providing the required quantity only e.g. one ball-pen only or a set of 10 envelops only (Not bulk); Providing an assortment such as tool kits e.g. Spanners/Screwdrivers/Pliers.
Storage	Time utility: Stock the product in warehouses and make it available only when / where required.
Credit and Service	Possession utility.
Availability	Place utility: Transport the product to locations, where there is demand.

09.01.06 Personal Selling

Salesmanship is personal selling - negotiating, emphasizing inducing and making the prospective buyer to take a decision in favour of going for the product being offered to him. Salesmanship is an attempt to induce people to buy goods. Salesmanship consists of winning the buyer's confidence for the seller's goods thereby winning regular and permanent customers.

09.01.06.01 Significance of Personal Selling or Salesmanship

Personal selling is a promotional tool. A salesman helps the producer and consumer in the following ways:

It is a flexible tool: Personal selling is a flexible tool in promoting sales and can adapt to the need of specific buyer.

It Involves minimum wasted efforts: In personal selling, the salesman directly attacks the target market and concentrate on the prospective customers

It results **in actual sales:** Personal selling is complementary to advertising and promotion technique. Advertising and promotion techniques can only attract attention of the customers and arouse desire to purchase the goods. They simply create demand. Personal selling converts that demand into actual sale by persuading the people to buy the product. A salesman answers the doubts of the prospective buyer and convince aim to purchase the goods.

It provides Feedback: Advertisement provides information about the product and the producer but does not provide any information about the tastes and mood of the consumers. The personal selling provides two way communications between the buyer and seller. It provides knowledge about the tastes, habits, and attitudes of the prospective buyers.

Advantages to consumers: A salesman informs the customers about the new products introduced the market, by suggesting to him the use of a product that will best satisfy his needs.

Limitation: Despite the various advantages, personal selling has a number of limitations. First, personal selling is the costliest element of the promotional mix. Secondly, Personal selling can accommodate only a limited number of consumers at a given time because he can attend only one customer at a given time. Thirdly, it is quite ineffective for creating consumer awareness about a product or service. Finally, Personal selling on the retail level has poor image in the eyes of the consumers. It is criticized for lack of honesty, strong pressures sales tactics, poor knowledge etc.

09.01.06.02 Steps in the Process of Personal Selling:

The process of personal selling consists of the following steps:

Pre-Sale Preparation: The first step in personal selling is the preparation of sales person. The sales persons must be properly selected trained and motivated for the job.

Prospecting or Locating the Prospective Buyers: It refers to locating the potential buyers for the product satisfactorily and screening them to make sure that their sales efforts will not go waste.

Approaching: Before calling on the prospects, the sales person should try to get information about their number, habits, spending capacity, motives, etc. He should know what product or brand they are using. After collecting such information, she should approach the customer in a polite and dignified way and introduce himself and his product to the prospective customers.

Presentation: The sales person, under this step, has to gain the customers attention. For this purpose, he should present his product and describe its characteristics in brief.

Demonstration: Demonstration is one of the bet methods of presentation. If necessary, the salesperson should display and demonstrate the working of the product.

Handling Objections: As every customer wants to make a best bargain for the money he is spending, presentation and demonstration of the product are likely to create some doubts and objections in the minds of the prospects. The sales person should be ready to clear all doubts and queries of the prospects politely. Handling objections tactfully helps in convincing the customers.

Closing the Sale: Making customer agree to buy goods and services means closing the sale.

Follow up: Follow up activity includes installation of the products, checking and testing its smooth performance, maintenance and after sale service. It helps building long-term relationship with the customer.

09.01.06.03 Essential Requisites of Effective Salesmanship

For practicing this art of salesmanship, one should know the fundamentals of success in the art of salesmanship. The following fundamental requisites are enumerated here under:

- Knowledge of Product.
- Knowledge of Company.
- Knowledge of Competitors.
- Knowledge of Customers.

- Knowledge of the Techniques of Selling.

09.01.07 Salesmanship

09.01.07.01 Definition

Salesmanship is an ***"art and science"*** of convincing the customer to buy a given product or service at a profit to the seller and a corresponding benefit to the customer, resulting in actual sale and a lasting satisfaction to the customer and thereby predispose him to come back to the seller for more of the same or some other product or service.

09.01.07.02 Types of "*salesmanship"*

Types of salesmanship:

- *Creative salesmanship:* creative selling means to create a desire for sale; and create a sale.
- *Competitive salesmanship:* Aim is to increase sales of existing products / services, no matter how. They outwit the competitors and increase sales volume. By means of: giving discounts, offering credit or any other incentives to the intermediaries or the ultimate customer / end-user.
- *Counter salesmanship*: Art of effectively passing on goods in exchange for money. Requisite characteristics are: a) To have adequate knowledge of the product, price and stocks b) To satisfactory answers to customer queries c) to be able to assist the customer to select the right product in right quantity.

09.01.07.03 Types of Selling Jobs

A) Manufacturers' salesmen:

a) Pioneer salesmen: Highly skilled, suitable for new product introduction and sales promotion activities.
b) Dealer / middlemen (intermediaries) servicing salesmen: They coordinate with distributors etc and collect orders for products / services. They collect market information and give feed-back to the Company. They are involved in billing and collections.
c) Merchandising salesmen: They assist retailers to improve sales by means of recommending: Showroom layouts, display stands, POP material (Point **O**f **P**urchase Material), credit policy, advertisement etc.

B) Wholesalers' salesmen: They coordinate with suppliers/manufacturers and retailers. They place orders on suppliers and obtain orders from retailers. They assist retailers to obtain credit facilities. They are involved in billing and collections.

C) Retailer sales men (counter salesmen and traveling salesmen):
a) Staple salesmen: Selling food, clothing, grocery etc
b) Specialty goods salesmen: They have good technical skills and sell products viz Water purifiers, Vacuum cleaners etc.
c) House-to house salesmen: e.g. Independent consumer salesmen meeting prospective customers personally, hawkers etc

D) Missionary salesmen: They propagate the merits of their goods / services. They have to maintain the goodwill of the manufacturers and hence called missionary salesmen. They have detailed knowledge of the products / services and closely involved in sales promotion activities.

E) Service salesmen: They are involved in sale of service products such a insurance, Movies' tickets, courier service etc.

F) Industrial salesmen: They possess high technical skills and sell goods only to industries and not individuals e.g. Electrodes, cutting tools, machine accessories, industry-consumables such as special chemicals, lubricants, paints, packing material etc.

09.01.07.04 Qualities of a Good Salesman

Personality of a salesman is the sum-total of the impression made on people coming into contact with him. Sales personality is the sum-total certain qualities and traits.
The fundamentals of successful salesmanship are contained in the following three factors.

1. Personality.
2. Product Knowledge.
3. Knowledge of Customer Psychology.

Personal Qualities of Good Salesmen:

A) Physical Qualities:
a) Health b) Posture c) Voice d) Appearance c) Grooming

B) Mental Qualities:

a) Alertness b) Imaginative c) self-confidence d) Initiative e) memory f) Observation
g) Resourcefulness h) Cheerfulness i) Cheerfulness

C) Social Qualities:
a) Effective speech b) Curtsey c) Tactful d) Co-operative e) Good manners f) Patience
g) Tolerance

D) Character:
a) Honesty b) Courage c) Sincerity d) Loyalty e) Determination f) Industriousness

Product knowledge derived from:

a) Personal experience.
b) Trade and tech journals.
c) Sales manuals / literature.
d) Sales bulletins.
e) Factory visits.
f) Meetings / Conferences.
g) Visual aids.

09.01.08 Customer Psychology

≠ Classification by sex:

A) Men: They have more knowledge and experienced. Do not wish to spend more time on shopping. They get bored quickly. They take quick buying decisions. They are savings-conscious.
B) Women: They are interested in latest fashion. They spend more time in selection; and hard to please. They are good bargainers and search in several shops before buying.

≠ Classification by age:

A) Children: They are interested in specific items such as toys, story books, color pencils, sweets, dresses etc. They are innocent and inexperienced.
B) Youngsters: They are impatient. They want latest fashion. Take quick decisions. They are impulsive buyer. Many do not have much finance.
C) Middle aged: They are experienced and can not be bluffed. They take mature decisions. They are generally financially sound and want the best of goods.

D) Elderly: They do not like any advice. They spend more time in shops before taking a decision. They have to be treated with utmost respect.

≠ Classification by geographical location:

A) Urban customers: They are educated, cultured ad well informed. They are usually polite. They want latest fashion. They Do not bargain too much.
B) Rural Customers: They are humble and price conscious. They do not care for curtsey. They move in groups and cannot be cheated or misguided. They want the product to last forever. They do not care about latest fashion.

≠ Classification by characteristics:

1. Argumentative type.
2. Shy type.
3. Silent type.
4. Talkative type.
5. Suspicious type.
6. Friendly type.
7. Hesitant type.
8. Impatient type.
9. Sarcastic type.
10. Pompous type.
11. Rude type.
12. Untruthful types.
13. Something for nothing type.
14. Impulsive type.
15. Group shopper type.

≠ Mental process of buyer vis-à-vis stages of selling process: A-I-D-C-A process:

A → Attention towards the product. (Attract attention; Posters, display and demonstration)
I → Awaken the **I**nterest (Explain salient feature of the product)

D ➔ Create a **D**esire to buy
C ➔ Secure **C**onviction and confidence in the product.
A ➔ Secure **A**ction.

The prospective buyer should be allowed to see, smell, touch, hear and feel the article to be sold. Explain clearly- the features, price, discounts, delivery details, warranty, service facility etc and convince the customer to buy the product without resorting to pressure-selling tactics.

09.01.09 Selling Process

Sales process refers to sequential or series of actions undertaken by the salesman to convert a prospect into a customer.

The general stages of sales process are as under:

09.01.09.01 Prospecting

Searching for persons / organizations in need of the product:

- Family-tree method / Endless chain method: Get references from the existing customers.
- Canvassing or cold turkey method: Preparing a random list of prospects and meeting thee e.g. door-to-door sales.
- Center of influence method: Take the help of influential persons; e.g. doctors, professors, politicians, businessmen etc…
- Personal observation method: e.g. locating club members, Visitors to a mall etc…
- Direct mail / telephone-calls method: e.g. Posting leaflets and making personal calls.
- Company records: Track the present and past customers of the company from records.
- Bird-dog method: Bird-dog is slang for those who make regular visits to their customers such as milk/newspaper vendors, gas delivery boys, security guards etc. They can provide valuable info on prospective customers.
- Exhibitions: Display and offer discount sales at an exhibition.

09.01.09.02 Pre-approach

Obtain additional information on prospects viz. economic status, official position etc…

- Get equipped with sales literature and leaflets.
- Classify the customers e.g. grade the prospective customers on 1 to 10 scale; 1 for min potential and 10 for highest potential and cover the more potential lot.
- Collect data from newspapers, company records, existing customers, fellow sales men, retailers, directories etc…

09.01.09.03 The Approach

Gain interviews by

- Personal calls.
- Sending business cards.
- Writing for an appointment.
- Carry gifts (called door-openers).

Action:

- Make visits at a mutually convenient date / time.
- Dress properly.
- Call back or make a repeat visit if required.
- Explain the product in detail.

Approach in retail outlet:

- Attract a hesitant customer decently.
- Welcome the customer.
- Greet the customer Offer a seat.
- Make a proper opening remark.
- Show willingness to serve.
- Display a positive attitude.
- Tell important selling features.
- Welcome objections and doubts and give honest clarifications.
- Respect even casual non-buying visitors; they may come back later.

09.01.09.04 Presentation or Demonstration

- Demonstration in actual use if possible. (or)
- Demonstration of a specific feature. (or)
- Conduct a dry run.

09.01.09.05 Meeting of Objections

- Listen to customer carefully.
- Anticipate questions / objections and prepare in advance.
- Admit valid objections.
- State superior and compensating points.
- Pass up some objections with a smile or a shrug. (Pass up method).
- Make the customer answer his own questions / objections, tactfully (Interrogation method).

Some common objections are:

- Price / discount structure.
- Delivery time.
- Payment mode.
- Service issues.
- Warranty issues.

09.01.09.06 Closing the Sale

"Closing" is the action on the part of the salesman to obtain "YES" from the customer close the sales transaction.

Steps in closing:

- Get a series of positive statements from the customer.
- Show alternatives and narrow down the choice.
- Hold attention of the customer.
- Allow objection and questions and answer honestly.
- Gain confidence of the customer.
- Let the prospect decide.

- Reserve some important features for disclosure at a critical stage of buying decision.
- Hit at the right time.

09.01.10.00 Sales Planning

09.01.10.01 Sales Organization

A) Purpose of sales organization:

- To assign responsibility and delegation of authority.
- To ensure that all necessary sales activities are performed.
- To achieve co-ordination and balance.
- To develop specialists.
- To economize the sales operations.

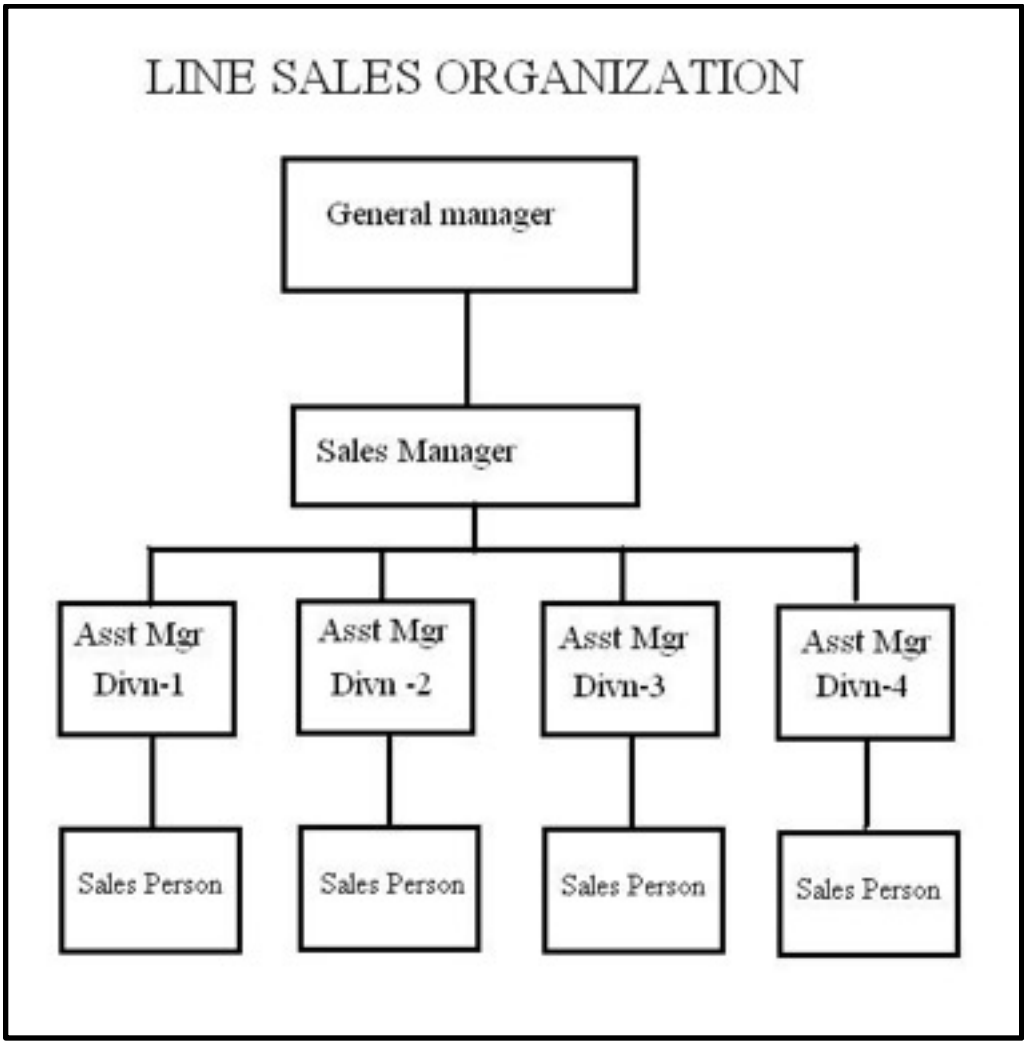
B) Setting up a sales organization:

- Define objectives of the sales organization.
- Determine the activities and their volume of performance.
- Grouping of activities into positions (Merchandizing, Product groups, commercial activities, Administration etc…
- Assignment of Personnel to positions.
- Provide for coordination and control.
- Define policies, systems, procedures, rule and regulations.
- Design performance review system.

C) Basic Types of sales organizations

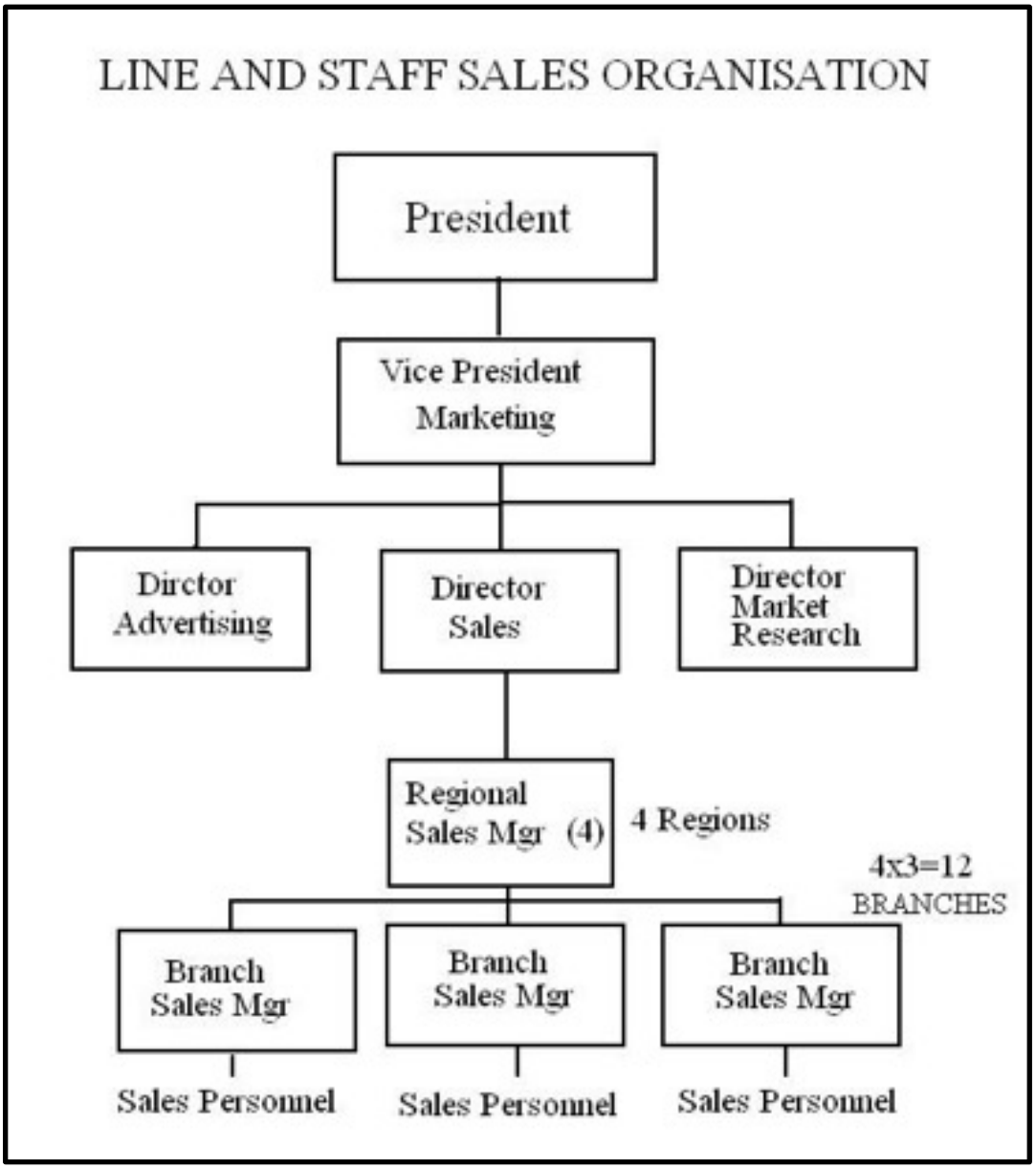
a) Line Sales Organization:

Sales manager reports to general manager, assistant sales managers for different products report to sales manager, sales men in a particular product line report to respective assistant sales managers. There is not much cross communication between persons at the same level.



b) Line and Staff Sales Organization:

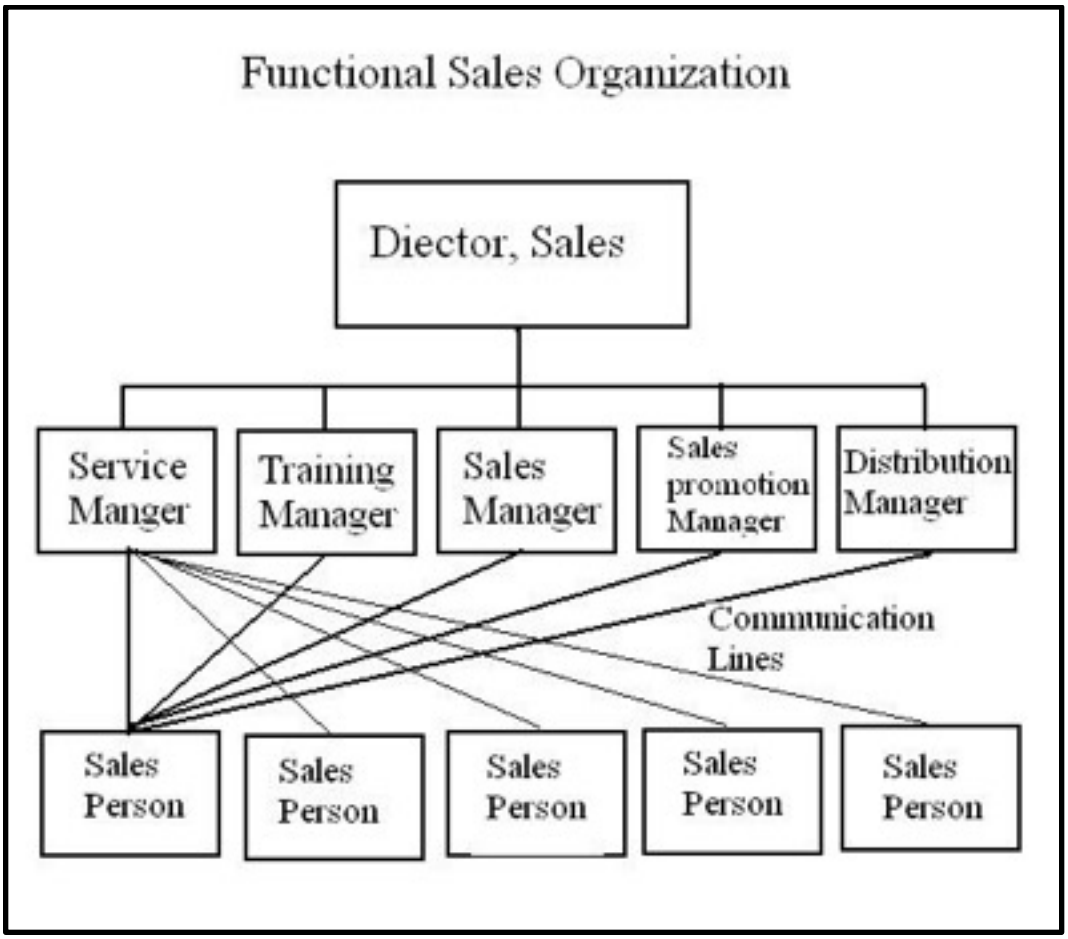
General sales manager, advertising manager, and market research manager report to vice president. Functional directors in charge of training, sales, personnel, sales promotion, and distribution report to general sales manger. Each director has his own staff for the function.



c) Functional Sales Organization:

Functional mangers, in charge of service, training, sales, sales promotion, distribution etc. report to director (sales). All of them interact with all the sales supervisors/staff. No matter where a particular function appears in the organization, it is the jurisdiction of the same functional manager. In a functional sales department, sales personnel receive

instructions from several executives but on different aspects (functions) of their work. There is a tremendous cross communication and interaction in such a set-up.



09.01.10.02 The Sales Budget

The sales budget is a blueprint for setting targets for sales volume, turnover, operating expenses, and net divisional contribution (profit). It is a business **PLAN.**
It is tool for **control** on operations by comparing actual performance vis-à-vis budget and take corrective action in case of deviations.
In a multi product / multi location organizations budgets are broken down, region-wise and product-wise. The region-wise budgets are further broken down, branch-wise, sales-person-wise etc.

Overall company budget is arrived at, by adding up figures of region-wise / product-wise budgets.

Steps in making a budget

1. Collect past sales statistics of various products e.g. region-wise / month-wise quantity.
2. Determine quantitative targets for all products region-wise / month-wise; considering the total manufacturing capacity limits of the organization.
3. Determine product-selling prices to arrive at financial value of the turnover.
4. Determine staff requirement in-line with the targeted volumes to arrive at staff cost to be budgeted.
5. Determine inventory levels.
6. Determine customer credit standards and estimate customer outstandings.
7. Determine the requisite working capital (Inventory carrying cost ***plus*** customer credit ***minus*** customer advances etc.) to assess interest charges, to be budgeted.

Formulate the budget in a format as under:

Broad Framework for Budgeting

1. Preamble.
2. Description of Product/Service: Detailed Product/ Service specifications.
3. Target Customer group/category – Customer Profile.
4. Market demand: past statistics and Forecast for next 3 years or more.
   State information source and basis for the projections.
5. Targeted market share and basis for the decision.
6. Differentiation strategy.
7. Perspective plan for 10 years.
8. Aggregate plan for current year and forecast for next 2 years.
9. Detailed production Plan for current/next 2 years.
10. Detailed month wise production plan for current year.
11. Capacity planning.
12. Investment details: Plant/machinery/equipment details and capital cost.
13. Organization Chart and Man-power summary: Department wise/Total figures.
    (Senor Mgt/Middle Mgt/Junior Mgt/supervisory staff/General Staff/Workmen-Skilled, Unskilled categories : Give breakup).

14. Inventory management: Work-in-progress/inventory policy & estimated values
15. Fixed Capital and working capital calculations: Values.
16. Show calculations under each head, as per the following budget format.

BUDGET: 2014-2015 and plan for next two years 2015-2016 / 2016-2017.

Serial No	**Item**	**Current Yr. Budget 2014-2015**	**Next Yr. Plan 2015-16**	**2nd Yr. Plan 2016-17**
1	Sales Turnover			
2	Transfer prices paid (Procurement cost)			
3 (1-2)	Gross Margin			
4	Variable Overheads			
5 (3-4)	Contribution			
6	Fixed Overheads / Staff & Admin Expenses			
7 (5-6)	Profit before Interest / Depreciation			
8	Interest on working capital			
9 (7-8)	Cash profit			
10	Depreciation			
11 (9-10)	Profit/Loss			

The budget may be further broken down into region-wise and product-wise for close monitoring.

There should be periodic review by CEO of the company, say every quarter; to review actual performance vis-à-vis budget parameters.

Critical performance review factors; *Budget vs. Actuals*:

- Sales quantity for all products.
- Sales turnover value.
- Staff strength / cost.
- Working capital.
- Interest paid to the banks.

Any deviations with respect to budget must be analyzed and corrective action taken.

09.01.10.03 Quotas

Quotas are quantitative objects assigned to sales organization units / individual personnel. As standards for appraising selling effectiveness quotas specify desired performance levels for sales volumes; such budgeted items as expenses, gross margin, net profit, and return on investment; selling and non-selling activities; or some combination of these items. In some organizations, sales management sets quotas for intermediaries, such as agents, wholesalers and retailers.

Quotas set for sales regions, or other units of higher organizational levels are broken down and reassigned to lower level units like sales districts, or individual sales personnel.

Quotas are devices for planning, direction and controlling sales operations.

Objectives of quotas:

- To provide quantitative performance standards.
- To obtain tighter sales and expense control.
- To motivate desired performance.
- To use in connection with sales contests.

Types of quotas:

- In terms of monetary values ($, Rs etc…)
- In terms of quantities (Numbers, Tons, Liters etc…)
- In terms of "Point-Sales-Volume" quotas: (Say Rs 10,000 sales worth one point for product A and so on).

Procedure for setting sales volume quotas:

- Derived from past statistics.
- Derived from territorial sales potential.
- Derived from total market estimates and breaking down into regional targets: Top-down approach.
- Derived from total Manufacturing capacity.
- Derived from executive judgment and experience.
- Derived from sales compensation received by sales force (To recover expenses).
- Derived from bottom-up targets (Self targets of regional managers).

Budget quotas:

- Turnover value quotas.
- Expense quotas.
- Gross margin quotas.
- Net profit quotas.

Activities Quotas:

- Total sales calls to distributors / retailers / customers.
- Total field visits made.
- Number of new customers developed.
- Number of demonstrations performed.
- Number of sales prospects identified.

09.01.10.04 Sales Territories

Establishing of sales territories facilitates matching selling efforts with sales opportunities. Sales personnel are assigned responsibility for serving particular groupings of customers and prospects and provide contact points with the markets. Territorial assignments lend guidelines for planning, direction and control of sales operations.

Definition: A sales territory is a grouping of customers and prospects assigned to a sales person. This could have geographical territory or simply a class of customers – mostly technical selling types- irrespective of locations.

Reasons for establishing or revising sales territories:

- Providing proper market coverage.
- Controlling selling expenses.
- Assisting evaluation of sales personnel / Contributing to sales staff morale.
- Aiding in co-ordination of personal selling and advertising.

Methods for setting up sales territories:

1) Selecting a basic geographical control unit:

- Pin code.
- Cities.
- Metropolitan areas.
- Trading areas (A dominant wholesale / retail center, A fruit market etc…)

2) Breakdown method:

Workload method:
The premise here is an equal load of work for every sales person. This method should be dynamic; not static. This method needs constant revision, as the conditions of market in terms of effort needed in selling and the level of competition keep changing.

09.01.10.05 Sales Control and Cost Analysis

Sales Analysis:

Allocation of sales effort: Are we concentrating on all areas of potential? Where is the maximum effort put in?

Data for sales Analysis: Sales data – mostly from invoices- need to be in the database for statistical reference and analysis.
Identification of weak areas of sales: To reinforce the resources to make improvements in sales in weak zones.

Marketing cost analysis:

Marketing cost analysis analyzes sales volume and selling expenses to determine the relative profitability of particular aspect of sales operation.
The first step in marketing cost analysis is sales analysis by territories, sales personnel, products, class of account, and size of order, marketing channels, and other categories.
The next step is to break down and assign selling expenses by sales territories.
The outcome indicates relative profitability of the sales territories.

Purpose: Marketing cost analysis determines the relative profitability of particular aspects of sales operations.

We need to get answers to the following questions.
Which territories are more profitable?
Which territories are weak?
What is the contribution from individual salesmen?
Which product line is yielding more profits?
Which is the most efficient marketing channel? (Profit per unit of sale?)

Marketing cost analysis techniques:

1) Classification of selling techniques:

a**)** Direct (separate) expenses: Expense that is traceable to a particular salesperson, Product, territory, customer, marketing channel etc. E.g. travel expenses, merchandizing, Commission paid to agents/distributors etc.

b) Indirect (common expenses: e.g. corporate management / head office expenses, General administration, Accounting, Personnel office etc; Sum total of these are allocated to each territory, product etc proportionately according to the effort put in, based on judgment of senior management.

2) Converting accounting expense data to activity expense groups:

Expenses may be summarized under the following heads.

- Sales salaries for a product group or branch.
- Sales commission for a particular product.
- Sales travel expenses for a particular person, product or branch.
- Rent of branch sales office etc…

3) Bases for allocating common expenses:

Allocation bases permit logical assignment of portions of common expense items to particular aspects of sales operation.

- Allocation of accounting expenses: Based on the number of sales transactions pertaining to a branch or a product.
- Allocation of personnel dept expenses: In proportion to the no of salesmen in the branch or working on a specific product.
- Allocation of salaries of senior management: In the ratio of time spent for a branch or a product; some times based on good judgment.
- Allocation of packing/transport cost: Based on weight or volume of the products sold.
- Allocation of administration expense: In proportion to the turnover value.

These are only general guidelines. It also depends on company's policy on allocation, so long as the allocation is logical.

Contribution / Margin:

Contribution margin = Sales revenue (-) cost of goods sold (-) direct expenses (-) allocated common expenses

Net profit = contribution margin (-) interest (-) depreciation.

09.01.11 Sales Force Management

09.01.11.01 Recruitment and selection

Recruitment is the process where the prospective employees are found and encouraged to apply. Selection is the process of choosing a few out of the total large reserve provided by recruitment.

Recruitment / selection are necessary**:**

- To fill in vacancies arising out of resignations and retirement.
- Additional workers / staff required for expansion of business.

Recruitment / selection process; steps:

1. Analysis of jobs to be done by salesmen:

Job description:

- Duties and.
- Responsibilities.

2. Determination of characteristics and qualities to be possessed by the salesmen for a particular category:

a) General qualities such as personality:

- Health.
- Intelligence.
- Honesty.
- Integrity.
- Sociability.
- Consistency.
- Power of observation.

b) Particular qualities:

- Educational requirement.
- Past experience.
- Product knowledge.
- Knowledge of customers.
- Knowledge of market.

c) Technical Knowledge:

- Specialized knowledge e.g. chemical engineering etc…
- Legal implications of the business.

3. Tapping various sources of recruitment:

- Internal sources: Promotions and Transfers.
- External sources: Advertisement, Employment exchanges, Recommendations, Campus recruitment, Wholesalers/Retailers Self-Offers etc…

4. Careful selection:

- Scrutiny of Applications and short listing.
- Personal Interview.
- Medical examination.
- Final interview.
- Offer of appointment.

5. Final Appointments

09.01.11.02 Training of salesmen

1. Importance of sales training:

- To improve sales performance.
- To influence prospects in a positive manner.
- Provide product knowledge.
- Reduce wastages.
- Develop high morale.
- Low turnover of sales force.

2. Objectives of training:

- To teach the principles of the “art and science” of salesmanship.
- To acquaint the salesmen about the company policies and procedures.
- Impart technical knowledge (product manuals).
- Train for product demonstrations.
- To train for obtaining customer feedback.
- To teach sales techniques.
- Familiarize about distribution network.

3. Methods of instructions:

- Classroom Method.
- Group discussions.
- Laboratory Methods.
- Visits to production shops.

09.01.11.03 Remuneration of Salesmen

1) Aim of good remuneration:

- Attracting talents.
- Keeping the sales force contended.
- Inculcating loyalty.
- Sound employee-employer relations.
- Control of sales' costs.

2) Factors affecting remuneration plan:

- Nature of the job.
- Nature of the product.
- Class of salesmen (viz. traveling salesmen, creative salesmen etc…)
- Financial capacity of the company.
- Distribution channels.
- Sales effort needed vis-à-vis advertisement level.

3) Essential features of a sound remuneration plan:

- Simplicity.
- Flexibility.
- Economics.
- Fair and equitable.
- Adequacy.
- Incentive oriented.
- Stability.
- Low administration effort.
- Parity with industry salary levels.

4) Method of remuneration:

- Straight salary method: Basic +allowances; increments, bonus.
- Straight commission method.
- Salary and Commission basis.
- Profit sharing method.
- Salary and special incentive scheme.

09.01.11.04 Motivation of Salesmen

Motivation is the process of stimulating people to perform in order to accomplish the desired goals.

Performance of a salesman depends on:

- His ability. &
- Level of motivation.

.

Performance = Ability x Motivation.

Need for motivation:

- Improvement in efficiency.
- Relieve tensions.
- Keep the sales force happy and contended.
- Human treatment.

Tools of Motivation:

- Incentive plans.
- Promotions.
- Adequate remuneration.
- Parity with industry salary level.
- Personal contact with Managers.
- Teamwork.
- Correspondence with Mangers.
- Review of performance and appreciation of good performance.
- Sales contests to: dispose off excess stocks, increase volumes, popularize products, and collection of customer out-standings.
- Sales conference.
- Publish bulletins and magazines.

- Involvement in design, production and marketing activities.
- Honors and awards for good performance.
- Participation in managerial / policy decisions.

09.01.11.05 Control and Supervision of the Sales Force

Control is the process of trying to achieve conformity between goals and actions. Controlling is an act of checking and verifying an act to know whether work is being done according to budgets / plans.

The process of control:

1. Establish standards of performance.
2. Measure the output.
3. Compare Actuals vs. standards and assess variance.
4. Change inputs to take corrective action.

09.01.11.06 Methods of Control

1) Call for reports:

- Periodic sales reports.
- Expense reports.
- Field failure reports.
- Competition price.
- Customer out-standings.
- Tour reports.
- Visits to customers / distributors.
- Customer complaints.

2) Allocation of Sales Territories:

- Specific Areas.
- Specific groups of distributors/retailers/customers.

The main object of allocation of sales territories can be summarized as follows:

- To hold salesmen responsible for sales and service in the territory.

- Supervise and control the sales force.
- To compete in the market.
- To serve the customers more effectively.
- Pinpoint responsibility and identify non-performers.
- Comparison the performance between salesmen.
- Comparison among sales areas.
- Assessment of sales potential in specific areas.
- For quick market survey.

Factors determining the size of sales territories:

- Nature of the product: (Small territories when sales effort is high e.g. high cost/ luxury items).
- Demand for the product (Large territories for infrequently purchased items).
- Transport facilities: (Smaller territories if transportation facility is inadequate).
- Level of competition: (Smaller territories where competition is intense). Population: (Small territories where the population density is high).
- Advertising and sales promotion level: (Larger territories if the advertising support is adequate).
- Ability of a salesman: (Larger territory for experienced/ efficient / senior salesmen).

3) Allocation of Sales quota:

Establish targets for the salesmen based on past sales figures and market trends.
Factors for fixing sales quota:

- Past sales records.
- Buying power of customers.
- New product introduction.
- Company policy (Higher quota in case of liberal credit policy).
- Total production level (Higher quota if production level/demand increases).
- Extent of competition: (Lower quota if competition is heavy).
- Opinion of experts: (Consultation wit distributors/retailers).

Methods of setting sales quota:

- Top management downward. (Break-up of total target downwards).
- Territorial estimates upward.(Grass roots approach).
- Combination of the above two methods.

- Past performance methods.
- Targets based on bench mark competitors.

Advantages of fixing sales quota:

- Helps in planning production.
- Helps in budgeting.
- Easy measurement of performance among salesmen and regions (Compare Plan vs. Actuals).
- To locate under developed market areas.
- Stimulates the salesmen to work harder and efficiently.

4) Field supervision by ➔

Regional mangers / Branch mangers / Area Mangers / Head office / Marketing personnel.

09.01.11.07 Evaluation of Performance

Purpose of evaluation:

- To measure actual performance vis-à-vis plans / targets.
- To recognize and reward efficient salesmen.
- To guide the sales force.
- To identify weak salesmen.
- To identify underdeveloped areas.

Performance measures:

- Volumes.
- Age-wise analysis of customer out-standings.
- No of customer complaints.
- Deviation from plans / targets.
- Expenses in relation to volumes.
- No of visits to distributors / agents / customers.
- No of calls made per unit of sales.
- Inventory levels / statist.

Chapter 09.02
Distribution Management

09.02.00 Distribution Management:

INDEX

09.02.17	Franchising	
09.02.18	Distribution Costs, Control and Customer Service	
09.02.19	Customer Behavior and Satisfaction	

09.02.01 Marketing Channels - Structure and Functions

09.02.01.01Introduction

This subject is of the marketing channels, the organizations that come together to bring products and services from the point of origin to the point of consumption.
The marketing channels are the downstream part of a value chain.
Thus, the originator of goods or services gains access to a market through marketing cannels.
Usually, combination of organizations specializing in manufacturing, wholesaling, retailing and many other areas join forces in marketing channels. These deliver any anything ranging from a screw to Aircraft.

This chapter covers:

- Definition / concept of a marketing channel.
- The purpose for using marketing channels to reach the market place.
- The functions and activities that go on in marketing channels.
- Membership in marketing channels.
- How the framework for analysis can improve the channel decisions made by the channel designers or managers.

09.02.01.02 What is a Marketing Channel?

A marketing channel is a set of interdependent organizations involved in the process of making a product or service available for use or consumption.
The nature of channels varies with the product and within the product as can be seen from the following examples:

A) Personal computers:

A-1) Producer ➔ Value added resellers / Retailers ➔ End users
A-2) Producer ➔ Direct sales to end users (and through the internet)

B) Books:

B-1) Authors ➔ Publishers ➔ book wholesalers ➔ Store-based retailers ➔ End users
(OR)
B-2) Authors ➔ Publishers ➔ Standard retailers such as Barnes and Noble, Borders etc ➔ End uses (Direct Buying at stores or through internet / online stores)
(OR)
B-3) Authors ➔ Publishes ➔ Online book sellers (Such as www.amazon.com) in partnership with shipping and logistics companies
C) Pharmaceuticals:

C-1) Producers approach [Physicians / Hospitals / distributors / Drug stores] through [contacts employee sales force / contract sales force] to promote sales
C-2) Product flows ➔ [Distributors /Retailers] ➔ Patients (directly) or through a Hospital Money may from the patient to pharmacy or from Insurance company to a pharmacy / Hospital.

D) Consumer durables:

Manufacturers ➔ Agents ➔ Distributors ➔ Wholesalers➔Retailers ➔ Consumers
Manufacturers ➔ Online Stores ➔ Consumers

09.02.01.03 Types of Channels

- Direct Marketing Channel. (or Zero Level) and
- Indirect marketing Channel.

A) Direct Marketing Channel:

This type of channel has no intermediaries. In this distribution system, the goods go from producer directly to the customer.

0 Level Channel:

Producer ➔ Consumer

E.g. Machine Tools, High value products such as Fork Lift Trucks, Electrical Transformers, Steam Boilers, Turn-key projects (Power Plants) etc

B) Indirect Marketing Channel:

B-1) One level channel:

Producer ➔ Retailer ➔ Consumer (OR)
Producer ➔ Distributor ➔ Consumer
There is only one intermediary in this type of channel (Retailer or Distributor); e.g. Refrigerator, Industrial Products

B-2) 2 Level Channel:

There are two intermediaries:
Producer ➔ [Wholesaler/Distributor] ➔ Retailer ➔ Consumer
E.g. FMCG ..Cosmetics

B-3) 3 Level Channel:

There are 3 intermediaries:
Producer ➔ Distributor ➔ Wholesaler ➔ Retailer ➔ Consumer
e.g., Consumer durable products (Appliances)

B-4) 4 Level Channel:

There are 4 intermediaries:

Producer ➔ Agent ➔ Distributor ➔ Wholesaler ➔ Retailer ➔ Consumer

There is no watertight classification of Channels.
Selection of a channel depends on nature of the product and business environment.
Running a marketing channel is a process and it is not over when the sale is made.

What is the purpose of a channel?

The definition is “Making a product or service made available for use or consumption.”
The objective of a channel is to satisfy the end users in the market.
After- sales- service is critical to the success of a business.

09.02.01.04 Dynamics of Marketing Channels: Why do they change?

Why should a marketing channel change its shape or new marketing channels emerge? Sources of impetus for channel development and change:

- Demand-side factors.
- Supply-side factors.

A) Demand-side Factors:

A-1) Facilitation of search:

End users are not aware of sources and the sellers do not how to reach the end user. The intermediaries facilitate searches on both sides of a channel.

For instance a customer is looking for a special type of paper, can go to a standard office stationery stores such as Office Depot (USA) and buy the product there rather than search for various manufacturers.

A-2) Adjustment of Assortment discrepancy:

There is always a natural discrepancy between the assortment of goods manufactured by a company and the assortment demanded by the end-user.
The following functions are carried out by the intermediaries.

- Sorting out: This involves breaking down a heterogeneous supply into separate stocks that are relatively homogeneous. (e.g. sorting out oranges by size and grade).
- Accumulation: The intermediaries bring similar stocks from various. manufacturers and accumulate a large homogeneous stock to meet the demands of retailers and there by the demand from consumers. (e.g. Bond paper / Photo copying paper etc…)
- Allocation: This involves the breaking down of bulk supplies into manageable. lots for distribution to retailers, who in turn break up the lots as per ultimate customer requirement. (e.g. hardware; is repacked into cartons and smaller packs).
- Assorting: This is building up of an assortment of products for resale in association with each other. [e.g. Making tool kits comprising (Spanners + Screw-driver + Wire-cutter + Pliers + Hammer + Pipe-wrench etc…)]

In short, intermediaries help end-users consume a combination of product and channel services as per their needs.

B) Supply-side factors:

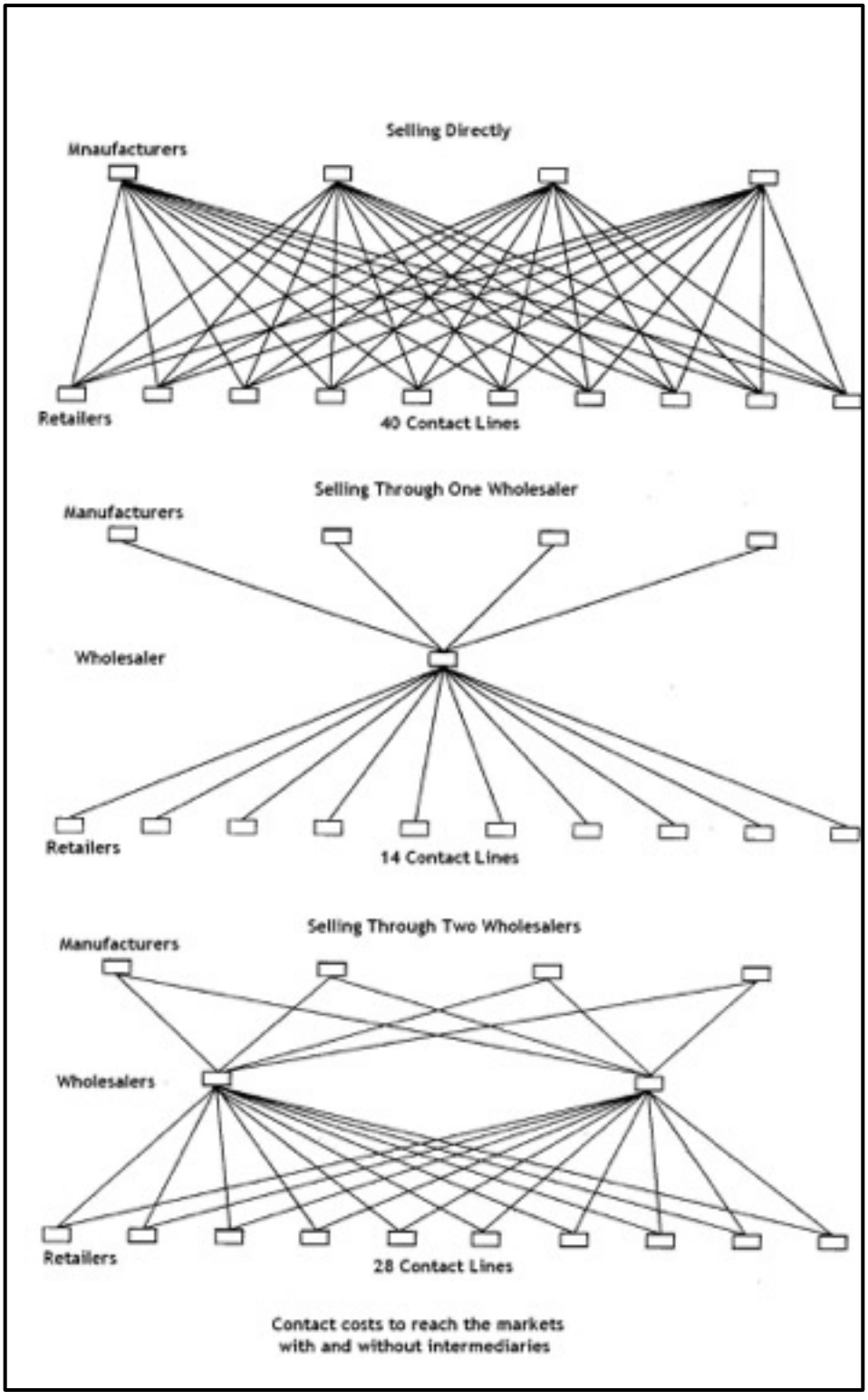
B-1) Routinization of transactions:

Each purchase transaction involves ordering, invoicing and collection of payments. By routnization we increase efficiency of channel activities. The buyer and seller must agree on the rate, discount, mode of payment etc.

B-2) Reduction in the number of contracts:

Without channel intermediaries, every producer would have to interact with every potential buyer in order to create all the possible market exchanges.
This principle guides manufacturers seeking to enter new markets without engaging more sales force.
The transaction load is distributed across the channel members and becomes manageable.

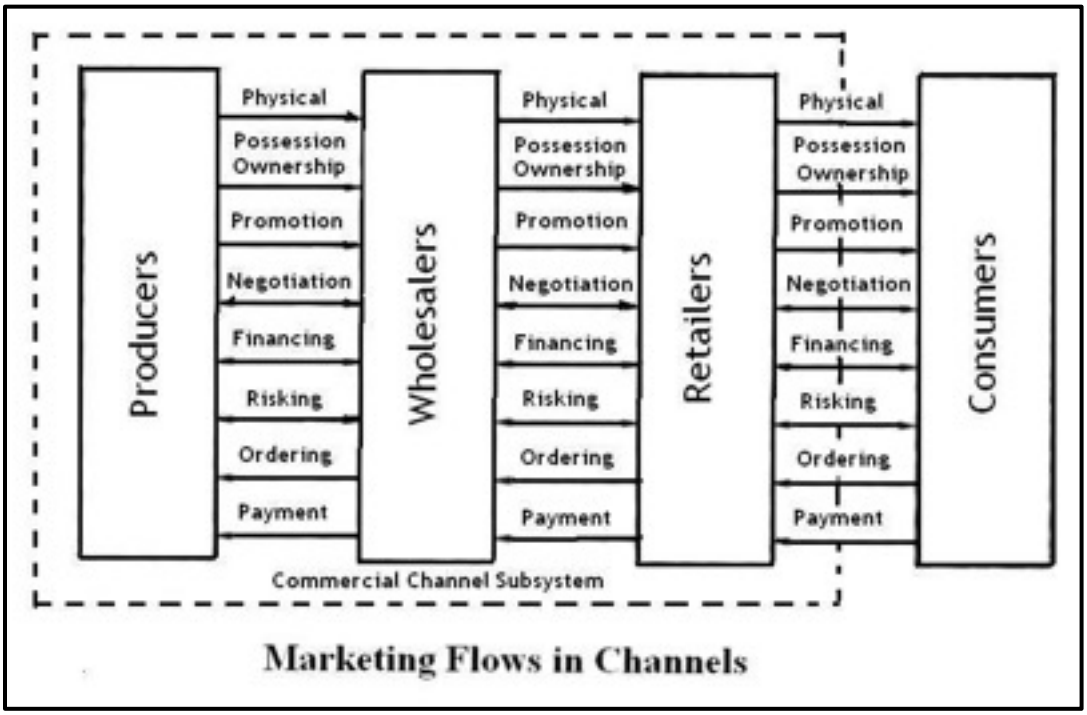
The following figure demonstrates the number of transactions vis-à-vis the number of intermediaries. The manufacturer can not handle too many transactions in absence of intermediaries / Channels.



Contact costs to reach the markets with and without intermediaries

09.02.01.05 What is the work of the marketing channel?

The work of a channel includes the performance of several market flows.
We use the term flow, rather than functions or activities to emphasize that these processes often flow through channels, being done at different points of time by different channel members.
We finalize this list in the following figure showing eight universal channel flows that might be performed in a channel containing producers, wholesalers, retailers and consumers.



As the figure shows, some flows move forward through the channel (physical possession, ownership and promotion) where as others move up the channel from end-user (order and payment), Still other flows can move in either direction (negotiating, financing, risking) Information does flow between every possible pair of channel members.
The flow of information improves the effectiveness of the channel as a whole, by way of improving sales forecast, cost reduction, better inventory management etc.

Types of information shared/exchanged through electronic data interchange relationships:

- Product Information.
- Stock status.
- Delivery schedules.
- Consumer feedback.
- Sales statistics etc…

09.02.01.06 Who Belongs to a Marketing Channel?

Key members are:

- Manufacturers.
- Intermediaries.
- End-users.

A) Manufacturers:

- Some manufacturers brand their products and are known to the customer.
- Some manufacturers do private-label production and the down stream buyer puts his own brand name on the product. Manufacturer does not invest in creating brand image and is not visible to the customers.
- Some manufacturers (e.g. Apparel) use a brand owned by another organization (Designers), but directly ship the product to the retailers. Sometimes it could be a joint venture where the manufacturer is visible.

B) Intermediaries:

The term, “intermediaries” refers to any channel member other than manufacturer or the end-user.
The three types of intermediaries are:

- Wholesaler.
- Retailer.
- Specialized.

B-1) Wholesalers include:

- Merchant wholesalers or distributors.
- Manufacturers’ representatives.
- Agents.

- Brokers.

A wholesaler sells to other channel intermediaries or to business end-users, but not to individual customer end-users.
Merchant wholesalers take both title and physical possession of inventory. They promote the product, arrange for finance, ordering etc. They make profit by buying at wholesale/ discounted rates and selling at a marked up price to their downstream channel members. Manufacturers' representatives Agents & Brokers do not take title nor keep stocks. They take part in sales promotion and negotiation of trade terms flows.

B-2) Retail intermediaries come in many forms such as:

- Departmental stores.
- Mass-merchandisers (e.g. Wal-Mart, Target etc…)
- Hypermarkets.
- Specialty stores.
- Convenience stores.
- Franchises.
- Buying clubs.
- Warehouse clubs.
- Catalogers.
- On-line retailers etc…

They sell a product or service directly to the en-users

C) End-Users:

They are:

- Business customers.
- Individual end-users.

We classify the consumers as marketing channel members, because they perform some channel flows such as:

- ➢ Financing: They pay for their purchases, before using and bear the cost of pilferage, spoilage etc…
- ➢ Storage: Consumers stock some stocks at home (e.g. Toilet paper rolls, napkins etc…) This reduces the storage load of intermediaries.

09.02.01.07 Channel formats as combination of channel members

This variety of channel participants can be combined in many ways to create an effective marketing channel.

The range and the number of channel members are affected by the nature of demand by end-users and the captaincy of the channel can vary from situation to situation.

09.02.01.08 Framework for channel analysis

Having learned the above channel concepts, we are in a position to design and manage the marketing channels.
A comprehensive framework for analysis is necessary to guide the channel manager through both initial design of the channel and its on-going management over time.
The concept of inter-dependence of channel members is critical to the success of a channel. Attention must be paid to all the design and management elements to ensure an effective marketing channel effort. For instance, the best-designed channel would fail if the retailer does not stock the product adequately.
Consumers will not buy what they can not see in the store.
In the next chapter, we use the terminology introduced here to discuss framework for channel design and management.
This framework is the basis for the succeeding chapters and shapes later discussion of channel institutions such as wholesaling, retailing and logistics.

09.02.02 Analytical Framework for Channel Design and Implementation

09.02.02.01 Introduction

What is the best marketing channel for a particular product or service?
The marketing channel challenge involves two major tasks:

A) To design the right channel.
B) To implement that design.

The design step involves:

- ➢ Segmenting the market.
- ➢ Identification of optimal positioning responses to a segment's demands.

- ➢ Targeting the segments on which to focus the channel's efforts.
- ➢ Establishing new channels (OR) Refining the existing channels.

The implementation step involves:

- ➢ An understanding of each channel member's sources of power and independence.
- ➢ An understanding of potential for channel conflict.
- ➢ Formulation of a plan to create an environment where the optimal channel design can be effectively executed; this outcome is called channel-coordination.

This chapter presents a framework for analysis that defines and enumerates the elements of these two tasks viz. A) Channel design and B) Channel Implementation.
The following figure depicts the important elements in Channel Design & Implementation Process.

This framework is useful both for creating a new channel in a previously untapped market and for critically analyzing and refining a pre-existing channel.
Given the great expense of establishment or refining a marketing channel and high cost of poor decision making, it is important consider all the aspects enumerated in this framework carefully.

CHANNEL MANAGEMENT: SCHEMATIC DAGRAM

CHANEL DESIGN AN IMPLEENTATION PROCESS

CHANNEL DESIGN PRCESS				Implementation Process
SEGMENTATION	POSITIONING	TARGETING	ESTABLSH NEW CHANNELS / REFINE EXISTING CHANNELS	CHANNEL IMPLEMENTATION
Define service output demands by segment	Define optimal channel flow performance for each segment	Choose the segments to target, subject to: ➢Environmental bounds ➢Managerial bounds ➢Competitive benchmarks	ESTABLISH NEW HANNELS: ➢Channel flow performance ➢Channel structure	Identify: ➢Power Sources ➢Channel Conflicts & Manage the conflicts
Identify environmental characteristics & constraints	Define optimal channel structure for each segment		REFINE EXSTING CHANNELS: ➢Gap analysis ➢Channel flow performance ➢Channel Structure	GOAL ➔ CHANNEL COORDINATION

09.02.02.02 Channel Design

09.02.02.02.01 Channel Design- Segmentation

Segmentation means the splitting of a market into groups of end users who are:

- Maximally similar within each group.
- Maximally different between groups.

The segments are best defined on the basis of demands for the outputs of the marketing channels.

Channel has to add value to the product marketed through it.
The channel may be viewed as a production line, producing / adding ancillary service outputs to the product line.

The channel outputs include:

- Bulk breaking.
- Spatial convenience.
- Assortment and variety.
- Waiting and delivery time.
- Supply of spares.
- Field service assistance etc…

For instance, let us consider two segments, such as "Family-End users" vs. "Individual office employees".

Nature of Service output	**Family Requirement**	**Service output Demand level**	**Individual office employee Requirement**	**Service output demand level**
Bulk breaking i.e. Supply small lots	Require large quantity; e.g. big can of fruit juice	Low	Want small qty... E.g. a cool-drink.	High
Spatial Convenience i.e. Nearness	Can spend more time to reach a super-market	Low	Want the shop nearby. Want to buy stuff during lunch hour.	High
Waiting and delivery time	Have some stock at home. Family can wait.	Low	Want it quickly	High
Assortment / Variety	A family needs more variety; each member has different taste eg. Soft drinks	High	Any thing will do…	Low

Thus, we have two market segments viz. Family (Suburban) vs Office staff (Downtown)

Likewise, we can have the following segments:

Criteria	**Segment-1**	**Segment-2**	**Segment-3**

Income Level	High income group	Middle class	Low-income group
Organization Type	Government	Corporation	Small Business
Institutions Type	Profit oriented	Philanthropic	Co-operatives
Geographical Location	Hot weather	Cold weather	Moderate weather

09.02.02.02.02 Channel Design - Positioning

When the marketing has been segmented into groups of end-users, each of which can be described by a set of service output demands, the channel manager should next define the optimal channel to serve each segment.
We call this ***positioning*** or *configuring* the channel.

Positioning a product means:

- Setting the product attributes.
- Setting Price.
- Setting Promotional mix etc…

to suit the segment's demands.
Positioning also refers to the design of the distribution channel to meet the segment's demands.

The optimal channel is defined first and foremost by the necessary channel flows that must be performed in order to generate the specific segment's output demands.
Channel flows are all the activities of the channel that add value to the end-users.
Further, the channel analyst must identify the optimal ***channel structure*** to produce the necessary channel flows that are demanded by a particular segment of end-users in the market.

Design of channel structure involves two main elements.

A) Who are the members of the channel?

E.g. Groceries:

- Do we choose small retailers or supermarkets/chain stores?
- Do we use independent distributors / Agencies or export management companies?

Take another example: Watches…

- Do we sell watches through small retailers (OR)
- Upscale channels such as Tiffany's, Jewelers etc… (OR)
- Through company show rooms?

B) Decision of how many of each type of channel members will be part of the channel.

This is called the ***channel intensity*** **decision.**
Do we deploy several outlets in one area? (OR) only one? (OR) only a few?
The factors to be considered are:

- We need to minimize channel conflicts among the retailers.
- We need to optimize the costs.
- We need to consider the aspect of logistics.

This exercise results in one channel profile for each segment that has been identified earlier.

Each of these channels is called ***zero-based channel.*** i.e. as if there is no pre-existing channel in the market.

The concept of zero-based channel means that:
The channel segment's service output demands are met adequately i.e. making the services easily available to end-users. & they are met at minimal cost.

Channel flows are discussed later in the context of environmental and managerial bounds as well as competitive benchmarks.

09.02.02.02.03 Channel Design - Targeting

The channel manager, after segmentation / identification of target groups and positioning the product / services, has to decide what segment to target and also what segment not to target.

Factors to be considered are:

A) External environment factors such as:

- Availability of land / space.
- Legal restrictions in the area etc…

B) Internal managerial bounds such as:

- Capital investment capability to establish warehousing facilities/office network
- Ability to meet fluctuating demands.
- Managerial expertise etc…

C) Competitive bench marking:

- Pre-existing practices and standards established by the competitors.
- Level of technology applied etc…

Meeting previously unmet service output demands can be a powerful competitive strategy.

We have now identified a subset of market's segments, using the segmentation and positioning insights derived earlier.

09.02.02.02.04 Channel Design - Establish new Channels (or) Refine the existing Channels

If no channel exists currently in the market for the segment, the channel manger may now establish the channel design that comes closest to meeting the target market's demands for service outputs, subject to environmental/managerial bounds constraining the design.
If there is a pre-existing channel in place in market, the channel manager should now perform ***gap analysis.*** Gaps can arise on supply side as well on demand side.
The differences between the zero-based and actual channels on demand and supply side constitute gaps in the channel design.
The demand-side gap means that the demands are not appropriately met by the channel. There may be undersupply or oversupply. Oversupply may result in higher prices.
On the supply side gap means that at least one flow in the channel of distribution is carried out at higher cost. We need to close this gap by reducing costs without lowering service standards.

The gap analysis and mechanisms to close gaps are discussed in detail later.

09.02.02.03 Channel Implementation

09.02.02.03.01 Channel Implementation - Identifying Power Sources

By the very nature of channel design, specific channel members are likely to specialize in certain activities and flows in a channel. If all the members do not work cooperatively or efficiently, the whole channel suffers. For instance the retailers do not display the product attractively, the efforts of other members of the channels get undermined. Incompatible incentives for different members may adversely affect the overall performance of the channel, due to interdependence of the members.
How then do we implement the optimal channel design? The answer lies in identifying, possessing and using the ***channel power*** to optimize the channel performance**.**
A channel member's power is "its ability to control the decision variables in the marketing strategy of another member in the channel at a different level of distribution"
Therefore, the channel manager has to devise a system to use the channel power influence the other members to do their job.
The result would be that the channel delivers the product / services to end-users adequately and at a minimal cost.
Details the channel power are enumerated later in this chapter.

09.02.02.03.02 Channel Implementation – Identifying Channel Conflicts

A channel conflict is generated when one channel member's actions prevent the channels ability to perform.
This also can happen if all the members are not equitably rewarded.
Channel conflict can stem from the following situations:

- ***Goal Conflict***: Differences between the channel member's goals and objective.
- ***Domain Conflict:*** Disagreement on the domain of action and responsibility / territorial preferences.
- ***Perception Conflict*****:** Differences in the perceptions of the market place.

He channel manager's job is to identify the areas of conflict and minimize the possibilities of conflict situation. The conflict can arise in case of poor channel design as also from poor implementation.
Example of a goal conflict:

A distributor may sell your competitor's product offering higher margins, whose goal is to maximize his own company's profits without worrying about the manufacturer's goals.

The situation can be redeemed by one or more of the following actions.

- Change the distributor.
- Increase the number of distributors in a territory.
- Offer higher margins.
- Improve Brand Equity.

Domain conflict may be resolved by changing a channel specification
Perception conflict may be resolved by better coordination and conferences/seminars among the channel members.
The details of channel conflict are discussed separately in this chapter.

09.02.02.03.03 Channel Implementation - The Goal of Channel Coordination

When the disparate members are brought together to advance the channel's goals, rather than their own independent goals, the channel is said to be ***coordinated***. The term is used denote both the coordination of interests and actions among the channel members, and the coordination of performance of channel flows to produce the service outputs demanded by target end-users.
The objective is to ensure the supplies to end-users to their satisfaction.
This is ongoing process as the conditions in the market place are dynamic, as always.

Summary:
The goal is to optimize the performance of the channel to meet the demands of end-users adequately
Segmentation ➔ Positioning of the product ➔Targeting ➔ Establishing new channels / Refining the existing channels ➔ Channel implementation (Identifying and using the power sources) ➔ Identifying and resolving channel conflicts

09.02.03 Segmentation for Marketing Channel Design: Service outputs:

09.02.03.01 Introduction

Marketing channel system design and management requires starting with end-user.

The channel manager needs to understand the nature of end-user demands in order to design an effective channel.
It is not about what the end-user wants to consume; It is about how the end-user wants to buy and use the products or services being purchase.

Thus, we take as given, the product sell and concentrate how to sell it rather than what to sell!

This chapter focuses on demand side of marketing channel problem by:
Study the end-user behavior and purchase trends. End-users will have differential purchase preferences for service outputs that reduce search, waiting time, storage and other costs. Grouping end-users in the market by demands for service outputs helps us define potential target market segments for which to design specific market channel solutions.

09.02.03.02 End-User Channel Preferences

Basic end-user types are:

- Business-to-Business Buyers.
- Individual consumers.

A particular product can be bought in multiple ways such as:

- Home delivery (e.g. www.homegrocers.com).
- One stop shopping experience (e.g. Say five companies coming together at one mall or at one website).
- Comparison shopping (e.g. Airline tickets at www.yatra.com , www.makeyourtrip.com).

09.02.03.03 Service Outputs

Channel systems remain viable by performing duties that:

- Reduce end-users' search.
- Waiting time.

- Storage.
- Cost.

These benefits are called the service outputs of the channel.
The generic outputs are:

1. Bulk braking.
2. Spatial convenience.
3. Waiting or delivery time.
4. Product Variety.

Some other outputs are customer education and after-sales-service etc.

A. ***Bulk breaking*** refers to end-user's ability to buy its desired no of units of product or service although they are produced in large quantities.
Higher bulk breaking results in smaller batches and enables the end-users to move the material directly into consumption, instead of storage. This amounts to a higher service output levels in favor f the end-user.
Higher purchase quantity would burden the end-user in terms of storage, while lower package-quantity might increase unit-selling price.
A family-type end-user might want bulk quantity (such as toilet paper, detergent etc) office goers might want only a small package (Such a cool-drink)
B. ***Spatial convenience*** is provided by market decentralization involving distributors, retailers etc. This reduces the search time and transportation needs for the end-users.

Following are some examples of spatial convenience:

- Super markets.
- Petrol pumps.
- Vending machines etc…

C. ***Waiting time or delivery time*** is defined as te time period that the end-user must wait from ordering point to actual delivery. Longer the waiting time, the greater the inconvenience to the end-user.
However, in some cases such as the family-type of end user may not mind delay in procuring provisions, since there is always some stock at home.

D. ***A greater product variety or wider product assortment*** results in higher output of the marketing channel. This results in a higher inventory at sales point and consequently a

higher cost to the end-user. The retailer may not be able to procure all the items from the same source to satisfy the need of an end-user demanding a wide assortment of components.

A tool-kit comprising, say a crew driver, wire-cutter, pliers, hammer, electric tester, a set of spanners etc is an example of an assortment. The retailer might have to procure the items from different sources to satisfy the customer needs, besides keeping a higher inventory level. The less the end-users participate in the marketing channel flows (in terms of search, storage, financing etc); greater will be the cost to them.

End users have two choices:
Low service output and low price (Travel to small grocery shops)
High service output and higher price (Online grocery shopping)

09.02.03.04 Trends in end-user references

A) Trends in B2B buyer preference:

A-1) Outsourcing invoicing, shipping etc…
A-2) Downsizing of the organization; Reducing employee numbers.
A-3) Alphabet soup (Acronyms).
E.g. JIT (Just in time), MRP (Material requirement planning) ECR (Efficient customer response) etc

B) Trend in Consumer preferences:
B-1) Lack of Time:
People are prepared to pay more for time saving systems such as home delivery, online shopping etc…

B-2) Increased product knowledge:

Price has to be right.
There must be product differentiation and superior product features.

B-3) Increased polarity in income levels:

High-income group is prepared to pay for a higher level of service
A business can adopt multiple levels of service to serve the needs of the rich and the not so rich. E.g. Hotels/ restaurants, Fashion garments, Jewelry and the like

09.02.03.05 Segmenting the Market by Service Output Demands

Segmentation means the splitting up into groups of end-users who are:

- Maximally similar within a group.
- Maximally different between the groups.
- Differ on dimensions that matters for building a distribution system.

The segments are best defined on the basis of demands for the outputs of the marketing channels.

Market research would produce a list of full set of service outputs that might be demanded by some or all groups of end-users in the market.

Once the list of possible service out-puts is identified vs. end-user groups, segmentation of the market can be done.

09.02.03.06 Meeting Service Output Demands

The basic concept in marketing is to seek and identify the customers' needs in the market place.
In the marketing channel strategy context, this means creating and running a marketing channel system that produces the service outputs demanded by the end-user segments.
How do we respond to unmet service output demands?

The key factors with examples are as follows:

A) Cost reduction: Change shipping mode.
B) Competitiveness: Introduce FMS.
C) Ease of entry: Consider the existing market players as also likely new entrants with advanced technologies and take appropriate action.
D) Excellence: Some wealthy customers would be willing to spend a lot of time and money to get the right product, say a home décor item.

09.02.03.07 The Role of Service Output Demand Analysis in Marketing Channel Design

After segmenting the market and identifying each channel segment's distinctive service output demands, the channel manager can now integrate these insights into the overall marketing channel design and management.
In particular, this information should be used to assess:

- The segment's attractiveness: This step provides a profile of advantages and drawbacks of each group of the potential purchasers.
- Target a subset of segments identified: This means choosing to focus on this segment to maximize sales and profits from selling to that segment.
- Customize the marketing channel system solution used to sell to each targeted segment. The information on the target segments can then be used to customize the channels; either to design a new channel or modify the existing channels to better respond to customers' demand for the service outputs of the marketing channel.

Ideally, the service output demand analysis performed by the channel manager should be used for both positioning and targeting purpose.
It is prudent to perform demand-side analysis before proceeding to the supply-side analysis for a successful channel design.
With this understanding of demand side of the marketing channel problem, we can now to turn to supply-side analysis in the next chapter.

09.02.04 Supply-side channel analysis – Channel Flows and Efficiency Analysis:

09.02.04.01 Introduction

Manufacturers, distributors and retailers participate in marketing channels to for the purpose of creating service outputs (Bulk breaking, quick delivery and assortment) demanded by their target end-users. Just as production is involved in producing products, the members are involved in productive activities, even though what they produce are intangible. The productivity derives from the value end-users place on the service outputs produced by the channel. The activities or functions that produce the service outputs are discussed in this chapter. We call these activities ***Channel Flows.***

CHANEL DESIGN AN IMPLEENTATION PROCESS

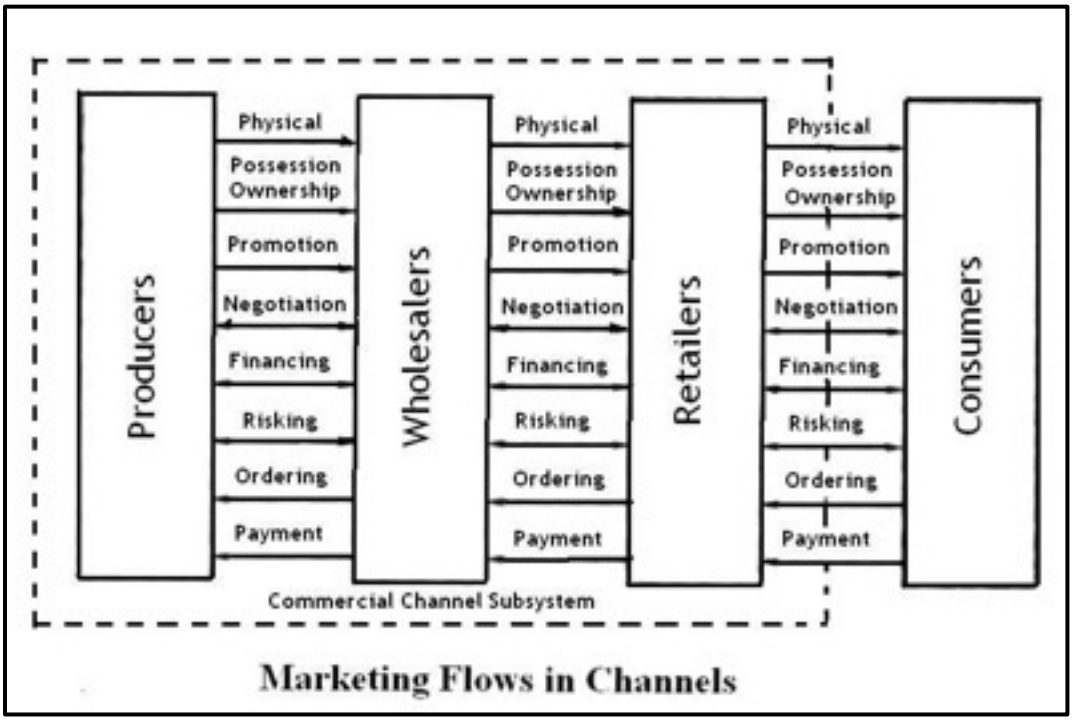
CHANNEL DESIGN PRCESS				Implementation Process
SEGMENTATION	POSITIONING	TARGETING	ESTABLSH NEW CHANNELS / REFINE EXISTING CHANNELS	CHANNEL IMPLEMENTATION
Define service output demands by segment	Define optimal channel flow performance for each segment	Choose the segments to target, subject to: ➢Environmental bounds ➢Managerial bounds ➢Competitive benchmarks	ESTABLISH NEW HANNELS: ➢Channel flow performance ➢Channel structure	Identify: ➢Power Sources ➢Channel Conflicts & Manage the conflicts
Identify environmental characteristics & constraints	Define optimal channel structure for each segment		REFINE EXSTING CHANNELS: ➢Gap analysis ➢Channel flow performance ➢Channel Structure	GOAL ➔ CHANNEL COORDINATION

Channel Management Schematic

Firstly, the detailed knowledge of the flow performance helps the channel manager to diagnose and remedy the short-comings in the provision of service outputs.
Secondly, the concepts of channel flows can be applied to designing a new channel or modification of an existing channel.
Thirdly, it gives the channel manager an idea of cost incurred by various channel members and enables him to- reward / allocate profits to - the channel members equitably.
An example: Peapod Electronic Grocery shopping (Home Delivery) and Fulfillment Process is demonstrated below. Peapod partners with Jewel-Osco Food store chain for physical supplies. Goods flow: Jewel-Osco ➔ Peapod ➔ Transporter ➔ Customer's Home

09.02.04.02 Channel Flows Defined
09.02.04.02.01 Eight Generic Channel Flows

Specific channel members may specialize in performing one or more flows. Every flow not only contributes to the production of valued service outputs but also is associated with cost. The channel flows are illustrated in the following figure.
Also, the following figure gives examples of the channel cost generating activities associated with each flow.



Marketing Flows in Channels

09.02.04.02.02 The Types of Channel Flows

1) Physical possession refers to all channel activities concerned with storage of goods and transportation between channel members.

2) Ownership: In consignment sales, the product is physically held by the distributor but the ownership remains with the producer/manufacturer.

3) Promotion flows in a marketing channel can take many forms such as:

- Personal selling by an employee.
- Selling by outside sales force (e.g. brokers).
- Media advertising.

Promotional activities are designed to:

- Increase the awareness of a product.
- Educating buyers on product features and performance.
- Persuading potential buyers to purchase.
- Improving brand equity etc…

4) The negotiation flow occurs when ever the terms of sale or of maintaining existing relationship are discussed and decided upon.

5) Finance costs are inherent in the terms of sale from one level to another level in a channel.

6) Risking

Factors are:

- Price lock-in.
- Damage in storage.
- Obsolescence.
- Inventory carrying cost.
- Warranty service responsibility etc…

7) Ordering and

8) Payment:

Automatic replenishment/reorder system reduces cost to some extent.
Total cost of maintaining the channel has to be controlled by the channel manager by proper performance of those flow levels that create valued service outputs.

09.02.04.02.03 Customizing the List of Flows for a Particular Channel

Some steps are:

- Combining two flows, such as possession and ownership to reduce cost and efficiency.
- Expand a flow into two elements such as deploying own sales force and advertisement.
- Combine storage and delivery functions.
- Have a long term contract to reduce negotiations.

09.02.04.03 Using Channel Flow Concepts to Design A ZERO-BASED CHNNEL

If we design a channel from scratch, without a pre-existing channel (Or even without considering the existing channel designs) is called **ZERO-BASED CHANNEL** and define it as follows.

A zero-based channel is on that meets the target market segment's demand for service outputs and at minimum cost of performing the necessary channel flows that produce the service outputs.

At the same time, cost reduction should not create holes in the channel, which can be exploited by the competitors to their advantage.
In short, the establishment of a zero-based channel involves recognition of what level of channel flows must be performed to generate the service outputs demanded – demands that are frequently unmet- in the market.

09.02.04.04 Profit Sharing Among the Channel Members – Equity Principle

Definition of equity principle:

Compensation in the channel system should be given on the basis of the degree of participation in the marketing flows and the value created by this participation. That is, compensation should mirror the contribution made by the channel member.

To live by the equity principle, the channel members must know what costs they have actually incurred and have an agreed-upon estimate of value created in the channel. Without this the channel members are open to dispute on the value created by different members and profit sharing norms.
In our example of Peapod electronic home delivery system, the value added lies in selecting from among a wide assortment from Jewel Osco (Physical Source for

groceries), smaller lots, act of home-delivery etc. The peapod expects to be rewarded suitably.

09.02.05 Supply-side Channel Analysis: Channel Structure and Membership Issues:

09.02.05.01 Introduction

The channel manager has the necessary information to answer questions abut overall channel structure once it is known what target segment's service output demands are, and what is the best channel flow performance pattern to generate those service outputs. The following figure (Replicated from earlier chapters for ready reference) focuses attention on the next issue of import of channel design- deciding the channel structure. This definition sets the scope of inquiry regarding channel structure decision making. ***A description of the channel structure comprises a summary of the types of channel members that are in the channel, the intensity or number of members of each type that coexist in the market, and the number of distinct channels that coexist in the market***

CHANEL DESIGN AN IMPLEENTATION PROCESS

CHANNEL DESIGN PRCESS				Implementation Process
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Identify environmental characteristics & constraints	Define optimal channel structure for each segment		REFINE EXSTING CHANNELS: ➢Gap analysis ➢Channel flow performance ➢Channel Structure	GOAL ➔ CHANNEL COORDINATION

09.02.05.02 What type of intermediaries should be used?

Once we decide to use intermediaries, we need to determine what kind of intermediaries are to be used.
We can use retail or non-retail intermediaries, who have the capacity to store (Physical possession) the goods. However, if customer education is more important than spatial convenience we might deploy independent sales representatives.
The following table lists other possibilities for types of intermediaries capable of performing particular flows.

Mapping from Flows to be performed to appropriate Intermediate Choices

Flows to be performed	Exampes of intermediaries that can perform flow
Physical Possession	Central warehouse Shipping Company (UPS, FEDEX etc) Distributor Retailer
Ownership	Central warehouse Distributor Retailer
promotion	Distributor Sales representative Broker Retailer Franchisee
Negotiation	Distributor Export marketing Company Sales representative
Financing	Distributor Broker Retailer Credit card company Banks Franchisee
Risking	Distributor Retailer Credit card company Franchisee
Ordering	Distributor Sales representative Retailer Franchisee
Payment	Distributor Shipping Company (UPS, FEDEX etc) Retailer Franchisee

Before we decide to choose particular type of intermediary, we must first know how the buyer wants to purchase the service product. We can sell popcorn at movies. We can sell beverages at a super market. We can sell an automobile through dealer. We can sell garments through a mall / company showrooms / Franchisees etc…
The key from end-user side is therefore to seek a retail intermediary that:

1) Matches consumer's desired shopping patters &

2) Connotes the overall quality and positioning level that the manufacturer seeks for the product.

09.02.05.03 Which specific intermediaries should be used?

The specific identity of the intermediary chosen should rest on a combination of efficiency and coordination factors.
Using another manufacturer's sales force and distribution network, to sell one's allied products is called ***"Piggy Backing"***
Some times, it can also be in the form of reciprocal ***"piggy backing"***
In piggybacking channel, the "***rider"*** is the firm making a product that needs distribution at minimal cost. The **"*carrier*"** is the other manufacturer who has excess capacity in its distribution system.
In sum, all the levels of decision making about membership in the channel revolve around three key factors:

- Demand-side issues.
- Supply-side or efficiency issues.
- Coordination issues.

09.02.05.04 How many channel members should there be at a given level of the channel?

Part of this channel structure decision is the choice of ***"distribution channel intensity"***
The "***channel intensity"*** is a decision about how many of certain type of channel partner to engage in one market.

Some examples:

Exclusive products, such as Lladro figurines, the intensity need not be high, as the art lovers are willing to spend more time on search. Likewise-- industrial products, hazardous chemicals, customized products fall under this category.

In contrast, breakfast cereals can be found for sale at a large number of outlets such as neighborhood grocery stores, supermarkets, food stores, hypermarkets. Such mass consumption items need a high intensity distribution. Likewise -- cool drinks, soaps, detergents etc fall under this category.

The continuum of possibilities for intensity of distribution is often described as ranging from:

Exclusive (Only one outlet per market: e.g. Exclusive art pieces such as Lladro)
Selective (A few outlets in a market: e.g. Watches, jewelry, furniture etc)
Intensive (Distributed as intensely as possible: e.g. soaps & detergents)

We need to consider the following aspects in determining the intensity:

- Too many outlets may increase the cost of distribution network.
- Too many outlets increase competition and the retailing is not profitable to the traders.
- Too many outlets may cause conflict situations among the channel members.
- Too few outlets cause loss of sales.
- Too few outlets would not create the visibility or brand equity.

Some trade-off decisions would become necessary.

09.02.05.05 Single Channel or Dual (Multiple) Channels?

In addition to choosing which type and how many intermediaries, the channel manager must also decide whether to operate one overall marketing channel or multiple channels. As discussed earlier, we need to consider demand-side factors, supply-side factors and coordination factors.
Example of selling PCs: Online selling over internet, Company outlets, Value added resellers (Adding accessories, software, service etc
On the demand side, dual distribution is a natural response to recognition of segments of end-users who demand different service outputs. Each such segment's ideal channel is unique, and the responsive channel manager creates a customized channel for each such segment.

Examples:

Coca-Cola is sold through multiple channels viz. supermarkets, food service outlets (restaurants & bars), vending machines, grocery stores etc…

09.02.05.06 Summary

Optimal channel structure has an element of the zero-based channel strategy.

The decision on channel structure has many levels, including whether or not to have intermediaries at all, what type of intermediaries to be used, and which specific intermediaries to be used. Beyond this, issues of channel intensity and dual distribution shape the overall structure decision.

A) Channel structure as a response to Demand-side factors:
The chosen structure must help to meet targeted segment's demands for service outputs. Certain channel structures / intermediaries are typically well suited for supplying particular service outputs.

We choose a channel structure depending on what is the main characteristic of service demands, such as:

- Bulk breaking.
- Spatial Convenience.
- Assortment.

B) Channel structure as a response to supply-side factors. Intermediaries are expected to perform the channel flows at optimal cost.
Clearly, the intermediaries expect suitable compensation for their performance.
The equity principle must be at play for effectiveness of a channel.

In sum, the right channel structure has to meet several important criteria such as:

- Does it meet segment's demands for service outputs?
- Does the channel minimize the total cost of performance, while sharing the profits equitably?
- Do the intermediaries perform their functions in a high quality?
- Are the members in a channel guided by equity principle and motivated?

Case study – Allwyn Watches Ltd:

Distribution of watches: Dual / Multiple distribution system in the company:

Company has own sales force in all major cities/Branches.
Company has own show rooms in all major cities.
Company has showroom at the entrance of the factory.

Watches are billed direct to retailers in town by the company's branch/warehouse. The Retailers receive the consignment of watches at their door-step. These retailers also sell other brand watches.
In addition, Franchisees are deployed to sell the brand exclusively in exclusive areas.
Layout of the Franchise showroom is standardized by the company.
Company has contracts with cooperatives for bulk supply of watches (e.g. Canteen stores - Armed Forces)
Company sells watches at a discount to employees, from the factory outlet.
Some specialty watch parts are exported (Automatic Movements).

09.02.06 GAP NALYSIS:

09.02.06.01 Introduction to Gap Analysis

The learning objectives in this chapter are:

- Be able to define a channel gap either as a shortfall or an over-supply of service outputs (A demand-side channel gap), or as an overly high total cost of running the channel (A supply-side gap).
- Understand the sources of channel gaps.
- Be familiar with the different types of channel gaps, on both demand and supply sides.
- Be able to identify strategies for closing various types of channel gaps.
- Be able to use the channel Gap Analysis Template to summarize knowledge about channel gaps in a given channel situation and suggest means of closing the gaps.

09.02.06.02 Sources and Types of Channel Gaps

09.02.06.02.01 Sources of Gaps

Channel managers must pay attention to both demand-side and supply-side factors to avoid gaps. Generally gaps occur because of bound placed on the channel manager. The manager seeking to design a zero-based channel may face certain constraints on his actions that prevent establishing the best possible design.
Before diagnosing the types of gaps, it is useful to discuss the bounds that create the gaps. We now concentrate on two such bounds viz. environmental and managerial bounds.
Environmental Bounds:

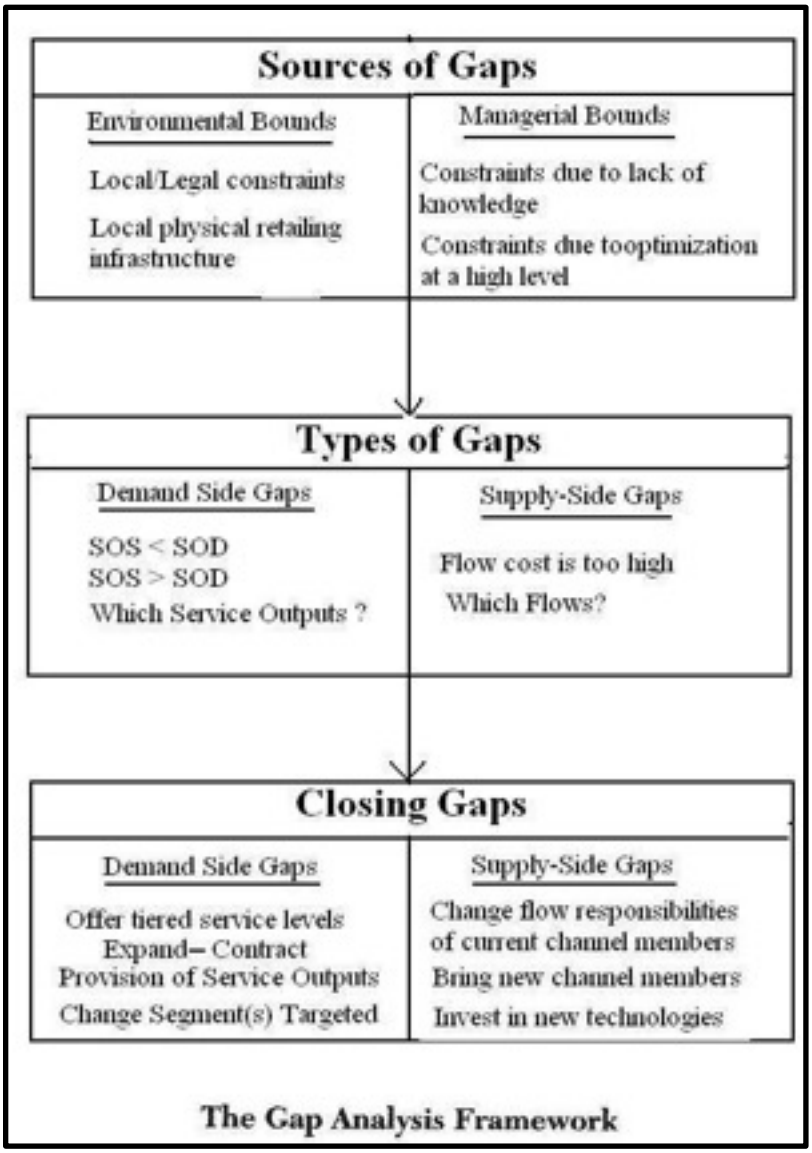
Local legal bounds such as:

- Legal Limits on share holding % by a foreign investors.
- Certain forbidden sectors for foreign companies e.g. Railways, airlines, press etc...
- Shortage of Land: Certain cities forbid large scale outlets e.g. Hypermarkets due to shortage of land.(e.g. San Francisco, US).
- Lifestyle restrictions peculiar to certain areas. E.g. Hongkong is a crowded city and people generally move in public transport. They cannot carry big lots form Sams' Club type outlets offering big batches at low prices. Moreover, their houses are small and consequently can not store bulk in their homes. They buy small lots in general.

Managerial bounds such as:

- Constraints due to *lack of expertise.*
- Inability to invest *funds.*

The following figure shows the Framework for gap analysis:



The Gap Analysis Framework

09.02.06.02.02 Types of gaps: Demand-side gaps

If gap exists on the demand-side, they create what we call **"a service-value gap".**
There can be two such situations where:
SOS = **S**ervice **O**utput **S**upplied
SOD = **S**ervice **O**utput **D**emanded

The gaps can arise in two ways where:

- SOS<SOD (Under-supply situation; Lower service-level at lower cost may not help, since the customers may feel that they are not realizing value for their money.
- SOS>SOD (Over-supply situation : e.g. Increase in product range and service-level may lead to higher cost and not acceptable to many customers).

09.02.06.02.03 Types of Gaps: Supply-Side Gaps

A supply-side gap exists when the total cost of performing all channel flows jointly is too high. This occurs when one or more flows – from physical possession to payment - are performed at high cost.
It is also possible to generate a supply-side gap by doing too little of one or more channel flows.
Supply-side gap may not exit when one or more channel flows are performed at a high cost so long as the total cost of the channel is optimal.
Example:
A company manufacturing bearings needs to stock entire range – even though some of the items are of high value - in all the warehouses to meet the market requirement.
One way is to have stock of all items all over.
Another way is to have a central warehouse for high value items and airfreight the components to the customers, as and when required.
On the face of it, air freighting may appear to be an expensive proposition; But on closer scrutiny, it may be cheaper than high inventory carrying cost involved in storage of high value items at all the warehouses.

09.02.06.03 Closing Channel Gaps

09.02.06.03.01 Closing Demand-Side Gaps

Three main methods of closing demand-side gaps exist:

1) Offering multiple, tiered service output to appeal to different segments. e.g, Sale of furniture; Have a contract system for supply of office furniture to large companies / Hotels. Another option is to sell through retailers.

2) Expanding or retracting the level of service outputs provided to the target groups. Service output provision can be changed in an upward or downward direction depending on whether the gap arises from lack or excess of service output provision. E.g. Low-cost airlines.

3) Altering the list of segmented targets e.g. In South America, when a grocery company faced competition from foreign hypermarkets under pricing their products found alternate segments where quality and high service level were desired by the customers. They offered home delivery, specialty items which hypermarkets can not offer.

09.02.06.03.02 Closing supply-Side Gaps

Channel gaps arising from high-cost channel flow performance on the supply side can also be managed through multiple means:

1) Changing the roles of current channel members to improve cost efficiency.
2) Investing in new technologies to reduce cost. (e.g. Computerized reservation system, Paper-less ticketing in airlines-E-tickets).
3) Bringing in new distribution function specialists to improve the functioning of the channel.

09.02.07 Vertical Integration: Owning the channel

09.02.07.01 Introduction

This chapter concerns the most fundamental question to ask when structuring a channel.

Should only one organization do all the work, thereby vertically integrating into the distribution stage?
Should it be a single organization: Manufacturer, agent, distributor, and retailer – all rolled into one company?
Should distribution be outsourced (upstream looking down) or production should be outsourced (down stream looking up), thereby keeping separate, the identity of manufacturers and down stream channel members?

Make or Buy: A critical determinant of company competences:
In marketing channels, make –or-buy decisions (Vertically integrate or outsource) are critical strategic choices.

The manufacturer becomes identified with its marketing channels, influencing its base of end-use customers and forming their image of the manufacturer. In addition, the manufacturer gains much of its marketing intelligence from its channels.

We need to consider what vertical integration entails, in terms of costs and benefits: long-term and shot-term.

09.02.07.02 Deciding when to vertically integrate forward: an economic framework:

09.02.07.02.01 Six Reasons to Outsource Distribution:

1) Motivation (Outside parties are better motivated as they are independent companies and profit orientation is high).
2) Specialization (Manufacturers may not have expertise in marketing/distribution).
3) Survival of the fittest (It is easy to enter or exit the distribution business unlike in manufacturing and the less efficient distributors are eliminated in a competitive market).
4) Economies of scale (Outside parties can pool the demands of multiple manufacturers and achieve economies of scale).
5) Heavier market coverage (Distributors can make more visits to customers as they can offer assortments that can not be offered by the manufacturers).
6) Independence of outside parties from any single manufacturer: (The customers can get impartial advice from independent outside parties rather than from the manufacturers. The distributors have more first hand feed back / information from the field/customers).

09.02.07.02.02 Vertical Integration Forward

1) Resorted to when competition is low.
2) Vertical integration may be desirable in case of specialized products and limited number of customers. In this case, the ***Hi-Tec*** info cannot be transferred to an outside party.
3) Vertical integration is often preferred to cope with ***environmental uncertainty***, where the market is dynamic. The manufacturer wishes to have control on business.
4) Vertical integration is preferred in case of ***performance ambiguity*** in the marketing channel. The Principal / Manufacturer is unable to establish performance indicators for distribution network. For instance when a new product is introduced, the sales may be low and it is not easy to asses the performance of sales agents.

The fundamental issue is that the outputs, or achievements, of a third party would not serve as good indicators of performance, either because there is no real baseline against which to compare results or because the data that are obtainable are of poor quality.

An important reason to undertake vertical integration is to gain market research or to create an option, to be evaluated in the future. Thus, in certain circumstances it is justified to integrate distribution not to do a better job of distributing but to do a better job of learning or hold open a door to future investment.

Owning it all is a solution of last resort to the problems of distributing effectively and efficiently.

09.02.08 Channel Power

09.02.08.01 Introduction - Nature of Power

09.02.08.01.01 Power Defined

Power is the ability of one channel member (A) to get another channel member (B) to do something which would no have been done in normal course.
Simply put, power is the potential for influence.
For example, let us take a situation where the price is reduced by a distributor.
The influencing power could have come from any of the following sources.

- ***Manufacturer***'s policy on transfer prices.
- ***Customers*** provoking a power cut.
- ***Environment***: Clearing up of Excess inventory. Competitor's action(s) etc…
- ***Within the distribution organization***: Policy to increase volume of business with lesser margins.

09.02.08.01.02 Is Power Good or Bad?

Power is an emotionally charged term. It has negative connotations: abuse, oppression, exploitation, inequity, and brutality. Used in this way power is condemned. But this can be a one sided view.
Power is the potential for influence and great benefits can be achieved by judicious use of power to drive the channel to operate in a coordinated way.

Like a hammer, power is a tool; neither god nor bad. It all depends on how you use the hammer to destroy an object or to mend it.

09.02.08.02 Why marketing channels require power?

Marketing channel members have to work together to serve the end-users. Each channel member is seeking its own profit.
Imagine what happens when a distributor jacks up the price to the retailers. The retailers, in order to maximize their profits also increase the price to customers. The net result is loss of sales to due to customer-resistance to price increase. So we need to have a member of the channel who could its power to influence the price to the end-user. If the channel is vertically integrated, the manufacturer could easily set right the situation by using its channel power.
Let us take a situation where the inventory is large at manufacturing center. The manufacturer tends to push the stocks into the distribution network. The distributor / retailers would order their requirement at short notice and do not keep adequate stock at the point of sales- thus the product display in terms of wider-range would be unsatisfactory from the customer point of view. This is a conflict situation. This is where power enters the scene, to balance the situation.

09.02.08.03 Power is the Mirror Image of Dependence

Let us take sociological vie of dependence. A's power over B is dependent upon B's dependence on A. A=Influencer & B=Target
03.01 Specifying dependence:

B depends heavily on A:

1. The greater the utility B gets from A and
2. The fewer the alternative sources for that utility, B can find.

09.02.08.03.01 Measuring Dependence Directly

A direct method is to assess both utility and scarcity and combine them.
To assess the utility we could estimate the profits generated by a member.
On scarcity side, we can assess how easily this member can be replaced in the channel.
We can combine these to get a sense of the dependence of one channel member upon the other.
Ask the following questions.

One quick method of approximating the other party's dependence is to estimate what h % you provide of its sales and profits.
In case of franchisees, this is not suitable because, they derive 100 % sales / profits from the franchiser.
Another way is to assess how well the member is performing relative to the competitor. Greater the relative performance of a member, higher the dependence of other member(s) on him.

09.02.08.04 FIVE Sources of Power

B is the target and A is the influencer

09.02.08.04.01 Reward Power
E.g. B is dependent upon A: The possibility of obtaining rewards by B from A can result in B falling in line according to the wishes of A.

09.02.08.04.02 Coercive Power
Coercive power stems from B's expectation of punishment by A if B fails to fall in line.

09.02.08.0 4.03 Exert Power
Expert Power is based on the target's (B's) perception that the influencer (A) has special knowledge/useful expertise that the target (B) does not possess.

09.02.08.04.04 Legitimate Power

To be ***legitimate*** is to be seen as right and proper, as being in accordance with what is seen as normal and as per established standards. (e.g. All members in a channel as per the wishes of manufacturers).

Legitimate power stems from Target Company's sense that it is in some way obliged to comply with the requests of the influencer.

09.02.08.04.05 Referent Power
Reference power exists when B views A as a standard of reference and allies with him.

09.02.08.05 Combining the Five Power Sources

In marketing channels, these powers are used in combination in a synergetic way.

Legitimacy can enhance expertise or vice-a-versa.
Coercion may be necessary to enforce legitimacy.
Legitimate power may be combined with reward power.
Example: A holding company has legitimate power over a group company, reward power by virtue of its ability to offer financial assistance, expertise power that can be exercised through another group company etc.

09.02.08.06 Balance of Power

Power is the property of relationship.
We can not say A is more powerful than B. Just as B depends on A for some utility, A also depends on B for a different kind of utility. A may be powerful in relation to B, but may be weak in relation to some other channel member. B has countervailing power and its own power base that can offset A's power sources.
Channel outcomes rest on the balance of power in a given relationship.

09.02.08.07 Dependence
09.02.08.07.01 Net dependence

Dependence is never one-way!

A and B are interdependent.
If A has some channel power over B, B also can also have some countervailing power to use against A. However, we have to view the countervailing power in a positive way, which can improve the channel performance in an overall way.

Example:

AGF, though a premier company in Europe is not well known in North America.
Fuji and Kodak were more popular there. Agfa, Canada crafted a strategy of supplying private label films to retailers such as supermarkets and drug stores. The retailers marketed the AGFA product in their own name as a premier-quality product under a private label. The big brother AGFA became dependent upon the retailers. The brand equity belonged to retailers and not to AGFA. However, AGFA has the countervailing influence by virtue of its expertise that retailers do not have. Thus it is a situation reflecting some balance of power.

09.02.08.07.02 Imbalanced Dependence / Exploitation

Imbalance power can lead to exploitation of more dependent party.
Of course, specter of exploitation is always present. A can, sometimes, appropriate the rewards due to B.

09.02.08.07.03 Imbalanced Dependence / Counter measures for the Weaker Party

B can cope with A's exploitation by some counter measures such as:

- Development of alternatives to A.
- Organizing a coalition against A.
- Simple Exit the channel and escape from A.

09.02.08.07.04 Tolerating Imbalanced Dependence / Common Scenario

The most common reaction to being a weaker party in an unbalanced relationship is no-reaction, especially in a global business environment. There is no easy answer.
We need to address the issue in two ways:

- Make the best out of the situation for the present
- Have a strategy to develop countervailing force / ability in due course

09.02.08.08 Exercising Power: Influence Strategies

The more the parties have power, the more they tend to use it. The following figure shows six influence strategies.

1. Promise strategy: promise of reward.
2. Threat Strategy: Do it; or else! Coercion.
3. Legalistic Strategy: Terms of agreement; Legitimacy.
4. Request Strategy: Please do so! Reward / Coercion implied.
5. Information Exchange Strategy: Expertise / Rewarding power.
6. Recommendation Strategy: Expertise / Stature.

The consequence of each strategy:

First three styles (Promise, threat, Legalistic) often provoke backlash as they are perceived to be high handed.
The last three styles (request, information exchange, recommendation) are more subtle and acceptable. Counterpart's autonomy is not threatened by such approaches.

09.02.09 Managing Conflicts to improve channel coordination

09.02.09.01 Introduction

Channel conflict is a state of opposition, or discord, among the members of a marketing channel. Conflict is a normal state in a channel; certain amount of conflict may also be desirable.

- Forms of conflict.
- Latent conflict.
- Perceived conflict.
- Functional conflict
- Overt conflict.

This chapter presents methods to discern the rue nature and level of conflict in a channel relationship.
This chapter also covers questions such as:

- ➢ What are the effects of conflict on the functioning of the channel, Coordination, and the ultimate performance?
- ➢ How does a conflict arise and can it be managed?
- ➢ What are the strategies for containing destructive and excessive conflict?

09.02.09.02 Assessing the degree and nature of channel conflict

09.02.09.02.01 What is a Channel Conflict?

Channel conflict arises when the behavior of a channel member is in opposition to his channel counterpart.
Channel conflict occurs when one member of a channel views its upstream or downstream partner is an adversary and opponent.
Competing parties struggle against obstacles in the environment.
Competing parties struggle against each other.

Self-interest is at the core of a conflict.
Latent conflict is due to conditions that set the interests of the parties at odds. This exists generally at such a lower level, that the channel member cannot see it.
In contrast, perceived conflict occurs when a channel member senses tat some sort of opposition exist; opposition to view points, of perceptions, of sentiments, of interests, or of intentions.

If not managed, conflict can escalate into ***manifest conflict.*** The opposition is visible in many forms usually blocking each others initiatives and withdrawing support.

One of the most serious sources of conflicts occur when, channel members are potentially competing with each other for same business. One solution to this problem would be to give some degree of exclusivity to a channel partner.

09.02.09.02.02 Measuring Conflict

How do we diagnose the level of conflict?

The best way is to gather four kinds of information.

- ➢ Counting the issues relating to the conflict.
- ➢ What is the importance of the issue to the dealer? Grade it, say, on 1 to 10 scales.
- ➢ Frequency of the disagreement.
- ➢ Intensity of the dispute.

09.02.09.03 Consequences of a Conflict

09.02.09.03.01 When Conflict is Desirable

Generally, conflicts destroy relationships. However, in certain cases conflicts improve relationships. This is functional conflict.

Functional conflict is common when channel members recognize each other's contribution and understand that each party's success depends on others.

The opposition leads them to:

- Communicate frequently and effectively.
- Establish outlets to express their grievances.

- Improve in systems and procedures.
- Develop of balance of power in their relationship.
- Develop a standard system of conflict resolution.

09.02.09.03.02 How intense conflict damages channel performance and coordination

High level of conflict erodes channel relationship. High level of manifest conflict affects an organization's satisfaction in a manner that damages the long-term ability to function as a close relationship and results in blocking behavior; blocking each other's initiatives is detrimental to overall performance.

As conflict level increases, the focal firm derives less from the channel; the profit indicators do decline. The members look for alternatives and the chain breaks up ultimately.

09.02.09.04 Major Sources of Conflict in Marketing Channels

Most conflict is rooted in differences in:

09.02.09.04.01 Channel Member's Goals

A producer may want higher growth, but the dealer may be interested only in profit margin/unit sale.

09.02.09.0 4.02 Their Perception of Reality

Perceptions differ markedly on basic topics such as:

- What the attributes of the product are!
- Which segments it serves!
- What the competition is!

09.02.09.04.03 What they consider as their domains

- Area jurisdiction of individual distributors competing for same business.
- Upstream members see its downstream members selling competitor's products—e.g. Allwyn Watches Ltd. did not like its dealers promoting sales Titan watches.
- Upstream members feel that their trade secrets are divulged to competitors.
- Multiple channels in same geographical area.

09.02.09.04.04 Autonomy Issues

End-user price decisions, Discounts etc…

09.02.09.04.05 Unwanted Channels: Gray Markets

Gray market is the sale of authorized, branded products through unauthorized distribution channels – usually bargain or discount outlets with lesser customer service.
E.g. Sale of wrist watches.

Who does it?

- ➢ Major distributors dump large quantity of material in other markets, unofficially.
- ➢ Import export agents.
- ➢ Suppliers themselves, in some cases, dump material in the market through unconventional channels.
- ➢ Existence of different prices in different markets causes migration of material to more lucrative markets.
- ➢ Differences in geographical locations where tax-structure I different
- ➢ Globalization: Foreign competition.
- ➢ Smugglers operating in the market.

09.02.09.05 Conflict Resolution Strategies

One way is to develop institutionalized mechanisms, such as arbitration boards or norms of behavior in a channel, so as to diffuse the disputes before they harden into hostile attitudes.
The other is to use patterns of behavior to try resolve conflict after it becomes manifest.

09.02.09.05.01 Institutionalized Mechanisms

a) Information-intensive mechanisms:
E.g. Joint membership in trade associations.
Drawback ➔ This may lead to leaks in trade secrets.

b) Exchange of persons between members as an institutional vehicle to turn channel members to devise solutions rather than engaging in conflict.

c) Co-Optation.

Cooptation is a mechanism to absorb new elements into leadership or policy-making structure of an organization.
E.g. Automobile manufacturers invite dealers into the company's marketing committee to review new-models and offers. Mercedes automobiles tried this out successfully.
Co-optation brings together representatives of channel members.

d) Third party mechanisms.

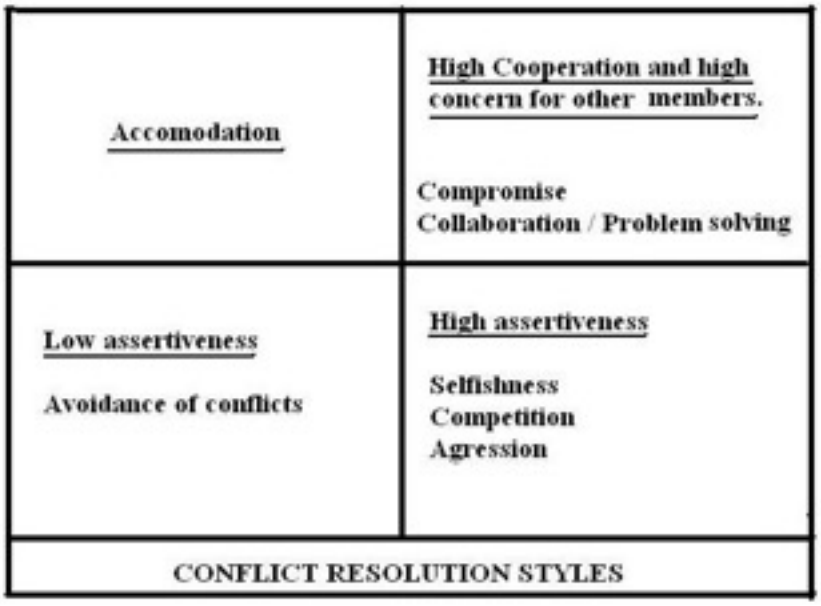
e.g. Mediations: Mediation is a process whereby a third party attempts to secure settlement of a dispute. The mediator typically takes afresh view of the situation. Mediators also assist the members to devise their own solution to the problem/dispute. An alternative to mediation is arbitration, wherein a third party actually makes a decision.

e) Building rational norms:

A channel's norms are its expectations about behavior of its members.
Some norms of a channel alliance are:

- Flexibility.
- Information exchange.
- Solidarity.

09.02.09.05.02 Styles of Conflict Resolution



Collaboration is a win-win approach. It is fashionable and contributes to favorable self-image, as well as favorable public presentation. A lot of information is needed to resolve the conflict, this way. This is an information intensive approach and trade secrets could leak out in this process.
Collaboration and problem solving approach is popular in franchising.
High assertiveness could lead to a zero-sum game and no one is benefited.
Low assertiveness approach may lead to status-quo situation and the conflict remains dormant.
Accommodation is a pro-active means of strengthening relationship by cultivating the other channel member.
Accommodation approach is good so long as there is no exploitation of ***"more-accommodating"*** member.

So far, we have focused on negotiation style of conflict resolution.

09.02.09.05.03 Resolving conflict and achieving coordination via incentives

What are the best arguments to use to persuade the channel member?
Considerable field evidence indicates that economic incentives work very well.
Good negotiators pursuing collaboration style, link the arguments to economics.
Economic arguments work extremely well when combined with a strong program of communications in good interpersonal working relationship.

Economic considerations are not merely a matter of offering a better price or higher allowance. These are highly visible and can be directly matched by competitors. Persuasive economic arguments are usually base on the ***package*** of factors that collectively create financial returns for a channel member.
Some ways are:

- ➢ Compensating for lower volumes by higher commission rate, and vice versa
- ➢ Compensate for lower commission by making it easy to sell, say by advertisement etc…
- ➢ Establishing the sales agent in a growing product category
- ➢ Increasing overall sales synergy, thereby spurring sales of other products in the agent's portfolio

09.02.10 Channel Implementation Issues; Distribution Intensity and Vertical Restraints

09.02.10.01 Introduction

Intensive distribution means that a brand can be purchased through many of the possible outlets in a trading area.
The opposite is exclusive distribution, whereby a brand can be purchased only one vendor in a trading area, so that a vendor has a local monopoly on the brand.
Typically, a brand is distributed with some degree of intensity, achieving partial coverage of possible outlets in the trading / marketing area.
Degree of channel intensity is a major factor driving the manufacturer's ability to implement its channel program.
The more intensity a manufacturer distributes its brand, the less the manufacturer can influence how channel members perform marketing channel flows.

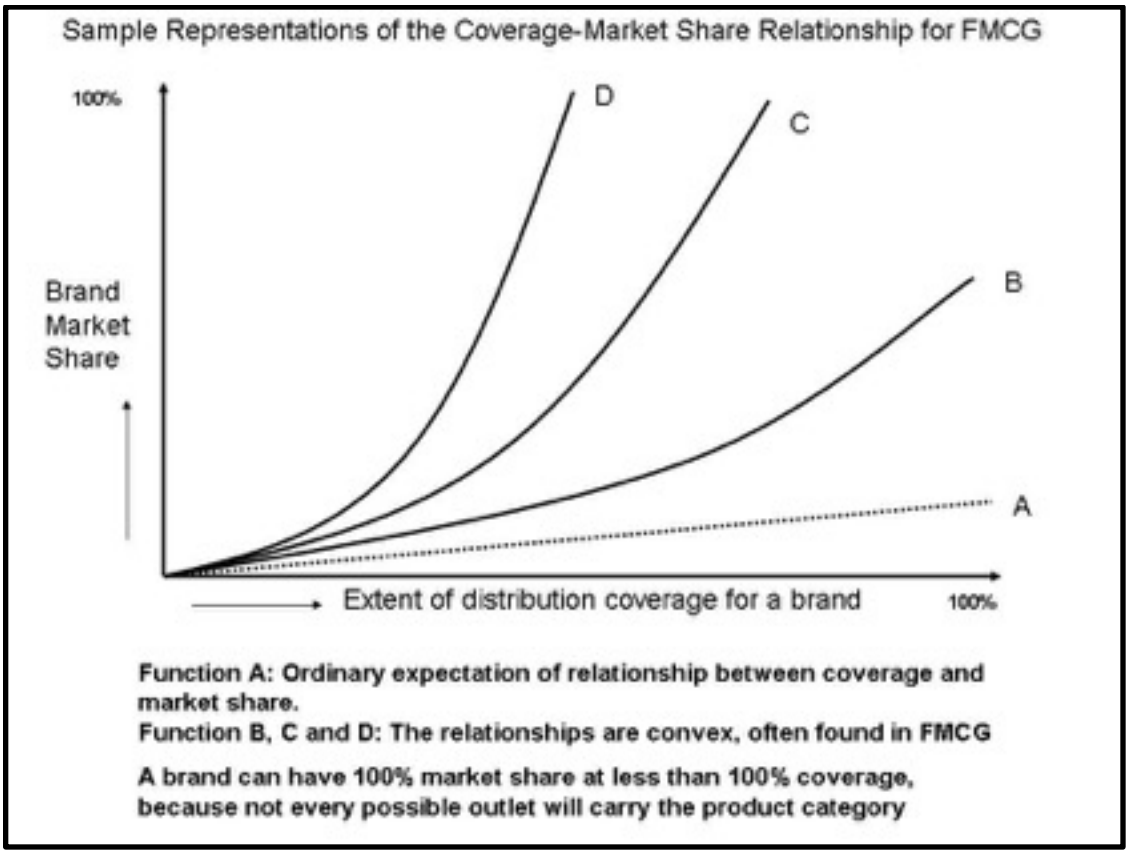
We need to arrive at a trade off between easy buyer access, which comes with high intensity, and influence over channel members, which comes with high degree of selectivity.

Vertical restraints are a contractual means of increasing manufacturer's power over the downstream members.
There is a great variety of mechanisms to restrain a channel member, including restricting a channel member's ability to seek whatever business it seeks, to resell its products, to set the price, and to carry competing brands.

09.02.10.02 Coverage versus assortment; Framing the decisions of upstream and downstream channel members

09.02.10.02.01 Is more coverage (intensity) better for manufacturers?

Most probably yes, for certain products such as FMCG (Tissue papers, coffee powder, stationery etc).
The risk in such purchases is low and the customers do not like to scout around for such convenience goods. Customers want easy access and the manufacturers can boost sales by simply increasing the number of outlets.
One indication of this phenomenon is that FMCG brand market share is disproportionately related to distribution coverage; as shown in the following figure.



09.02.10.02.02 Why downstream members dislike intensive distribution?

Channel members prefer exclusivity. Higher intensity is not in their interest.
Channel members prefer to differentiate theme selves by offering unique assortments.
When there are too many outlets in the trading area, a channel member may draw a customer interested in a famous brand and then steer the customer to buy a cheaper and unknown brand.
If they do not get the desired profit, they may just display the product, but sell other brands. They may altogether discontinue the product.

09.02.10.02.03 Can a manufacturer sustain intensive distribution?

Intensive distribution often creates a situation of lackluster sales support, defection of downstream channel members, and engaging in even switch tactics by the members.
How can the manufacturer remedy this situation?
One solution is contractual. The manufacturer can attempt to impose a contract on the channel member demanding certain standard conduct.
Another solution is to invest in a pull strategy to build brand equity. The retailers are forced to keep stocks and sell at lower prices due to customer preferences. This is often the case in case of FMCG products. A third solution is to limit the coverage and concentrate on desired / loyal channel members.

A fourth solution is to contractually impose RPM (Resale Price Maintenance). The seller is expected to maintain a floor price below which he cannot sell. This will help all the members/resellers to maintain certain minimum profit margins. RP is a vertical restraint. The competition is not based on price. However, the reseller cannot give discounts directly to the customers, in certain situations demanding disposal of stocks. The discounts may be camouflaged in some other form, such as free gifts etc on purchase of certain goods.

09.02.10.02.04 Degree of Category Exclusivity

One way out of the conflict(s) arising out of high intensity/market coverage is to permit the reseller to carry a limited number of competitor’s products to enable the channel member to carry out assortment supplies.

09.02.10.02.05 Degree of Selectivity

Too much selectivity may foster lackluster representation and lowers the product’s visibility.

One factor is the nature of the product.

- Convenience products such as milk, stationery etc requires a low degree of selectivity.
- Some goods such as shoes, electric iron etc needs intermediate degree of selectivity.
- Specialty and high value products such as machine tools require a high degree of selectivity; where customers are prepared invest time and money in search operation.

Another factor is brand strategy / Positioning and premium pricing.
Example: Mercedes-Benz automobiles are positioned as high-end products (High quality and premier price segment)

Brand strategy / Target market is another factor.

Some brands target a niche market.
The more restricted the market, the more selective the distribution.
Example: High-end maternity clothing for professional women.

09.02.10.03.00 Influence over the Channel Members

09.02.10.03.01 Selectivity / Intervention Approach

Generally, the manufacturers do not take hands off approach and allow the market forces to play. They adopt an intervention approach and do not allow the invisible competitors and their collaborators (read - some distributors) to influence the market.
Manufacturers can use ***selective distribution*** to exercise considerable influence over downstream members. Low coverage carries a considerable opportunity cost. This is worthwhile when the brand has a premium quality position.
In general, the resellers do not like excessive intervention by manufacturers - over decisions reg:

- Ultimate selling price.
- Promotional activities.
- Displays at point of purchase.
- POP material.
- Target customers.
- Stocking levels etc…

Selectivity creates reward power, which in turn creates influence.
Manufacturer's arguments:

- Exclusive market coverage means higher reseller's margins- a motivating factor.
- With a small-dedicated group of resellers, the manufacturer expects vigorous overall efforts to improve sales.
- Motivated and limited number of resellers take on, introduction of new products whole-heartedly.

Limited number of resellers- higher selectivity- can also influence the manufacturers to give the better term such as lower price, short delivery, better credit etc. This may happen since the manufacturers do not have too many alternative channel outlets.

09.02.10.03.02 Manufacturer-specific Investments by Downstream Members

There are certain specific investments made by distributors/retailers which may not be useful to promote alternate/competitor's brands.
Some investments pertain to:

- Technical training.
- Special storage arrangements.(e.g. Cold storage equipment).
- Customer training.
- Developing a loyal customer base.
- Service facilities e.g. Service of air conditioners.

An effective way to reassure the reseller is to limit the distribution..
Selective distribution is the currency that the manufacturer can use to induce the reseller to make brand-specific investments.

09.02.10.03.03 Dependence Balancing

Trading territory exclusivity for category exclusivity:
The principle is that no channel member wants to depend on another channel member.
The manufacturer has to balance the dependence level.
This calculated mutual dependence is akin to balance of terror in international politics, which minimizes exploitation of one group by the other.
In short, the more the manufacturer limits its coverage of a market area, the more the reseller limits its coverage of the associated product category.

At the extreme, each side trades exclusivity for exclusivity.
Resellers offer the manufacturer exclusivity in its product category.
In return, manufacturers offer resellers, exclusivity in the market area.

09.02.10.03.04 Reassurance: Using selectivity to stabilize fragile relationship

A weaker member may fear the consequence of a break-down of the contract / term. The stronger party – generally, the manufacturer- needs to reassure the weaker channel member in the channel.

09.02.10.04 Cutting Costs and Raising Sales

The main strategy of cost reduction is to limit the number of trading partners.
This is done by way of:

- Reduction in the number of sales personnel.
- Reduction in the number of transactions.
- Fewer, but larger orders and larger batches in manufacturing.
- Easier coordination and review effort.

09.02.10.05 Vertical Restraints

A vertical restraint is a contractual interdiction by the manufacturer of normal behavior for channel members. These restraints constitute interference in the running of the channel member's own business.

The most common restraints fall into the following 3 categories.

1) Customer coverage policies reg. Target segments, geographical jurisdiction etc.
2) Pricing Policies (Resale Price maintenance)
3) Product line policies (Oblige channel members to carry some products and not others)

Objectives of Vertical restraints / contractual obligation:

1) Vertical restraints are a way to induce each side to carry our commitments.
2) To dampen intra-brand competition and to promote inter-brand competition.
3) Exercise control by the manufacturers in terms of product performance / safety and economic manufacturing.

4) To provide product leadership.
5) To minimize legal disputes.

09.02.11 Strategic Alliances in Distribution

09.02.11.01 Introduction

Marketing channels typically are composed of multiple companies, each pursuing its own interests.
In a well-functioning alliance, two or more parties in a marketing channel function as if they were one.
They may make end-customers believe they are dealing with a single organization that is fully vertically integrated.

09.02.11.02 Strategic alliances: Their nature and motives

09.02.11.02.01 What is a strategic distribution alliance?

In a strategic alliance, two or more organizations have connections (Legal, economic or interpersonal) that cause them to function according to a perception of a single interest, shared by all the parties. An alliance is strategic when the connections that bind the organizations are enduring and substantial cutting across numerous aspects of each business.
Alliances go under many labels, including close relationships, partnerships, relational governance, hybrid governance, vertical quasi integration, and committed relationships.

09.02.11.02.02 Why forge a strategic distribution alliance? Upstream motives

Distribution alliances begin the producer's recognition that it can profit from the many advantages a downstream member can offer, at least in principle.

Purpose / Objectives:

- ➢ Building commitment and motivation of downstream members.
- ➢ Coordination of marketing activities more tightly.
- ➢ Transfer of marketing functions from many small players to a handful of giant players (Consolidation).
- ➢ Rebalance the power arrangement in the distribution setup.
- ➢ Erect barriers to entry of new manufacturers.

09.02.11.02.03 Why forge a strategic distribution alliance? Downstream motives

The motive of downstream channel members to build alliances revolves around having an assured and stable supply of desirable products. The motive is consolidation here.
Channel members try to cut costs by alliances, by way of better credit terms and sharing the cost of obsolescence, quicker deliveries etc.
Upstream and downstream members fundamentally pursue alliances for same reasons: enduring competitive advantage, leading to profit.

09.02.11.03 Building commitment by creating mutual vulnerability

09.02.11.03.01 Expectation of Continuity

Expectation of continuity is essential before any organization invests in building in future.
Their expectation of doing future business on behalf of principal strengthens for:

- Producers whom they trust.
- Producer with whom they can have two-way / transparent communication.
- Producers with reputation of fair dealings.
- Producers with whom they are already doing some business satisfactorily.

09.02.11.03.02 Commitment must be Mutual

Asymmetric commitment is rare, because the partners to an alliance do their calculations before agreements are made.
What is worrisome is the hidden agenda of a partner.
How do we measure the commitment of a partner?

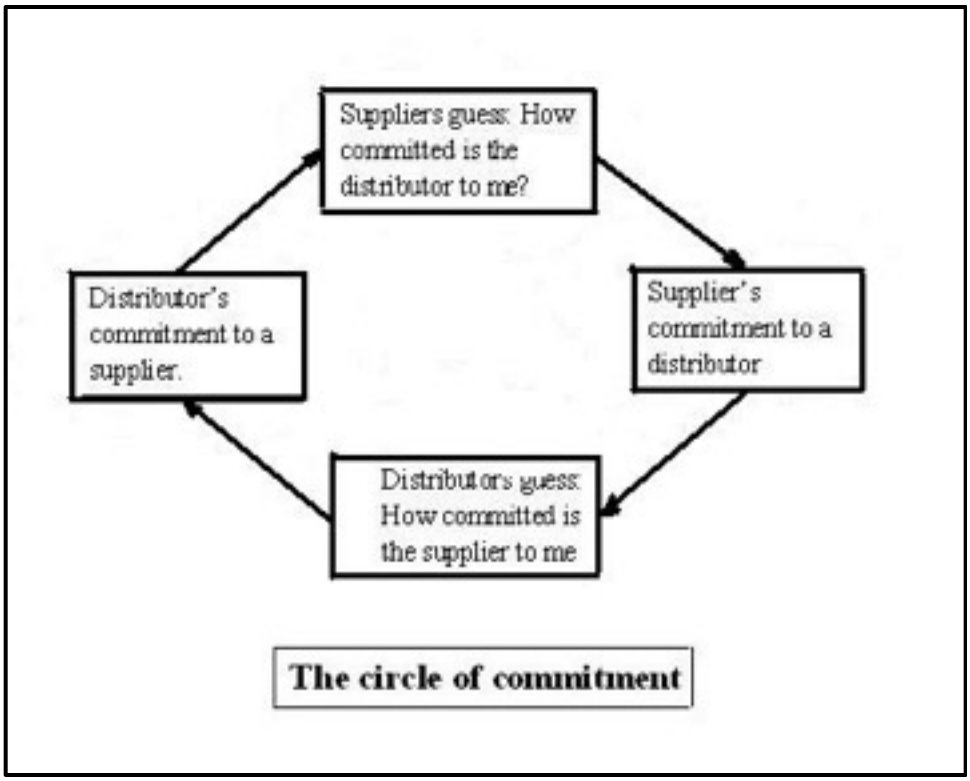
Ask the following questions.

- Did you have any acrimonious past with the supplier earlier?
- What action the supplier is taking to tie up business with you?
- Is the supplier going to do direct selling?
- What is the cost of breakdown in the relationship? Does it involve huge write-off(s)? Who will bear the cost?

09.02.11.03.03 Actions that bind the distributors to suppliers and vice versa

If the supplier and the distributor share the investments related to marketing operations, equitably, the relationship may survive over a long period. It is a convincing signal that both alliance partners are committed. The distributor should make product specific investments, which in turn, encourage the supplier to make big contributions in a joint effort. In a nutshell, to get commitment one has to give commitment.

The following figure shows the circle of commitment:



The circle of commitment

09.02.12 Legal Constraints on Marketing Channel Policies

09.02.12.01 Introduction

Channel managers can devise many policies to administer distribution system.
Some of these policies can restrain or direct the activities of various channel members, and may affect the competitiveness of the overall market.
As such, they can they can fall under legal antitrust scrutiny.
The policies addressed are as under.

- Market coverage policies (Restricting geographical jurisdiction of a distributor by producer).
- Consumer coverage policies (Restricting sales to a particular consumer by the distributor).
- Pricing policies (Specifying Resale Price Maintenance –RPM; Specifying a min floor price below which the product can not be sold by the distributor/retailers).
- Product line policies (Setting product-range- limits to what a distributor can sell or full-line forcing by the manufacturer).
- Termination of policies (When there is no legitimate reason to change channel members).

09.02.12.02 Legal Disputes

Some legal disputes can arise when:

- There is an unfair competition.
- Dumping by foreign suppliers.
- Restricted areas of investment e.g. National security.
- Motivated mergers and acquisitions.
- Disputes in implementation of contracts between channel members.
- Selling banned substances surreptitiously.
- Tax laws are broken.
- Conflicts occur on account of dual distribution systems.

09.02.13 Retailing

09.02.13.01 Introduction

Modern retailing is fiercely competitive and innovation oriented.
The purpose of this chapter is to describe how retailers position themselves in this environment.

Definition: Retailing consists of the activities involved in selling goods and services to ultimate users for personal consumption.

Thus, a retail sale is one in which the buyer is an ultimate customer, as opposed to a business or institutional purchaser. In contrast to wholesale sales – purchase for resale or for business, industrial, or institutional sales – the buying motive for retail sale is always

for personal or family satisfaction stemming from the final consumption of the item being purchased.
Types of retailers:

- Hypermarkets.
- Supermarkets.
- Departmental sales.
- Small Neighborhood store.
- Non-store sales (Mil-order sales, online sales) etc…

09.02.13.02 Retail Positioning Strategy

On cost side, they mainly focus on margins and inventory turnover goals.
On demand side, the retailers choose what service outputs to provide to their stoppers.

Cost side positioning:

Traditional retailing systems are categorized as high-margin-low-turnover operations. In contrast, modern retailing systems are characterized by low margins and high inventory turnover; and are oriented towards high efficiency lower selling prices to customers. Following are some examples of retail chains:

- Discount (e.g. Wal-Mart: High productivity, lower operating expenses, high sales, low cost).

- Category killer (e.g. Home Dept-- Construction material) Low operating costs, high productivity etc…

- Departmental stores (e.g, federated-- High gross margin, merchandise management.
- National chain (e.g. JCPenny--High gross margin, merchandise management).

- Apparel specialty (e.g. The Limited--High gross margin, merchandise management; mark-down control).

Some criteria for measuring performance:

- Sales per sq ft (Space productivity).
- Sales per employee (Labor productivity).

- Sales per invoice (Mechanizing program productivity).

SPM = Strategic Profit Model:

Retailers choose a path to suit their economic objectives.

Demand side positioning:

A) Bulk breaking:

Examples:

- Warehouse stores such as SAMS club supplies bigger bulk at lower price.
- High-service retailers buy large quantities and sell small lots at appropriate prices depending on segment / target group.

B) Spatial convenience:

Examples:

- Home delivery for working women- due to lack of time.
- Specialty stores need not be in suburbs / residential areas. Customers are willing to search.

- Convenience stores in family neighborhoods / residential areas.

C) Delivery Time:
Examples:

- A super market has to store all items and all the time: Hold high inventory.
- Vending machines: No waiting time.
- Specialty items and discounted bulk supplies can quote longer deliveries.

D) Product Variety vis-a-vis Assortment:

Variety means breadth of generically different items (e.g. Wal-Mart has high variety at low prices but limited assortment offer).
Assortment means supply of goods within a generic group (e.g. Computers, software and accessories).

09.02.14 Non-Store retailing and Electronic Channels

09.02.14.01 Introduction

Retailing does not have to take place through brick-and-mortar retail stores.
We discuss two major forms of non-store retailing.
1) Catalogue retailing.
2) Direct selling.

09.02.14.02 Catalogue Retailing

This system offers spatial convenience.
They are useful for shopping from home, albeit with some delay in delivery.
Retail catalogues offer a set of service outputs to their buyers.

Assortment and variety vary widely from catalogue to catalogue.
They are more focused on, specialty ones with an in-depth assortment in a narrow range of goods.

Smaller catalogues permit mailing to target groups at low cost.
Sometimes, discount-sales-items are catalogued by a supermarket to attract the customers with special offers.

When a new business is started in some areas, catalogues are posted to the residents in the area.

Some costs/risks/activities:

- Procurement of product from suppliers if it does not produce the item: Inventory problems.
- Creation of catalogue: Costs a lot of money.
- The mailing list: Difficult to produce.
- Shipments: Problem of logistics: Needs sophisticated warehousing technologies.
- Out-of-stock: Customers may be dissatisfied.

09.02.14.03 Direct Selling Organizations (DSOs)

Direct selling is defined as "the sale of a consumer product or service in a face to face manner away from fixed retail location.
DSOs are companies that use direct selling techniques to reach final customers. They are distinguished from catalogue sale operations by their reliance on personal selling, which is the key to both DS channel structure and its positioning as a retail option.

Some examples:

- Tupperware (Household storage items).
- Amway (Household cleaning products, appliances etc…)
- Mary Kay (Cosmetics).

They may all have on-line presences. Their distributors also may have on-line presence.

09.02.14.04 Electronic Channels

In this mode, we use internet as a means to reach end-users. The types are:

- B2C (S ales to consumers).
- B2B (Business to Business sales).

09.02.15 Wholesaling

09.02.15.01 Introduction to Wholesaling

Wholesaling refers to business establishments that do not sell products to any significant degree to ultimate household customers.

Instead, these businesses sell products to significant degree to other businesses such as:

- Retailers.
- Merchants.
- Contractors.
- Industrial users.
- Commercial users.

In a channel stretching from the manufacturer to the final user, wholesaling is an intermediate step.

09.02.15.02 Whole sale Distributors

They are independently owned and operated firms that buy and sell products to which they have taken ownership. Hey generally have their own warehouses for receiving, stocking, and shipping.

Some manufacturers have branches and warehouses to stock and sell physical goods. They perform wholesale distribution themselves as part of vertical integration. Agents, brokers and commission agents sell products for consumption but do not take ownership.

09.02.15.03 Essential Tasks of Wholesale Distributors (8 Generic channel flows)

1. Physical possession of goods.
2. Take title / ownership.
3. Promote the product.
4. Negotiations.
5. Financing (Providing working capital).
6. Risk taking (Credit terms to down stream members).
7. Processing orders.
8. Handling payments.

09.02.15.04 Agents, Brokers, and Commission-agents in Wholesaling

They focus on flows of promotions and negotiations.

They are generally specialists in product information.
They do not take ownership of goods.
Manufacturer handles stocking, financing etc and has great control over the agents, grocers, and commission agents. They are called Manufacturer's representatives (MRs)
A rep is a down stream channel member, functioning as equivalent of company sales force. Like the direct sales force, an MR sells to other channel members, such as wholesaler-distributors, OEMs , and retailers.
Conventions for MRs can vary widely. An MR can also provide professional services on an outsourced basis. It can work as law office, Ad agency, accounting firm etc.

09.02.16 Logistics and Supply Chain Management

09.02.16.01 Introduction

Logistics is the management of the flow of physical material.
Logistics involves the processing and tracking of factory goods during warehousing, inventory control, transport, documentation, and delivery to customers.

09.02.16.02 The Building Blocks of Logistics in Marketing Channels

09.02.16.02.01 Inventory Management

Working capital, Optimizing inventory carrying costs etc

09.02.16.02.02 Order Fulfillment (Obtaining the items and packing) and Transportation

By rail, sea, road, by air, or by a combination (e.g. Containers by road subsequently by rail or by ship).
Third party logistics providers are quite popular. E.g, FedEx. They can also form alliances with fright forwarders and air carriers.

09.02.16.02.03 Orders, Invoices and Payments:

A major facilitator of logistical change is the reduction in the exchange of documents and in the amount of human processing, they require. Document handling has been greatly reduced due to the growth of EDI (Electronic data interchange). This means direct company-to-company communication strictly via computer, with no human intervention.

The computer-to-computer communication can be:
Queries on inventory, orders, dispatches, receipts of goods, invoices and automatic money transfers etc.

09.02.16.03 Supply Chain Management

A supply chain is the set of entities that collectively manufactures a product and sells it to an end point (The ultimate customer).They include only players that add value in production and distribution. Customer satisfaction is the responsibility of the entire supply chain and not that of individual member of the chain.
Supply of components, raw material and services are essential to the running o operations in any business. Such chains of ***supplier to➔ factory to➔ customers of the factory*** had always existed. The traditional tasks will retain their importance as long as a factory has to cater to its customers. What is new is that, currently a huge emphasis is placed on the linkage or CHAIN aspect of the process and these chains have to strengthen for successful operations.

Supply Chain: **SUPPLIER'S SUPPLIER ➔ SUPPLIER ➔MANUCATURING COMPANY ➔ CUSTOMER ➔ CUSTOMER'S CUSTOMER**

We need to know minute details of all the players in this chain and their problems. It cannot be a solo performance. Every party in the chain has to perform and it should be a win-win situation for all.

Note: The competition is no more between two individual companies, but between different supply chains.

It ought to be emphasized that all traditional functions such as purchase, inventory control, material handling, warehousing, transportation etc will remain. What changes is the orientation- a new outlook of teamwork and the way managers would look at the participants in the supply chain. With this new outlook would emerge new systems and procedures that would support the new business logic. All the techniques of materials management would have to be applied with the "chain" in view.
According to **CSCMP (Council of Supply Chain Management Professionals)"**
"Supply Chain Management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, who can be suppliers, intermediaries, third party service providers, and

customers. In essence, Supply Chain Management integrates supply and demand management within and across companies."

The objectives of supply chain are:

a) Service orientation (i.e. service to the customer) and ensuring that the customer gets value.

b) System orientation i.e. looking at the supply chain as a whole and not in terms of is constituent partner companies.

c) Competitiveness and efficiency.

Binding factors for the Supply chain constituent members are:

a) Mindset:

- Alignment of strategies.
- A culture of trust and cooperation.

b) Coordination:

- Flow of information, finance and material.
- Improved process orientation.

c) Sharing information:.

- Short-term production schedules and material requirement.
- Long term production plans.
- Changes in design and product mix.

d) Sharing of risks and rewards:

- Each company should feel that it has got its appropriate share of financial profits or other gains.
- There should also be proportionate sharing of risks involved in business.

e) Joint problem solving:

- Supply chain is a family and all problems pertaining to product design, quality, logistics etc are solved by mutual cooperation.
- For instance, they could participate in TQM jointly.

09.02.17 Franchising

09.02.17.01 Introduction

Franchising is a marketing channel structure intended to convince the end users that they are buying from a vertically integrated manufacturer, when in fact they may be buying from a separately owned company. Franchisers are upstream manufacturers of a product or originators of a service. They write contracts with franchisees-separate companies that are downstream providers.

End-users (Customers of franchisees) should believe they are dealing with the franchiser's subsidiaries. Therefore, the franchisee assumes the identity of the franchisor, projecting itself as though it were the franchisor's operation.

This deliberate loss of a separate identity is the hallmark of franchising.
To do so, franchisee awards the franchisor category with exclusivity.
To further the projection of the franchisors identity, the franchisee purchases via contract and by the payment of fees, the right to market the franchisor's brand, using the methods, trademarks, names, products, know-how, production techniques, and marketing techniques developed by the franchisor**.** E.g. **McDonalds…**
And yet, the franchisee is a separate business, with its own balance sheet.

Franchising is an inherently contradictory marketing channel.

09.02.17.02 Franchising - The start-up package

When you buy a license for a business format ie ***Franchise,*** you acquire a brand name and know-how from the franchiser of all marketing decisions that have been made for the business.
Acquiring of brand name is the most critical factor in taking up a franchise-license, especially if you have the capital and no business ideas of your own.

09.02.17.02.01 The know-how Comprises

- Market survey and site selection.
- Facility design and layout.
- Lease negotiation advice.
- Financial advice.
- Operating manuals.
- Management training programs.
- Training of the franchisee's employee.

09.02.17.02.02 Ongoing Benefits

Once you have started a franchised fast-food restaurant, what services can you expect from the franchiser as an ongoing business?
These include:

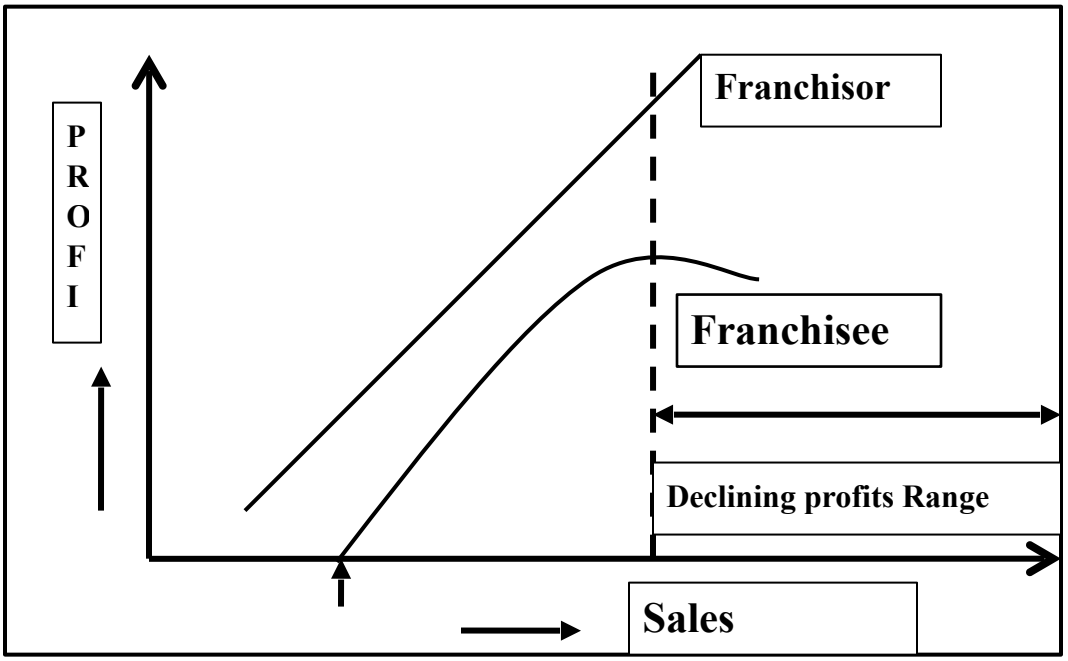
- Field supervision and inspection.
- Management reports.
- Merchandising and promotional material.
- Training.
- National advertisement.
- Centralized planning.
- Market data guidance.
- Auditing and record keeping.

09.02.17.02.03 Franchising Contract

The following three sections of a franchise contract determine who will enter the arrangement and how it will function.

1. Payment system: Lump sum fee, Royalty calculations and initial investment.
2. Real estate: Who holds the lease and how it may be transferred?
3. Terms of reference: Royalty is on sales and not on profit, since sales are easily verifiable. Termination: Arises when one of the parties do not honor the contractual terms.

09.02.17.02.04 Sales-Profit patterns for franchiser and franchisee



B = Breakeven Level

The profit starts declining after a certain volume of business.
After this level, there in incongruity of goals at this point.
Franchiser tries to maximize sales to get more royalty, where as the franchisee tries to maximize profits. This is a potentially a conflict situation.

09.02.18 Distribution Costs, Control and Customer Service

09.02.18.01 Introduction

Selling and distribution costs broadly represent marketing cost.
Selling costs seek to create, stimulate demand, secure orders and retain customers.
Distribution costs cover the sequence of operations starting with dispatch of a product from manufacturer to ending with delivery to the end-user.

These costs are sub-divided into:

1. Transportation: Freight (Railways, Roadways, Airways, Seaways), Insurance etc…

2. Warehousing: Land-Bldg cost / Rent Material Handling, insurance, documentation etc…
3. Inventory carrying cost: Interest on working capital, Ordering cost, Obsolescence cost etc…
4. Packaging Cost: Packing material, Labour etc…

09.02.18.02 Need for Distribution Cost Analysis

Reasons:

- ➢ To determine cost of sales for different jobs and products, and extent of profitability in each of them.
- ➢ To help fixation of optimum sales level.
- ➢ To control cost of efforts in different areas of distribution activities, to determine the profitability of various sales outlets under different conditions in different markets and by different methods.

09.02.18.03 Allocation of Distribution Costs

Distribution costs are usually common to several functions and can only be approximately allocated based on certain criteria. Distribution overheads are similar to manufacturing costs which could be identified with the product, division, unit etc.

09.02.18.04 Analysis of Distribution Cost

If profit is to be maximized, sales efforts should be directed towards most profitable of products and customers through the most economic channels of distribution.
The analysis of distribution costs can be discussed on the following lines.

- Product and Product lines.
- Individual customers or group of customers.
- Channels of distribution.
- Sales staff.
- Geographical area and territories.
- Order sizes.

09.02.18.05 Control Systems for Efficiency

- Operating Efficiency (e.g. Cost per Ton-Kilometer).
- Financial Efficiency (e.g. Ratio of operating profit to capital employed ratio).

- Service level Efficiency (e.g. Ratio of no. of door-to-door services to total no of services rendered).
- Marketing Efficiency (e.g. Market share, Growth rate etc).

09.02.18.06 Productivity Aspects and Logistics Management

Distribution Costs, Control and Customer Service

Productivity Aspects and logistics Management

The following ratios are suggested by the Asian Productivity Organisation (APO) for physical and financial productivity measures:

1. Right Delivery Ratio = $\frac{\text{No. of deliveries on time/year}}{\text{Total no. of deliveries/year}}$

2. Route Potential Ratio = $\frac{\text{Tonne kilometre run/route}}{\text{Tonne kilometre capacity/route}}$

3. Accidents Ratio = $\frac{\text{No. of accidents/year}}{\text{No. of trips operated/year}}$

4. Service Ratio = $\frac{\text{No. of consignments booked/year}}{\text{No. of consignments planned/year}}$

5. Vehicle Utilisation Ratio = $\frac{\text{Vehicle kilometre actually run/day}}{\text{Vehicle kilometre planned/day}}$

6. Breakages Ratio = $\frac{\text{No. of consignments damaged in transit}}{\text{Total no. of consignments}}$

7. Business Efficiency Ratio = $\frac{\text{Tonne kilometre achieved/year}}{\text{Tonne kilometre planned/day}}$

8. Operating Express Ratio = $\frac{\text{Total operating expenses}}{\text{Total earnings}}$

9. Net Profit Ratio = $\frac{\text{Net Profit}}{\text{Total earnings}}$

10. Promptness Ratio = $\frac{\text{No. of prompt deliveries/year}}{\text{Total no. of deliveries/year}}$

10.02.19 Customer Behavior and Satisfaction

10.02.19.01 Introduction; Customer/Consumer Behavior and Customer Satisfaction:

The study of consumer behavior is the understanding of how individuals or organizations behave in a purchase situation. Both physical and psychological factors are at play in a buying situation.
Marketing concept is a consumer oriented marketing philosophy.
Consumer wants and needs are to be satisfied.
Selling focuses on the needs of the seller.
Marketing focuses on the needs of the customers; creating a product, delivering and consuming.

Consumer behavior is the study of when, why, how, and where people do or do not buy products. It blends elements from psychology, sociology, social anthropology and economics. It attempts to understand the buyer decision-making process, both individually and in groups. It studies characteristics of individual consumers such as demographics and behavioral variables in an attempt to understand people's wants. It also tries to assess influences on the consumer from groups such as family, friends, reference groups, and society in general.

Customer behavior study is based on consumer buying behavior, with the customer playing the three distinct roles of user, payer and buyer. Relationship marketing is an influential asset for customer behavior analysis as it has a keen interest in the re-discovery of the true meaning of marketing through the re-affirmation of the importance of the customer or buyer. A greater importance is also placed on consumer retention, customer relationship management, personalization, customization and one-to-one marketing.

Customer satisfaction, a business term, is a measure of how products and services supplied by a company meet or surpass customer expectation. It is seen as a key performance indicator within business and is part of the four perspectives of a Balanced Scorecard. In a competitive marketplace where businesses compete for customers, customer satisfaction is seen as a key differentiator and increasingly has become a key element of business strategy.

Customer satisfaction is an ambiguous and abstract concept and the actual manifestation of the state of satisfaction will vary from person to person and product/service to product/service. The state of satisfaction depends on a number of both psychological and physical variables which correlate with satisfaction behaviors such as return and recommend rate. The level of satisfaction can also vary depending on other options the customer may have

and other products against which the customer can compare the organization's products and Reece Reid and Amber Knight is fit.

The ten domains of satisfaction include: Quality, Value, Timeliness, Efficiency, Ease of Access, Environment, Inter-departmental Teamwork, Front line Service Behaviors, Commitment to the Customer and Innovation.

10.02.19.02 Societal Perspective

Customers prefer differentiated products to match their own personal needs, personalities and life styles.
We need to realize the responsibility to protect consumer interest.
Environmental issues are assuming importance. E.g. Use of plastic bottles, aerosol sprays have negative impact/
Cross cultural consumer research-studies are used as a basis for product development and promotional strategies.
Psychographic segmentation or grouping people by the way they behave, are universal and are generally applicable to different geographical locations.

10.02.19.03 Lifestyle and Consumer Behavior

Psychographics may be viewed as a method of defining lifestyle in measurable terms.
Lifestyle segmentation research measures:
1. How people spend their time engaging in **activities.**
2. What is of **Interest** or importance to them?
3. Their **opinions** about themselves and the world around them.

Together, these three areas are referred to as ACTIVITIES, INTERESTS and OPINIONS, or simply AIOs.
The following table indicates the lifestyle dimensions that may be investigated among consumers.

LIFE STYLE DIMENSIONS			
Activitie	**Interests**	**Opinions**	**Demographics**
Work	Family	Themselves	Age
Hobbies	Home	Social issues	Education
Social events	Job	Politics	Income
Vocation	Community	Business	Occupation

Entertainment	Recreation	Economics	Family size
Club membership	Fashion	Education	Dwelling
Community	Food	Products	Geopgraphy
Shopping	Media	Future	Coty size
Sports	Achievements	Culture	Stage in life cycle

In a large-scale lifestyle research project, questionnaires are mailed to respondents seeking traditional demographic information, usage rates of different products, media habits and their AIOs (Activities, Interests and Opinions).
Using statistical data of AIOs, demographics and product usage, the marketer will construct user profiles by relating levels of agreement on all AIO items with the levels of usage of a product and with demographic characteristics. A pattern emerges from this, in which AIO statements cluster together, that is similar respondents are grouped together from a lifestyle perspective.

Lifestyle segmentation involves two steps.

1. Determination is made of which lifestyle segment will efficiently produce to greatest number of consumers.

2. Defining and describing the selected target customers in more depth to understand how they may be attracted and communicated with.
Lifestyle characteristics may be used a basis for segmentation.

10.02.19.04 Maintaining Customer Satisfaction

Continuous improvement is the key to maintaining customer satisfaction.
Customer satisfaction is a moving target.

Following are the steps necessary to implement an organized process for meeting / exceeding customer expectations.

- Define the critical performance attributes of the product that influence the customers positively.
- Define the performance standards, associated with these attributes.
- Quantify the performance of the company and the competitors in satisfying the customer expectations.

The following figure shows a model for ensuring customer satisfaction.

Model for Customer Satisfaction

Chapter 10
Marketing Management

10 Marketing Management

Marketing is a contest for drawing people's attention.

... Seth Godin

Marketing is too important to be left to marketing department.

... David Packard

Table of Contents

10.01.00 Overview

10.01.01 Definition

Marketing deals with identifying and meeting human and social needs profitably.
The American Marketing Association defines marketing as:
Marketing is an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stake holders. Marketing is the art and science of choosing markets and getting, keeping, and growing customers through creating, delivering, and communicating superior customer value.

10.01.02 Exchange – Core Concept

Exchange, the core concept in marketing, is the process of obtaining a required product from an agency by offering something of value.

Five conditions need to be satisfied for the process of exchange to succeed:

1. There are at least two parties.
2. Each party has something of value to the other party.
3. Each party must be capable of communicating and delivery of a product or service.
4. Each part is free to accept or reject the exchange offer.
5. Both parties trust each other.

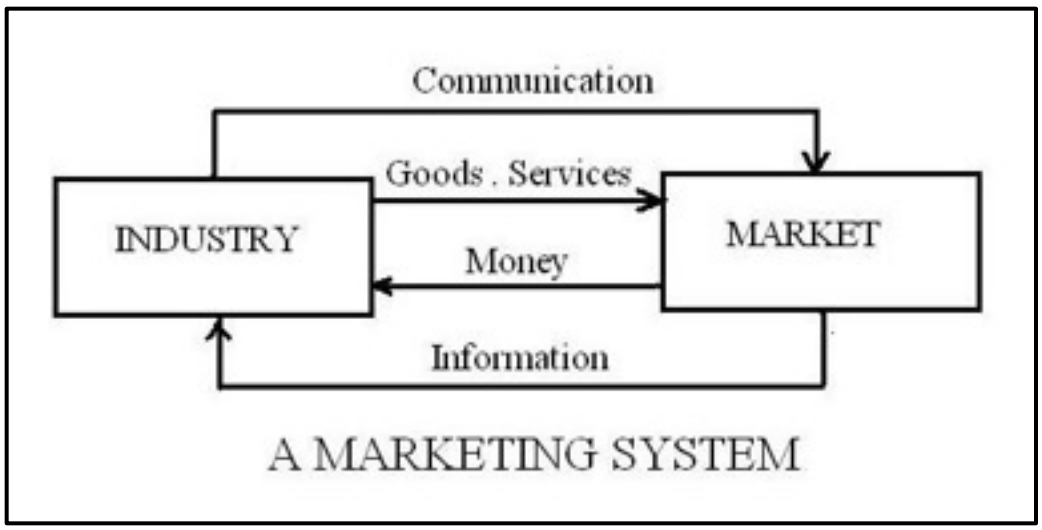
10.01.03 Entities Marketed

The following entities are marketed:

1. Physical Goods: e.g. Refrigerators, Furniture, Garments etc…
2. Services: e.g. Airlines, Hotels, Hospitals etc…
3. Events: e.g. Trade Shows, Sporting Events etc…
4. Experience: e.g. Water Parks, Haunted House etc…

5. Persons: Artists, Musicians, Chefs etc…
6. Places: Tourist Spots, Entertainment Centers such a Las Vegas etc…
7. Properties: Real Estate, Stocks and Bonds etc…
8. Organizations: Universities, Museums, Trusts etc…
9. Information: News Papers, Websites, encyclopedias etc…

10.01.04 Marketing System



10.01.05 Marketing Concepts

10.01.05.01 Production Concept

- High Efficiency.
- Low Cost.
- Mass Production.

10.01.05.02 Product Concept

- Performance.

- Innovation.
- Quality.
- Price.
- Availability.
- Service.

10.01.05.03 Selling Concept

- Aggressive Sales Promotion.
- Distribution Channels.

10.01.05.04 Marketing Concept

- Proactive orientation.
- Customer Satisfaction.

10.01.06 Tasks of Marketing Management

1. Develop marketing strategies and plans.
2. Capture market insights: Buyer needs and behavior.
3. Connect with Customers.
4. Build strong brands.
5. Product positioning.
6. Communicate value to customers.
7. Deliver value to customers.
8. Plan long-term growth.

10.02.00 Marketing Strategies and Plans

10.02.01 Customer Satisfaction:

Marketing involves satisfying customer needs and wants; the task of any business is to deliver customer value at a profit. The basic strategy is to be better than competition in one or more ways based on the core competence and abilities of the company. It could be leadership in quality, service, price, and / or uniqueness.

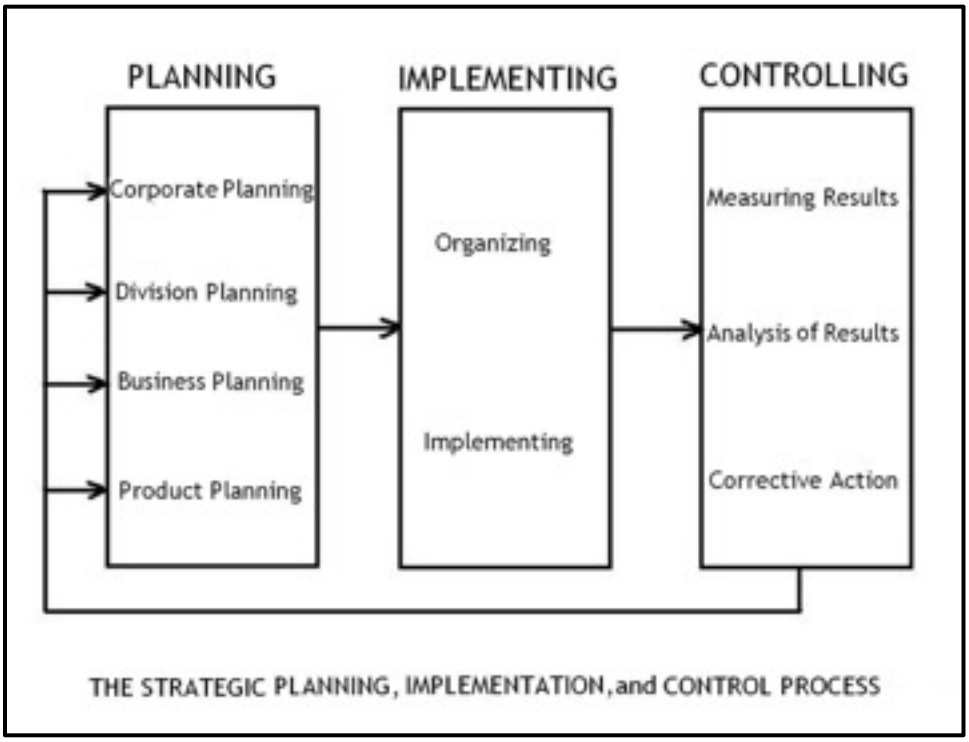
Core competence has the following characteristics:

1. It is a source of competitive advantage in that it makes significant contribution to perceived customer benefits.
2. It has application in a wide variety of markets.
3. It is difficult for competition to imitate.

10.02.02 Levels of Planning

Strategic planning is carried out at four levels:

Corporate Level is responsible for division wise resource allocation and planning for business growth including expansion of an existing business (or closing an existing business line) and introduction of a new business / product lines.
Each division within the corporation is responsible for resource allocation for each business unit / product line as also for planning for growth and profitability.
Each business unit within a division is responsible for resource allocation for each product line and developing a strategic plan to carry that business into a profitable future.
Each product line within a business unit is responsible for marketing plans and product design / development activities.
Of course, there would be an overlap of various functions at different levels. It is the responsibility of corporate management to monitor implementation of the strategic plans and take corrective action as and when necessary.
The complete strategic planning, implementation, and control cycle is illustrated in the following figure.



10.02.03 Steps in Strategic Planning

1. Statement of business mission.
2. SWOT analysis (Analysis of Strengths, Weaknesses, Opportunities, and Threats).
3. Goal formulation.
4. Strategy formulation.
5. Program formulation.
6. Implementation.
7. Feedback.
8. Control.

10.02.04 Profitability

We need to measure profitability of a business; product-wise, Region-wise, Customer-wise etc in order to make business decisions.

Some financial indicators are as follows:

1. Profit Margin: Net Profit / Net Sales.
2. Asset Turnover: Net Sales / Total Assets.
3. Return on Assets: Net Profit / Total Assts.
4. Financial Leverage: Total Assets / Net-worth.
5. Rate of Return on Net-worth: Net Profit / Net-worth.

10.03.00 Understanding the Market

10.03.01 Market Information

Marketing managers need a continuous flow of information in order to understand customer needs, wants, preferences, and consumption patterns. Marketing Information (MIS) consists of people, techniques, and procedures to gather, sort, analyze, evaluate, and communicate timely and accurate information to the decision makers. Such a system is developed from internal company records, market intelligence records, and market research.

10.03.01.01 Internal Records

Internal records supply statistics and past performance results.

10.03.01.02 Market Intelligence

A market intelligence system is a set of procedures and sources used by managers to obtain information about developments in the marketing environment. The sources of information are news papers, trade publications, internet, suppliers, customers, distributors, trade conferences, and the like. The information so gathered is discussed in the periodical review meetings to enable managers take appropriate business decisions.

10.03.01.03 Market Research

Market research is systematic design, collection, analysis, and reporting of data and findings relevant to specific marketing situation faced by the company.

Market research involves the following steps:

1. Define the problem and research objectives.
2. Develop a research plan for gathering information.
3. Collect information through qualitative observations in the market place and formal surveys using statistical sampling techniques.
4. Analyze the information by tabulating data, and develop frequency distributions. In addition we may compute various statistical parameters such as mean, median, standard deviation to understand the nature of the market. These techniques are enumerated in the chapter titled “Business Statistics”. The most common distribution pattern is a bell shaped curve termed “Normal distribution pattern”.
5. Present the findings to management and have a brain storming session among the managers involved.
6. Make the decision concerning product design, pricing, market reach, quality improvement, target customer groups etc…

10.03.02 Demand Forecast

Forecasting is the art of anticipating what buyers are likely to do under a given set of conditions.

Some techniques of forecast are:

- Time series analysis / Extrapolation from statistical data.
- Expert opinions / Delphi method of forecasting.
- Exponential smoothing.
- Operations Research / Simulation
- Market Survey.
- Linear Regression.

These techniques were enumerated earlier in the chapter titled “Production and Operations Management” under sub-head ‘Forecasting’.

10.03.03 Environmental Forces

Within the rapidly changing global picture, there are many environmental forces which are mostly uncontrollable that affect business. The company has to monitor these factors in order to adjust their business to be in sync with the environmental conditions.

Types of Environments:

10.03.03.01 Demographic Environment
Population growth, Population age-mix, Ethnic market, Household patterns etc

10.03.03.02 Economic Environment:
Income levels, Distribution of wealth, Savings habits, Credit facilities etc.

10.03.03.03 Social and Cultural Environment
Consumption habits, Ethnic diversity, Core Values of people (Attitude towards entertainment, Dressing habits, Affinity for education) etc.

10.03.03.04 Natural Environment
Availability of raw material, Energy costs, Climate etc.

10.03.03.05 Technical Environment
State-of-the-art technology, Government regulations on newer technologies, Opportunities for innovation etc.

10.03.03.06 Political – Legal Environment
Business regulation, Special interest groups (Senior citizens, Minorities, Environmentalists, etc.

10.04.00 Customer Satisfaction

Customers are well informed these days as they have tools to verify company’s claims. Customers tend to be value-maximizers. They estimate which offer will deliver the most

perceived value and act on it. Therefore, customer satisfaction is the key success factor in business.

10.04.01 Customer Perceived Value (CVP)

The customer perceived value is the difference between prospective customer's evaluation of all the benefits and costs of an offering and the perceived alternative. Total customer value is the perceived monetary value of the bundle of economic, functional, and psychological benefits customers expect from a given market offering.

10.04.02 Total Customer Satisfaction

Whether the buyer is satisfied after making purchase depends on the offer's performance in relation to the buyer's expectation. If the performance falls short of expectations, the customer is dissatisfied. If performance matches expectations, the customer is satisfied. If the performance exceeds expectations, the customer is highly satisfied.

10.04.03 Measuring Satisfaction

We may conduct surveys to assess the level of customer satisfaction. We can collect and organize data on various aspects – such as quality, price, delivery, performance, service etc – of customer satisfaction on a scale of 1 to 10. Analysis of such data can be helpful in assessing the level of customer satisfaction.

10.04.04 Product and Service Quality

Customer satisfaction largely depends on product quality and service assuming the price is OK. In quest to maximize customer satisfaction companies adopt TQM techniques (Total Quality Management Technique). This subject had been dealt with in an earlier chapter titled "Total Quality Management)

10.04.05 Maximizing Customer Lifetime Value (CLV)

CLV describes the net present value of the future profits expected over the customer's lifetime purchases. Usually top 20% of customers yield 80% of the profits. However, part of this profit is lost serving the bottom 20% of the customers. Therefore, it is essential to retain the top 20% of customers by serving them well and '*terminate'* the bottom 20% diplomatically.

10.04.06 Customer Relationships Management (CRM)

CRM is the process of managing detailed information about individual customers and take measures to retain their loyalty by meeting their expectations on critical factors.

Framework for CRM:

1. Identify the rich and profitable customers. Do not go after every customer.
2. Assess their CLV (Customer Lifetime Value).
3. Interact with such customers to gather information on their needs and to build strong relationship.
4. Customize products and services to such customers.

10.04.07 Customer Database

A customer database is an organized collection of comprehensive information about present individual customers and prospective customers. The data should be current, accessible, and actionable. The database is not a mere mailing list of customers. A business database should contain history of purchases by business customers comprising past volumes, prices, and profits made out of those transactions. The list may also contain information on their buying preferences, dates of birth, wedding anniversaries, hobbies, favorite foods, social standing, and economic status etc. This information is stored in a data warehouse. This will facilitate data mining process – knowing the unknown – and enable the company to develop and retain profitable customers.

10.05.00 Market Segments and Targets

10.05.01 Levels of Market Segmentation

Sellers that use mass marketing engage in mass production, distribution, and promotion of one product for all buyers. The argument for mass marketing is that it creates the largest potential market, which leads to lower costs and lower prices. This in turn leads to higher volumes and profit margins. Companies are turning to micromarketing at one of the four levels viz. segments, niches, local areas, and individuals.

10.05.01.01 Segment Marketing

A market segment consists of a group of customers who share similar set of wants. For instance we can segment car market into a) low cost transportation b) Luxury driving. “Young car buyers” is not a segment but can be termed as a sector.

10.05.01.02 Niche Marketing

A niche market is a customer group seeking a distinctive mix of benefits. We can identify niche markets by dividing a segment into sub-segments. The customers in a niche market are prepared to pay premium on the products that best satisfy their unique needs.

10.05.01.03 Local Marketing

Local marketing is tailored to the needs and wants of a local consumer group such as:

- Trading areas.
- Neighborhoods.
- Small towns.
- Villages etc…

Local marketing may dilute the brand image, if interpreted differently in different localities. Economy of scale can not be achieved in this process.

10.05.01.04 Individuals / Customization

The ultimate level of segmentation leads to “customized marketing” or “one-to-one marketing”.

This process is facilitated by internet. Many online companies are offering a choice-board, an interactive online system that allows individual customers to choose a specific product by choosing from menu of attributes, prices, and delivery options.

10.05.02 Segmenting Consumer and Business markets

Because of the inherent differences between consumer and business markets, we can not use exactly the same basis for segmentation.

10.05.02.01 Bases for segmenting Consumer market

10.05.02.01.01 Geographic Segmentation by:

1. Region.
2. City
3. Climatic conditions.
4. Population density etc…

10.05.02.01.02 Demographic Segmentation by:

1. Age group.
2. Life stage.
3. Gender.
4. Income levels.
5. Social class.
6. Generation.

10.05.02.01.03 Psychographic Segmentation by:

1. Psychological / Personality traits.
2. Lifestyles.
3. Core values.

People in the same demographic group can display different psychographic profiles.

10.05.02.01.04 Behavioral Segmentation by:

1. Occasions: e.g. Christmas, Valentines Day, Mothers' day etc…
2. Benefits: e.g. Friendly service, Convenience of shopping etc…
3. User Status: e.g. Potential users, First-time users, regular users, ex-users.
4. Usage Rate: e.g. Light, medium, or heavy product users.
5. Loyalty Status: e.g. hard-core Loyals, Shifting Loyals, Switchers with no loyalty towards any brand.
6. Attitudes: e.g. Enthusiastic, positive, indifferent, negative, hostile etc…

10.05.02.02 Bases for Segmenting Business markets

10.05.02.02.01 Demographic Segmentation by:

1. Type of industry.
2. Size of the company.
3. Location of the company.

10.05.02.02.02 Segmentation based on Operating Variables by:

1. Technology level.
2. Usage (Light, medium, or heavy).

10.05.02.02.03 Segmentation by Purchasing Approaches:

1. Purchase volumes.
2. Purchase policies.
3. Payment terms.
4. Quality standards.

10.05.02.02.04 Segmentation by Business Characteristics:

1. Buyer-Seller similarity.
2. Attitude toward risk.
3. Loyalty.

10.05.02.02.05 Segmentation by Situational Factors:

1. Urgency of customer requirement.
2. Special / Non-Standard products.
3. Volume of business.

10.05.03.00 Market Targeting

Once the company has identified its market-segment opportunities, it has to decide how many and which ones to target.

Criteria for targeting:

- Measurability: The size of the segment, Purchasing power of the segment etc…
- Profitability: Substantial volumes, Good prices etc…
- Accessibility: Ease of reach of the customers, Facilitation of service.
- Longevity: Long term prospects of the segment.
- Technology: Possibility of the segment contributing to product improvement / development.

10.06.00 Brand Equity

The American Marketing Association defines a brand as “a name, term, sign, symbol, or design, or a combination of them, intended to identify the goods and services of one seller or a group of sellers and to differentiate them from those of competitors.”
Brand equity is the added value endowed to products or services, reflected in how consumers think, feel, and act with respect to a brand, as well as the prices, market share, and the profitability the brand commands for the company. Brand equity is an important intangible asset that has psychological and financial value to the company.

10.06.01 The Role and Scope of Brands

Brands identify the source of a product and enable customers to assign responsibility to a particular manufacturer or distributor. Customers find out which brand would satisfy their needs in general. Customers who are starved of time make decisions based on the strength of brand equity.
Branding is all about creating differences. The principle of product differentiation – creating a product or service better than competition in more than one way – practiced by a company has a significant impact on purchase decisions by a customer. A brand is a signal to the customers to assess the relative merits of various market offers. For a branding strategy to be successful and brand value to be created, the consumers must be convinced that there are meaningful differences among brands in the product or service category.

10.06.02 Building Brand Equity

Marketers build brand equity by creating the right brand knowledge structures with the right customers. The following are the main brand equity drivers:

1. Choice of brand elements or identities making up the brand image e.g. brand name, logos, symbols, slogans, packages, brand ambassadors, jingles etc. The elements must be memorable, meaningful, and likable. They also need to be protectable (legally), and transferable.

   e.g. Nike 

   .

2. Marketing activities and supporting marketing programs. e.g. Interesting and memorable merchandise. e.g. T-shirts with a logo.

3. Associations indirectly transferred to the brand by linking it to some other popular entity (person, place, or thing).

An indirect way to measure brand equity is to track consumers' brand knowledge structure.
A direct approach assesses the actual impact of brand knowledge on consumer response to different aspects of the marketing.

10.06.03 Developing Brand Strategy

The brand strategy reflects the number and nature of common and distinctive brand elements applied to different products sold by a company. Devising a branding strategy involves deciding on the applicability of existing brand elements to a new product.

Options for deciding a new brand name:

1. Develop new brand elements.
2. Apply some of the existing brand elements.
3. Use a combination of new and existing brand elements.

General Brand Strategies:

1. *Individual brand names:* This system does not affect the image of a company, if a particular brand fails in the market.
2. *Blanket Family brand names:* (One brand name for all products): This involves instant recognition of the product and less cost of brand promotion.
3. *Separate family names for all product groups:* This is not advisable if the company is involved in manufacturing / selling too many and diverse products.
4. *Corporate name combined with individual product name:* In this case the company name legitimizes the product, and the name individualizes the product. E.g. Tata Salt. Tata Tea, Tata Steel, Tata Sky etc. This is good strategy if the company is consistently marketing successful products.

10.07.00 Dealing with Competition

10.07.01.00 Market Positioning

Positioning is the act of designing the company's offering and image a distinctive place in the mind of target market. The goal is to locate the brand in the minds of consumers to maximize the potential benefit to the company.
Examples: Tata Company for ethical business practices; Maruthi-Suzuki Automobiles for widespread service network; Apple Computers for Hi-Tech and innovative products etc.

10.07.02 Differentiation Strategies

Products must be differentiated and must be superior to competitive products in more than one way.

Here are some aspects of meaningful differentiation concerning physical products:

1. Product performance.
2. Product features
3. Service level.
4. Repairability.
5. Pricing.
6. Reliability.
7. Durability.
8. Conformance to quality standards.
9. Style.

When the physical product can not be differentiated easily, the key to competitive success lies in adding value services and improve their quality.

The main service differentiators are:

1. Ease of ordering.
2. Delivery.
3. Installation.
4. Customer training.
5. Maintenance contracts.

10.07.03 Competitive Forces

1. Threat of intense rivalry in a segment; i.e. too many competitors in a segment.
2. Threat of new entrants.
3. Threat of substitute products.
4. Threat of growing bargaining power of consumers.
5. Threat of newer technologies.
6. Threat of price war.

10.07.04 Competitive Strategies

A company can gain insight into its competitive position by identifying and classifying its competitors and itself according to the role each plays as a market leader, market challenger, market follower, or market nicher. On the basis of this classification, the company can take specific actions in line with its current and desired roles.

1. Market-Leader Strategy: e.g. Leadership in the areas of quality, price, volume, service etc….
2. Strategy of defending market share: e.g. strengthening brand image, preemptive defense by attacking rivals in some way or another, adding new territories etc…
3. Innovation Strategy: e.g. introducing new products, introducing newer technologies etc…
4. Strategy of sales promotion: e.g. intense advertizing, Introducing special schemes etc…
5. Market Challenger strategy: e.g. matching the standards of competition at lower prices, technological leapfrogging, aggressive entry into vacant market slots etc…

6. Market-Follower Strategy: e.g. imitation of apple's smart phones by several other companies. Often, it is more profitable to imitate the market leader, who bares all the cost of development. Many companies follow the leader rather than confront the leader.

10.08.00 Pricing Strategy

Purchase decisions are based on how consumers perceive prices and what they consider to be the current actual price and not the market stated price. Consumers often make purchase based on prices. Consumers may have a lower price threshold, below which prices signal inferior quality. Likewise, a price above higher threshold level may be seen as not worth the money by the consumer.

10.08.01 Procedure for Price Setting

A six step procedure ➔

1. Select the pricing objective: (e.g. skimming the market, sustainable pricing, Lower price to beat competition etc…)
2. Determine the demand: (Study price vs. demand relationship, price sensitivity of the market, Economy of volumes, Forecast for a distant future etc…)
3. Estimate costs at different levels of volume.
4. Analyze competitors' costs and prices vs. quality.
5. Select a pricing method:
   Options ➔
   a) Mark-up pricing i.e. cost + margin basis.
   b) Target-Return pricing on the basis of planned return on investment.
   c) Perceived value pricing based on customer's perception of the value.
   d) Value pricing i.e. low prices for a high quality.
   e) Going rate pricing based on competitors' product prices in the current market.

6. Select the final price: considering brand's quality, company's policies, Impact on other products of the company, reaction from distributors, dealers, retailers, sales force etc…

10.08.02 Response to Competitors' Price Changes

Market leaders often face aggressive price cuts by smaller companies trying to improve their market share.

The brand leader can respond in different ways:

1. Maintain prices and profit margins and hope to regain market.
2. Maintain price and add value to retain customers.
3. Reduce price by cutting costs.
4. Maintain prices and improve quality.
5. Increase prices, add value, and improve quality.
6. Launch a low-price fighter line i.e. create a separate low-price brand.

At times, companies may have to cut prices to increase volumes at the risk of a price war in the market; or increase prices to improve profit margins or cut losses, at the risk of loosing market share. Continuous monitoring of prices is essential.

10.09.00 Marketing Communications

Although advertizing is often a central element of a marketing communications program, it may not be a decisive factor in building a brand quality.

10.09.01 Modes of Communications

The marketing communications mix consists of six major modes of communications.

1. Advertising.
2. Sales Promotion.
3. Events.
4. Public Relations.
5. Direct Marketing.
6. Personal Selling: Face-to-face interaction with prospective customers.

Other forms of communications:

1. Product styling.
2. Price.
3. Shape and color of packaging.
4. Stores décor.
5. Salesmen personality.
6. Company’s stationary.

Each of the above factors communicates something to the customer. Every brand contact delivers an impression that can strengthen or weaken a company’s image.

10.09.02 Profiles of Major Media Types

Medium	Advantages	Disadvantages
Newspapers	Flexibility, Timeliness	Short life, Poor Reproduction
Television	Audio-Visual, High reach	High cost, Fleeting exposure
Direct mail	Low cost, Focused	Junk-mail image
Radio	High reach, Low cost	Only audio, Low attention
Magazines	High credibility, High quality reproduction	Some waste circulation, Less coverage
Yellow pages	Wide reach, Low cost	High competition, Creative limitations
Brochures	Impressive, Flexibility	High costs, wastage
Internet	Interactive, Unlimited coverage, Low cost	Only for well educated, Cluttered

10.09.03 Common Communication Platforms

Advertising	Sales Promotion	Events / Experiences	Public Relations	Personal Selling	Direct Mktg

TV, Print Media	Contests	Sports	Speeches	Sales meetings	Catalogs
Packaging	Gifts	Festivals	Seminars	Fairs & Trade shows	Mailings
Brochures	Samples	Arts	Annual Reports	Samples	Tele-mktg
Posters	Trade - shows	Company museums	Donations	Incentives	TV-Shopping
Billboards	Demo's	Street activities	Lobbying		E-mail
Point of Purchase (POP) material	Coupons	Factory tours	Company magazine		Voice-mail
Logos and symbols	Rebates	Entertainment	Publications		

10.09.04 Advertisement Budget

Factors to be considered in setting advertisement budget:

1. Product life cycle stage: Established brands spend less on advertisements.
2. Market share: High market share require less advertisement expenditure as a % of sales.
3. Competition and clutter: When there is severe competition we need to spend more on advertising.
4. Advertising frequency: Higher frequency creates a long lasting impression in the minds of customers.
5. Product substitutability: When there are too many options, we need to spend more on advertising - e.g. Soft drinks, Cigarettes, Biscuits, Liquors etc…

Chapter 11
Business Statistics

11 Business Statistics

Statistics are no substitute for judgment.

... Henry Clay

Statistics are used much like a drunk uses a lamppost for support and not for illumination.

... Scully

11.08.02	Sampling Methods
11.08.02.01	Simple Random Sampling
11.08.02.02	Stratified Sampling
11.08.02.03	Cluster Sampling
11.08.02.04	Multistage Sampling
11.08.03	Sampling Distribution
11.09.00	Regression

11.01.00 Overview of Business Statistics

11.01.01 Definition of Business Statistics

The word statistics refers to a special discipline or a collection of procedures and principles useful as an aid in gathering and analyzing numerical information for the purpose of drawing conclusions and making decisions.
Statistics may be defined as the science of collecting, organizing, presenting, analyzing, and interpreting numerical data for making better decisions.
Statistical methods applied to business activities may be termed as “Business Statistics”

11.01.02 Types of Statistical Methods

11.01.02.01 Descriptive Statistics

Descriptive Statistics includes statistical methods involving collection, presentation and characterization of a set of data in order to describe various features of that set of data.
Descriptive statistics include graphic methods and numeric measures.
Graphic methods comprise bar charts, line graphs, and pie charts etc.
Numerical measures include measures of central tendency, dispersion, skewness, and kurtosis.
We shall detail these terms later in this chapter.

11.01.02.02 Inferential Statistics

Inferential statistics include statistical methods which facilitate estimate the characteristics of a population or making decisions concerning a population on the basis of sample results. A population (or universe) is a group of elements or observations relating to a phenomenon under study for which greater knowledge and understanding is needed. The observations in a population may relate to incomes of people, quality of manufactured goods, road accidents, events like births and deaths etc. For instance, during elections psephologists make a statistical study of voting tendencies of a population to predict election results. This is an example of inferential statistics.

11.01.03 Scope of Statistics

Statistics and Computers: Computers and Information Technology have a significant influence on application of statistical methods in various fields of business management. Computers help in processing and maintaining past records of operations such as

production, sales, inventory transactions etc. This data can be analyzed to study the trends and enable business managers to make appropriate decisions.

Governments collect statistics relating to prices, production, demographics (size, growth, density, distribution, births, deaths, diseases etc), and the like. Statistical methods are extensively used in the field of economics in studying the behavior of prices, production, and consumption of commodities, money-matters etc.

Statistical methods applied in business management improve the capability of making effective decisions regarding future activities.

Examples of application of statistical methods in business areas:

a) Marketing: Demand forecasts for a product, new product introduction etc…
b) Production: Statistical quality control techniques, production forecasts etc…
c) Finance: Investment patterns. Financial forecasts etc…
d) Personnel: Manpower planning, accidents etc.....

11.02.00 Frequency Distribution

11.02.01 Raw Data

Raw data are collected data which have not been organized numerically. An example is the data on heights of 100 students in a classroom.

11.02.02 Arrays

An array is an arrangement of raw numerical data in ascending or descending order of magnitude. The difference between the largest and smallest numbers is called the '*range'* of the data.

11.02.03 Frequency Distribution

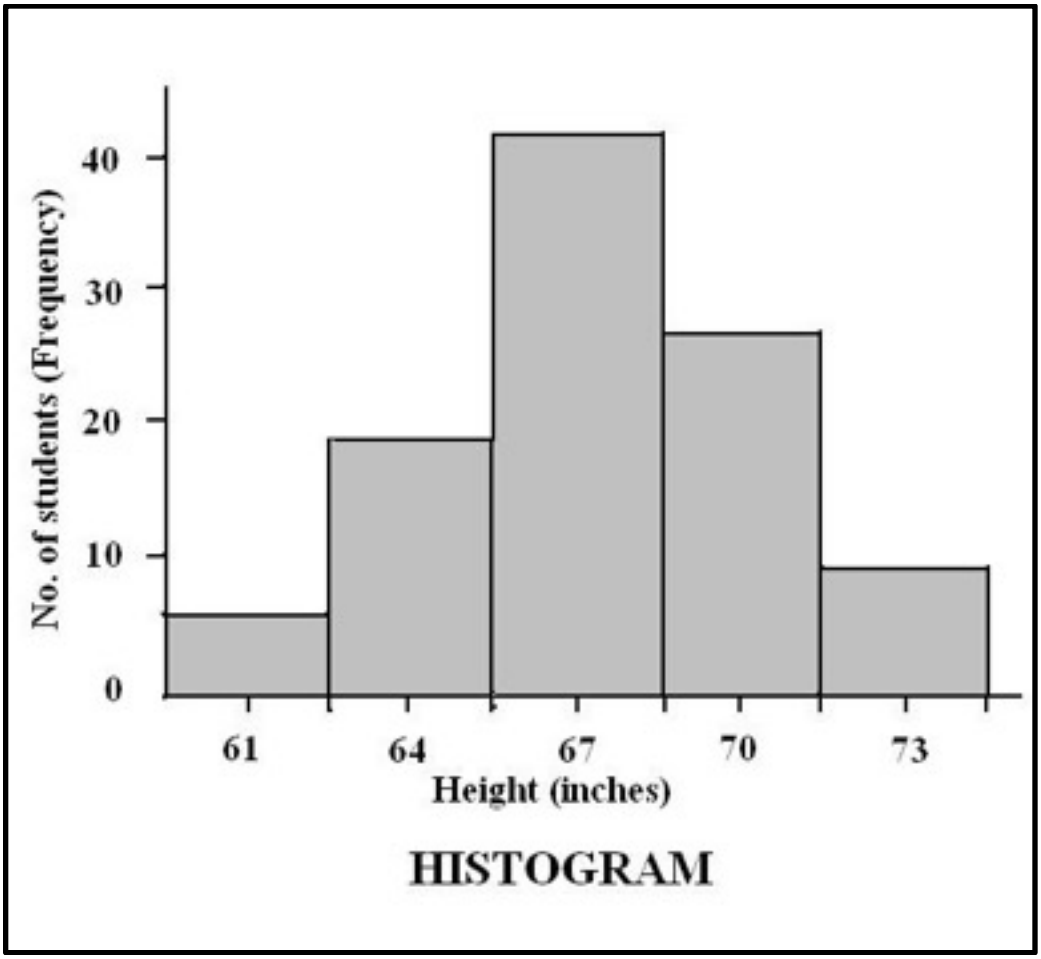
When summarizing large masses of raw data, it is often useful to distribute data into classes or categories and to determine the number of individuals belonging to each class, called a class '*frequency'*.

These concepts are demonstrated in the following example:

Height (inches)	No. of Students
60-62 *	5 **
63-65	18
66-68	42
69-71	27
72-74	8
Total	100

Class interval = 60-62 *
Upper class limit = 62
Lower class limit = 60
Class frequency = 5 **
Range of data = 74-60 = 14 inches.

This data may be organized in the form of a histogram as under:



11.03.00 Measures of Central Tendencies

Let symbol X denote a variables having values $X_1, X_2, X_3 \ldots\ldots X_n$.
Let us consider the following set of values for the variable x:
2,2,3,4,5,5,6,6,6,7,7,8,9

11.03.01 The Arithmetic Mean $\bar{X}$:

Let $\bar{X}$ Denote the arithmetic nean.

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \cdots + X_n}{n}$$

The arithmetic mean = [2+2+3+4+5+5+6+6+6+7+7+8+9 / 13] = 70/13 = 5.38

11.03.02 The Mode

The mode of a set of numbers is that value which occurs with the greatest frequency i.e. it is the most common value. The array can be unimodal or multi-modal.
In the above case, mode =6
In some cases, the mode may not exist at all.

11.03.03 Median

The median of a set of numbers arranged in order of magnitude (i.e. in an array) is the middle value or the arithmetic the arithmetic mean of two middle values.
In the above case, median = 6
Let us consider the following set of numbers:
5, 5, 7, 9, 11, 12, 15, 18.
In this case, median = (9+11) / 2 = 10

11.03.04 Empirical relation between mean, mode, and median

Mean –Mode = 3(Mean-Median)

11.03.05 Geometric Mean

The geometric mean of a set of numbers $X_1, X_2, X_3 \ldots\ldots X_n$

= nth root of the product of the numbers i.e.

nth root of $[X_1 * X_2 * X_3 ** \ldots\ldots X_n]$

Geometric mean denoted by G:

$$G = \sqrt[n]{X_1 * X_2 * X_3 * \cdots * X_n}$$

11.04.00 Measures of Dispersion

The degree to which numerical data tend to spread about an average value is called variation or dispersion of data.
Let symbol X denote a variables having values $X_1, X_2, X_3 \ldots\ldots X_n$.
Mean Value = $\overline{X}$:

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

Various measures of dispersion or variations are:

1. Range (R):

$R = [X_n - X_1]$ where X_n = Highest Value & X_1= Lowest Value.

2. Mean Deviation (MD)

$$MD = \frac{1}{n}\sum_{i=1}^{n} |X_i - \overline{X}|$$

3. Standard Deviation (SD or σ):

$$SD = \sigma = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N}}$$

where **SD** = σ = *the standard deviation of a sample,*
Σ *means "sum of,"*
X = *each value in the data set,*
$\overline{X}$ = *mean of all values in the data set,*
N = *number of values in the data set.*

The **standard deviation** (**SD**) (represented by the Greek letter sigma, **σ**) measures the amount of variation or dispersion from the average. A low standard deviation indicates

that the data points tend to be very close to the mean (also called expected value); a high standard deviation indicates that the data points are spread out over a large range of values.

Following example illustrates the concept of standard deviation

For a finite set of numbers, the standard deviation is found by taking the square root of the average of the squared differences of the values from their average value. For example, consider a **population** consisting of the following eight values:

$$2,\ 4,\ 4,\ 4,\ 5,\ 5,\ 7,\ 9.$$

These eight data points have the mean (average) of 5:

$$\frac{2+4+4+4+5+5+7+9}{8} = 5.$$

First, calculate the difference of each data point from the mean, and square the result of each:

$$\begin{array}{ll} (2-5)^2 = (-3)^2 = 9 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (5-5)^2 = 0^2 = 0 \\ (4-5)^2 = (-1)^2 = 1 & (7-5)^2 = 2^2 = 4 \\ (4-5)^2 = (-1)^2 = 1 & (9-5)^2 = 4^2 = 16. \end{array}$$

Next, calculate the mean of these values, and take the square root:

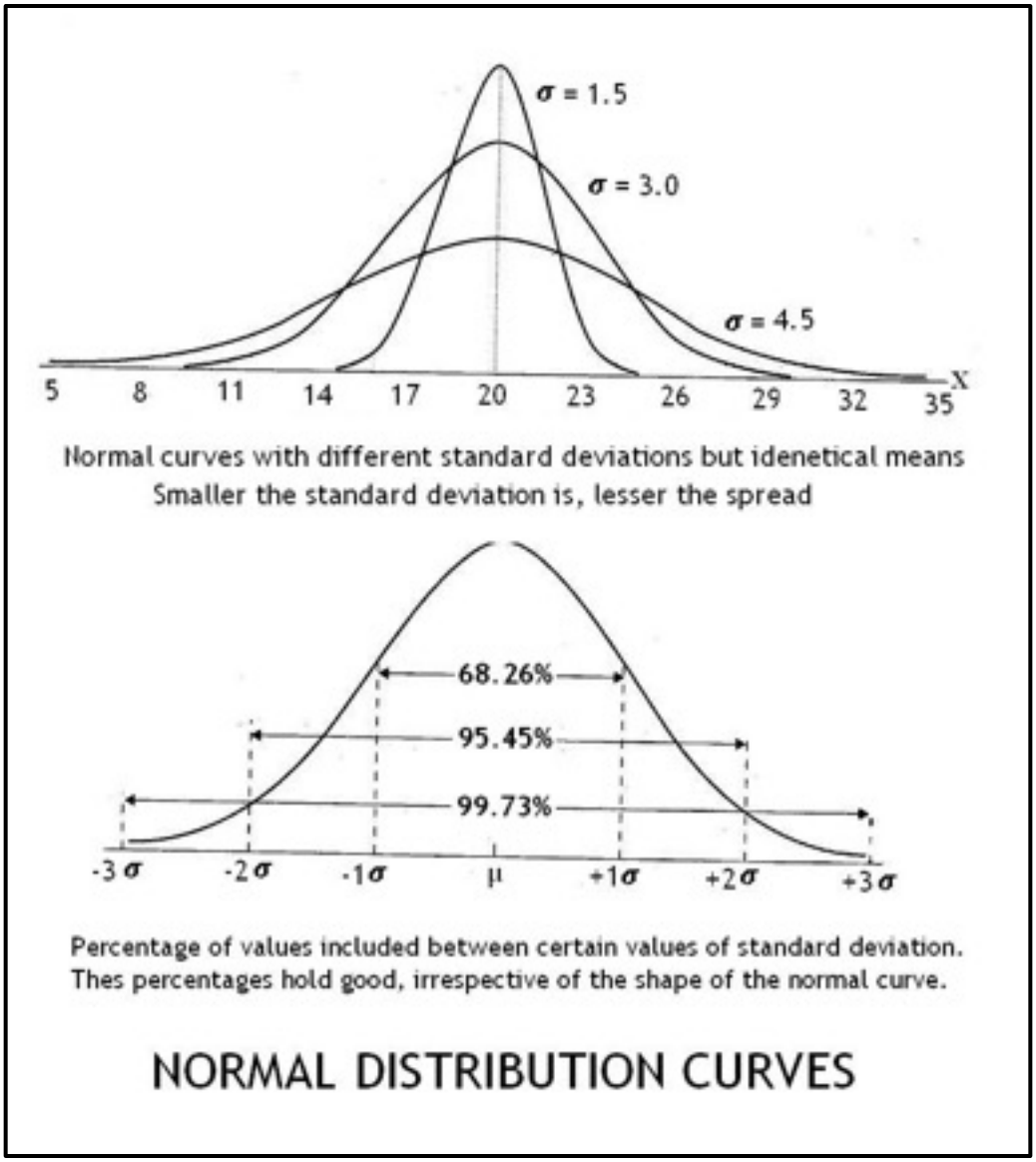
$$\sqrt{\frac{9+1+1+1+0+0+4+16}{8}} = 2.$$

Standard Deviation **σ** = 2 for this population

This quantity is the *population* standard deviation, and is equal to the square root of the variance.

It is a measure of the spread of the normal distribution. Smaller the standard deviation is, lesser the spread.

It is the best measurement of process variability, because the smaller deviation-value, the less variability in the process



11.05.00 Moments, Skewness, and Kurtosis

11.05.01 Moments

If $X_1, X_2, X_3, \ldots\ldots X_n$ are the 'n' values of the variable X,

We define 'j'th moment around the mean $\bar{x}$ as per the following formula.

Moments - Centered Around $\bar{x}$

$$m_j = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^j$$

---

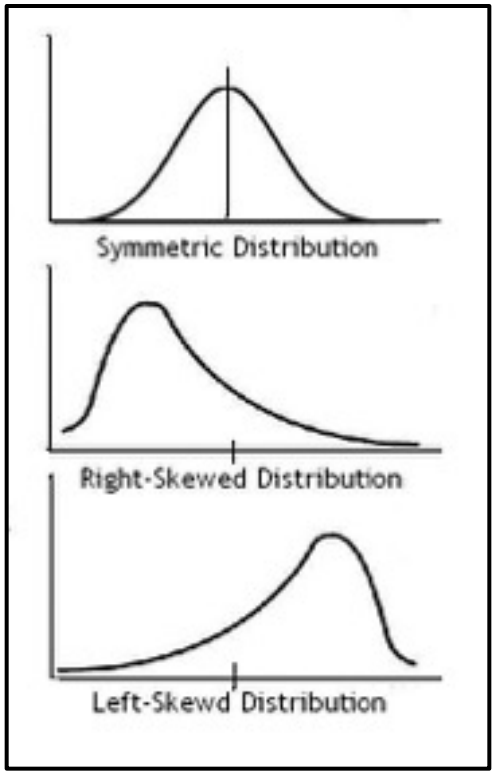
j stands for the order of the centered moment.

11.05.02 Skewness (SK)

Skewness is the degree of asymmetry, or departure from symmetry, of a distribution.

$$SK = \frac{3(\text{Mean} - \text{Median})}{\sigma}$$

The following figure illustrates the types of skewness; symmetrical, right-skewed, and left-skewed distributions.

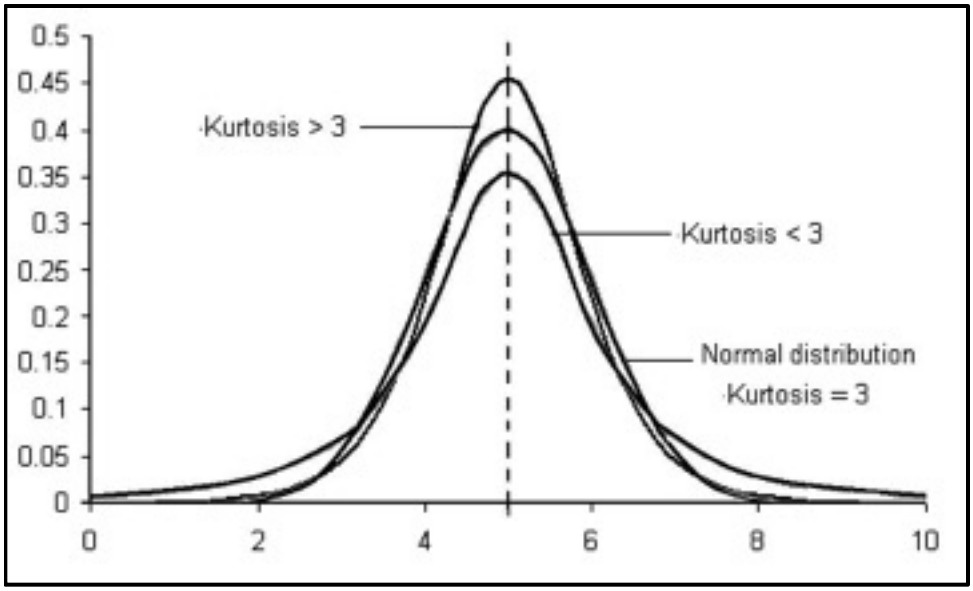


11.05.03 Kurtosis (K)

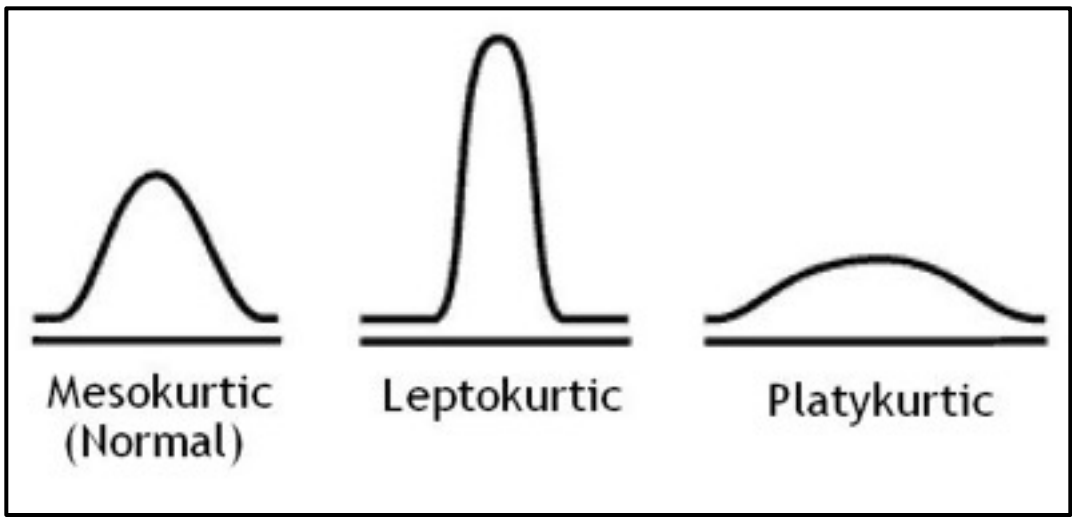
Kurtosis is the degree of peakedness of a distribution, usually taken relative to a normal distribution.
Kurtosis is a measure of the peakedness of a distribution. The (normalized) kurtosis statistic is calculated from the generated output values with the following formula:

$$kurt(X) = \frac{E\left[(X-\mu)^4\right]}{\sigma^4}$$

Kurtosis is sometimes used in conjunction with the skewness statistics to determine whether an output is approximately normally distributed. A Normal distribution has a kurtosis of 3 so any output that looks symmetric and bell-shaped, has zero skewness and a kurtosis of 3 can be considered approximately Normal. The following figure shows 3 distribution curves with kurtosis of >3, <3, =3.



There is some specialized terminology is associated with kurtosis. The following figure is self-explanatory.



Leptokurtic – having kurtosis > 3 (with high peak)
Mesokurtic – having kurtosis = 3 (Flat topped)
Platykurtic – having kurtosis < 3 (Normal)

11.06.00 Fundamentals of Probability

Suppose an event 'E' can happen in h ways out of a total of 'n' possible equally likely ways. Then the *probability* occurrence of the event (called its success) is denoted by:

$$P = Pr\{E\} = h/n.$$

The above definition of *probability* has a disadvantage that the words "equally likely" are vague. This expression is valid for a situation such as "tossing a coin" resulting in heads or tails, where the outcome "equally likely" is valid.

A) Classical Approach:

A general definition of probability states that ***probability*** is a numerical measure –varying between 0 and 1- of the likelihood or chance of occurrence of an uncertain event. It states that, during a random experiment, if there are 'a' possible outcomes where favorable event 'A' and 'b' possible outcomes where the event 'A' does not occur, and all these possible outcomes are mutually exclusive, exhaustive, and eqiprobable, then the probability that event 'A' will occur is defined as:

P(A) = a / (a+b) = Number of favorable outcomes / Total number of possible outcomes = c(A) / c(S)

For instance, if a dice is rolled, then on any trial, each event (face or number) is equally likely to occur since there are six equally likely exhaustive events, each will occur one-sixth of the time. The probability of occurrence of an event is based on prior knowledge of the process involved.

B) Relative Frequency Approach:

In situations where the outcomes of a random experiment are not all equally likely or when it is not known whether outcomes are equally likely, application of the classical approach is not desirable to quantify the possible occurrence of a random event. When an experiment is repeated many times, that event may occur some proportion of time. Thus, the approach calculates the proportion of time (i.e. *relative frequency*) with which the event occurs over an infinite number of repetitions of the experiment under identical conditions.

Probability of event ‘A’ is defined as:

P (A) = Limit (as n ➔ infinity) {c(s) / n}

Where c(s) represents the number of times that an event ‘s’ occurs in ‘n’ trials of an experiment.

C) Mathematical Expectation:

If ‘X’ denotes a discrete random variable, which can assume the values $X_1, X_2, \ldots. X_n$ with respective probabilities $p_1, p_2, \ldots.., p_n$, where $(p_1 + p_2 \ldots + p_n) = 1$, the mathematical expectation of ‘X’ (or simply called Expectation of ‘X’) denoted by E(X) is defined as:

$E(X) = p_1 * X_1 + p_2 * X_2 + \ldots. + p_n * X_n = \Sigma\, p*X.$

Also probability of occurrence of an event ‘A’ viz. P (A) **(+)** probability of non-occurrence of event ‘A’ = 1

11.07.00 Probability Distributions

11.07.01 Normal Distribution

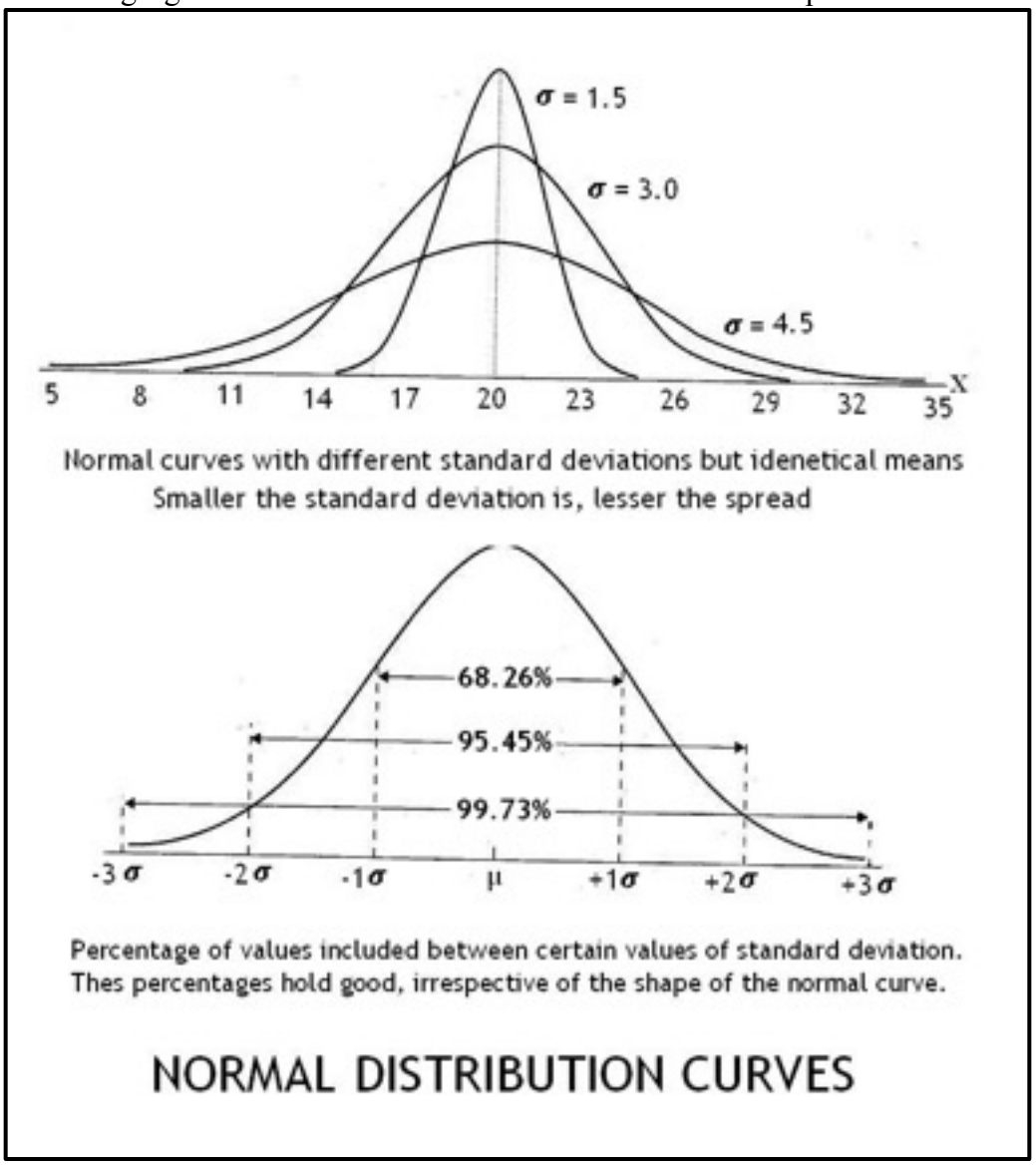
In any probabilistic situation each course of action may lead to a number of different possible outcomes. A listing of all the possible outcomes of a random variable with each outcome’s associated probability of occurrence is called probability distribution. The random variable in this type of probability distribution can take any numeric value in a range or an interval. If we measure the sizes (say diameter) of all sand grains on a beach, the size can take any value in a range and it would be a continuous probability distribution. If we plot the size of sand grains on X-Axis and the associated frequency on Y-Axis, it would be bell-shaped curve with a normal distribution pattern. Likewise, if we plot heights and weights of all students in a college with the associated frequencies, the results would be similar. Same would be the case if we tabulate the income levels of all families in any region. Nature seems to follow a predictable pattern for many kinds of measurements. The sum of probability to each of these infinitely large numbers of values is no more than ‘1’ (One).

In probability theory, the **normal** (or **Gaussian**) **distribution** is a very commonly occurring continuous probability distribution - a function that tells the probability that

any real observation will fall between any two real limits or real numbers, as the curve approaches zero on either side. It is a bell shaped curve.

We have discussed - earlier on in this chapter - certain measures such as central tendencies and dispersion of a distribution pattern. The normal distribution is a continuous probability distribution, which can be described as a stepless form of distribution i.e. the variable can take any numerical value without any steps in a range or interval.

The following figure illustrates the nature of a normal distribution pattern.



The total area bound by this curve and X-Axis is I (One)

The normal distribution is immensely useful because of the central limit theorem, which states that, under mild conditions, the mean of many random variables (samples) independently drawn from the same population is distributed approximately normally, irrespective of the form of the original distribution. We have used this trait in the application SQC techniques.

A normal distribution is defined by the equation:

$$f(x, \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Z = (x-μ) / [illegible]

The parameter μ in this definition is the *mean* or *expectation of* the distribution. The parameter [illegible] is its standard deviation. A random variable with a Gaussian distribution is said to be normally distributed.

If μ = 0 and [illegible] = 1 , the distribution is called the standard normal distribution or the unit normal distribution denoted by $N(0,1)$ and a random variable with that distribution is a standard normal deviation**.**

We have seen the application of this type of distribution in the earlier chapter titled "TQM" under the sub-heads of "Six-Sigma Capability" and "Statistical Quality Control".

Standard Normal Distribution Table:

This is a ready reckoner table for calculation of probability under specified conditions.

It is a Normal Distribution with mean 0 and standard deviation 1.It shows you the percent of population:

- between 0 and Z (option "0 to Z")
- less than Z (option "Up to Z")

∫ greater than Z (option "Z onwards")

It is correct to 0.1%, for example 17.36% is rounded to 17.4%The Table

You can get more accurate values from the table below. The table shows the area from 0 to Z.

The standardized value of a normally distributed random variable is called a *Z* score and is calculated using the following formula.

$$Z = \frac{X - \mu}{\sigma}$$

x = the value that is being standardized
μ = the mean of the distribution

[illegible] = standard deviation of the distribution

Normal Distribution Function:

$$f(x, \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Substitute $Z = \frac{X - \mu}{\sigma}$

$$f(x, \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{z^2}{2}}$$

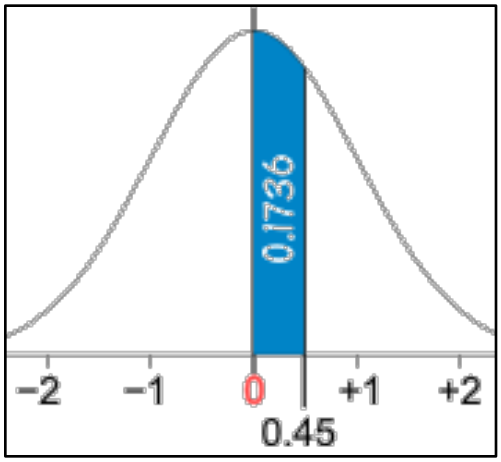
Instead of one LONG table, we have put the "**0.1**"s running down, then the "**0.01**"s running along. (Examples of how to use is given below)

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141

0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706

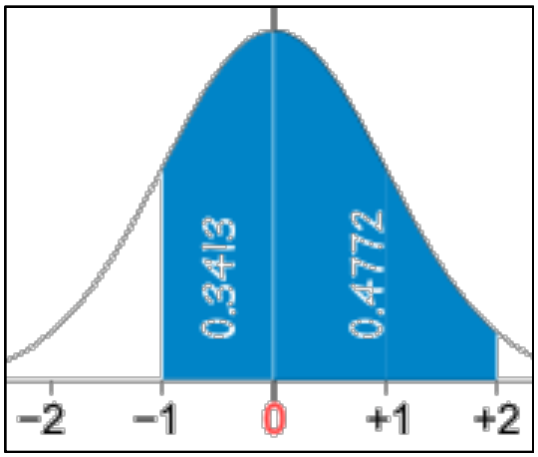
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

Example - 1: Percentage of population between 0 and 0.45



Start at the row for 0.4, and read along until 0.45: there is the value 0.1736and 0.1736 is **17.36%**

So 17.36% of the population is between 0 and 0.45 Standard Deviations from the Mean. Because the curve is symmetrical, the same table can be used for values going either direction, so a negative 0.45 also has an area of 0.1736



From **−1 to 0** is the same as from **0 to +1**: At the row for 1.0, first column 1.00, there is the value **0.3413**

From **0 to +2** is: At the row for 2.0, first column 2.00, there is the value **0.4772**

Add the two to get the total between -1 and 2: 0.3413 + 0.4772 = **0.8185**
And **0.8185** is **81.85%**

So 81.85% of the population is between -1 and +2 Standard Deviations from the Mean.

11.07.02 Binomial Distribution

Binomial distribution is a discrete type, unlike normal distribution pattern which is a continuous probability distribution.

In probability theory and statistics, the **binomial distribution** with parameters *n* and *p* is the discrete probability distribution of the number of successes in a sequence of *n* independent yes/no experiments, each of which yields success with probability *p*. A success/failure experiment is also called a Bernoulli experiment or Bernoulli trial.

The binomial distribution is frequently used to model the number of successes in a sample of size *n* drawn with replacement from a population of size *N*.

If ‘p’ is the probability that an event will happen in a single trial (called the probability of success) and ‘q’ = (1 – ‘p’) is the probability that it will fail to happen in any single trial (called the probability of failure) then the probability that the event will happen exactly ‘x’ times in ‘n’ trials [i.e. x successes and (n – x) failures will occur] is given by the formula:

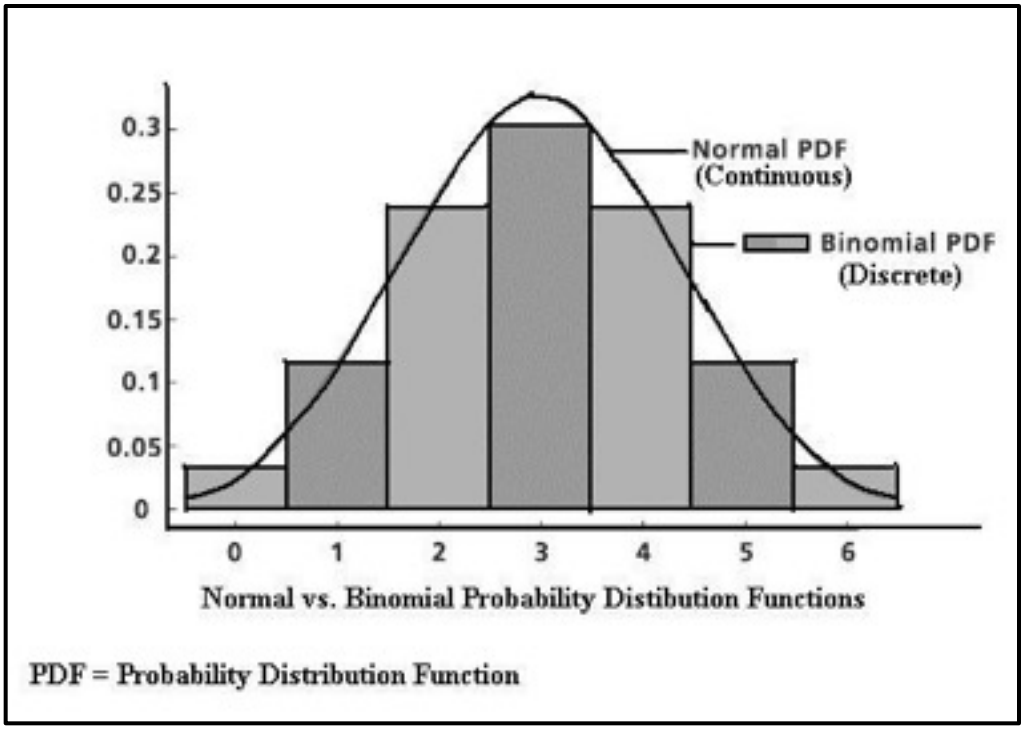
$$P(x \text{ successes}) = \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x}$$

Where X = 0,1,2, ……, N and N! = N (N – 1) (N – 2) ….1. 0! = 1 by definition.

Some properties of binomial distribution:

Mean binomial probability: $\mu = np$

Standard Deviation: $\sigma = \sqrt{n\,(p)\,(1-p)}$



Example of application of binomial distribution:

If 20% of the bolts produced by a machine are defective, determine the probability that 4 bolts chosen at random will have a) 1 defective bolt and b) 0 defective bolts.

P = 0.2; q= (1-0.2) = 0.8

a) P(1 defective bolt out of 4) = $_4C_1 (0.2)^1 (0.8)^3 = 0.4096$

b) P(0 defective bolts out of 4) = $_4C_0 (0.2)^0 (0.8)^4 = 0.4096$

11.07.03 Poisson Distribution

Poisson distribution is a discrete type of distribution.

Following is the probability function of Poisson distribution.

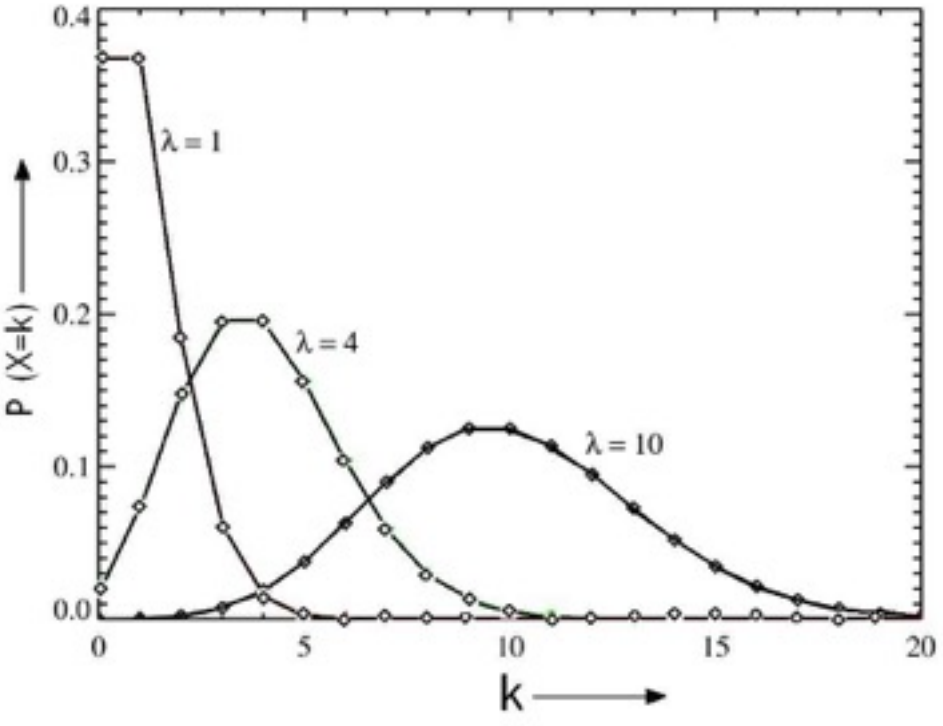
$$P(x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

where

$x = 0,1,2,3,4,\ldots\ldots$

$e = 2.71828$

$\lambda =$ long run average



Horizontal axis is, the index k, the number of occurences. The function is only defined at integer values of k. Connecting lines are shown to serve only as guide for the eyes. Y axis shows the probability of occurence at X = k.

Poisson distribution Function

Some properties of Poisson distribution:

1. Mean μ = [illegible]
2. Standard deviation [illegible] = $\sqrt{\lambda}$

Let us consider the example of road accidents happening in a particular region. The long run average of the number of accidents taking place over an interval is known; but we can not predict exact timing of an accident. The accidents do not happen continuously but they happen at random. This is a case where Poisson distribution is applicable. We can, by application of Poisson distribution formula, estimate the probability of certain number of accidents that are likely to happen in a given interval.

An example of Poisson distribution function:

Q) If the probability that an individual suffers a bad reaction from an injection of a given serum is 0.001, determine the probability that out of 2000 individuals exactly 3 will suffer a bad reaction.

Solution:

$$P(x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

where

$x = 3$

$e = 2.71828$

$\lambda = Np = (2000)(0.0001) = 2$

P(3 individuals suffering bad reaction)

$$= \frac{2^3 e^{-2}}{3!} = \frac{4}{3e^2} = 0.180$$

11.08.00 Sampling Theory

11.08.01 Overview of Sampling Theory

Sampling theory is a study of relationships existing between a population and samples drawn from the population. It is useful in estimation of unknown population quantities

(such as population mean, variance etc.), called population parameters, from a knowledge of corresponding sample quantities (such as sample mean, variance etc.), called sample statistics. In statistical inference we use random sample or samples to extract information about the population from which it is drawn. The information we extract is in the form of summary statistics; as a sample mean, a sample standard deviation or other measures computed from the sample. Sample statistics are treated as estimator of population parameters viz. μ,  , p, etc.

The process of selecting a sample from a population is called sampling. As the sample size gets higher, the statistical inference is likely to be more accurate.

11.08.02 Sampling Methods

11.08.02.01 Simple Random Sampling

We assign a number to each member of the population. Then we select specified number of samples by using random numbers picked up from a table of random numbers in the range of the population size.

11.08.02.02: Stratified Sampling

We stratify the heterogeneous population into homogeneous sub groups to give better representation to all categories and then select samples using random numbers. This sampling population procedure is more efficient than simple random sampling procedure because, for the same sample size, we get more representativeness from each segment of the population.

11.08.02.03 Cluster sampling

Their entire population to be analyzed is divided into smaller groups or chunks of elements and a sample of the desired number of areas selected by simple random sampling method. Cluster sampling offers more heterogeneity within the groups and more homogeneity among the groups. This is the reverse of stratified sampling, where there is more homogeneity within each group and heterogeneity across the groups.

11.08.02.04 Multistage Sampling

This method of sampling is useful when the population is widely spread and random sampling is not possible. The researcher might stratify the population in different regions of the country and then stratify by urban and rural and then choose a random sample of

communities within the strata. These communities are then divided into city areas as clusters and some of these are randomly considered for study. Each element in the selected cluster may be contacted for the desired information.

11.08.03 Sampling Distribution

If the population is very large or sampling is with replacement:

$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

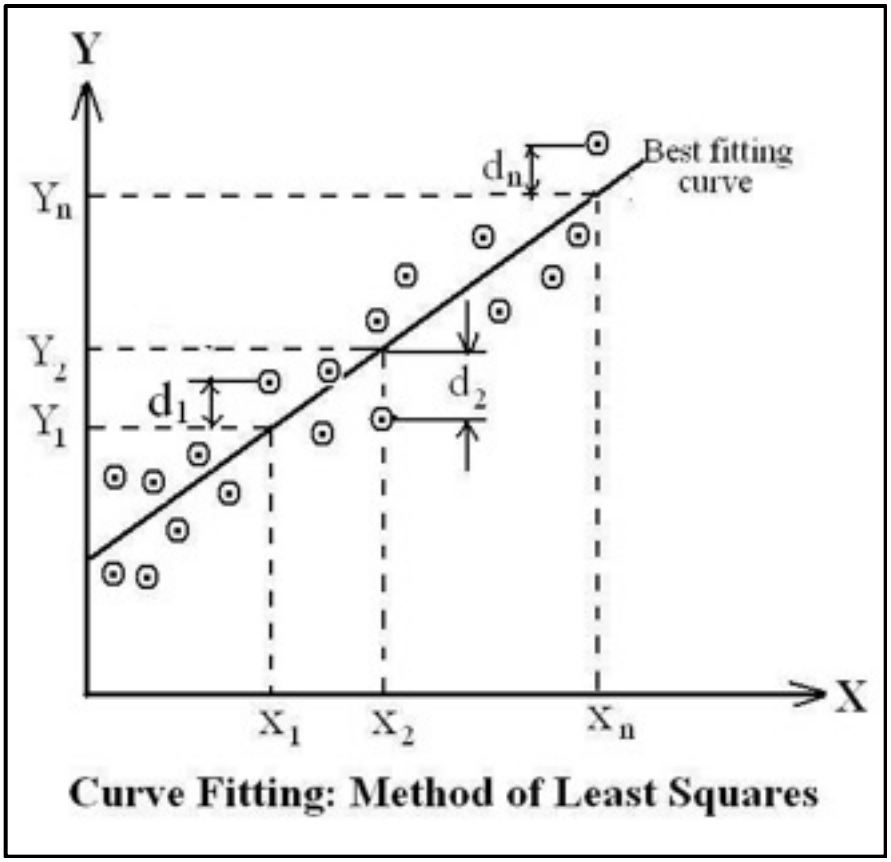
Where μ and [illegible] are the mean and standard deviation of the population respectively and
$\mu_{\bar{x}}$ and $\sigma_{\bar{x}}$ are the mean and standard deviation of the sampling distribution respectively.

Please note that i$\mu_{\bar{x}}$ is the mean of the means of various samples.
Likewise, $\sigma_{\bar{x}}$ is the standard distribution of the means of various samples.
For 'n' is greater than or equal to 30, the sampling distribution of means is approximately a "normal distribution" irrespective of the type of distribution of the population.
In case the population is normally distributed, the sampling distribution of means is also normally distributed even for small number of samples i.e. for even in case 'n' is less than 30.

By using the sampling theory, we can estimate the parameters of a population (μ, [illegible] etc.) by using the statistics of the samples.

11.09.00 Regression; Curve Fitting and the Method of Least squares

In statistics, **regression** analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables.
Often, we wish to estimate the value of variable y corresponding to a given value of x. Resulting curve is called a regression of y on x. If we desired to estimate the value x from a given value of y, we would use a regression curve of x on y.



Curve Fitting: Method of Least Squares

We have a situation where we have a tabulation of some trend statistics and the readings tabulated 'y' against 'x' on a graph are scattered. As the trend is not clear, we need to arrive at a best possible line or best fitting curve from the statistical data..
We can adopt the method of least squares for arriving at the best possible fit.

Linear regression is a mathematical technique that relates one variable, called an *independent variable,* to another, the *dependent variable,* in the form of an equation for a straight line. A linear equation has the following general form:

Criteria for the best fit: y = a + b.x
Sum of the squares of deviations ($d_1, d_2, \ldots, d_n$) = Minimum.

$$S = d_1^2 + d_2^2 + d_3^2 + \cdots\cdots + d_n^2 = \text{Minimum}$$

Method of Least Squares:

$Y = a + bX$

Y is the dependent variable

X is an independent variable

$$S = d_1^2 + d_2^2 + d_3^2 + \cdots + d_n^2$$

$$s = \Sigma [a_n + b_n x_n - y_n]^2 = \text{Min}$$

$$\frac{\partial S}{\partial a} = \frac{\partial S}{\partial b} = 0$$

$$2(a_1 + b_1 x_1 - y_1) + 2(a_2 + b_2 x_2 - y_2) + \cdots (a_n + b_n x_n - y_n) = 0$$

$$2(a_1 + b_1 x_1 - y_1)x_1 + 2(a_2 + b_2 x_2 - y_2)x_2 + \cdots (a_n + b_n x_n - y_n)x_n = 0$$

$$na + b\Sigma x - \Sigma y = 0$$

$$a\Sigma x + b\Sigma x^2 - \Sigma xy = 0$$

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\Sigma xy - n\bar{x}\bar{y}}{\Sigma x^2 - n\bar{x}^2}$$

Using partial differential equations to satisfy the above criteria, we arrive at the following equations:

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\Sigma xy - n\bar{x}\bar{y}}{\Sigma x^2 - n\bar{x}^2}$$

where

$$\bar{x} = \frac{\Sigma x}{n} = \text{mean of the } x \text{ data}$$

$$\bar{y} = \frac{\Sigma y}{n} = \text{mean of the } y \text{ data}$$

Exercise:

We are given sales figures for 8 quarters.
We need to forecast sales for the 9th quarter.

Statistical Data:

Quarter (x)	Sales (y)	X square	x.y
1	600	1	600

2	1550	4	3100
3	1500	9	4500
4	1500	16	6000
5	2400	25	12000
6	3100	36	18600
7	2600	49	18200
8	2900	64	23200
Σ = 36	16150	204	86200

$\overline{X}$ = 4.50 (36 / 8)

$\overline{Y}$ = 2019 (16156 / 8)

By substituting these values in the above equations we arrive at the values of ‘a’ & ‘b’

a = $\left[\overline{Y} - b.\overline{X} \right]$ = 2019 - 4.5 b

b = [86200 – 8x4.5x2019] / [204 – 8x4.5x4.5] = 322

a = 2019 – 322x4.5] = 570

Equation ➔ y = 570 + 322.x

Using this equation we conclude that:

Forecast for 9th quarter = 570 + 322x9 = 3,468 units

Chapter 12
Operations Research

12 Operations Research (OR)

If we knew what it was when we were doing, it would not be called research, would it? ... Albert Einstein

Index

12.01.00 Basics of Operations Research

12.01.01 Introduction to OR

OR is the application of scientific method, tools, and techniques to provide a quantitative basis for decisions involving the operations of systems. The objective of OR is to find an optimal solution to operational problems under certain prevailing restrictions.
A solution for any decision making problem requires answers to the following questions:

1. What is the problem?
2. What is the objective?
3. What are the restrictions?
4. What are the alternatives?
5. What is the criterion for evaluation of alternatives?
6. How do we arrive at an optimal solution?

In OR, we do not have single general technique to solve all mathematical models that can arise in practice.

The most prominent OR technique is *Linear programming*. It is designed for models with linear objective and constraint functions.
Some of the important techniques are:

1. *Integer programming* in which the variable assume integer values.
2. *Dynamic programming* in which the original model can be decomposed into more manageable sub problems.
3. *Network programming* in which the problem can be modeled as a network.
4. *Nonlinear programming* in which the functions are non linear.

In OR, solutions are not always obtained by using mathematical formulae. Instead, they are determined by algorithms. An algorithm provides fixed computational rules that are applied repetitively to the problem, with each repetition (called iteration) moving the

solution closer to the optimum. For instance, “Transportation Model” involves a process of algorithm. Because the computations are tedious and voluminous, the algorithms can be executed by only computers. Some mathematical models are so complex that defy any mathematical technique; and we may have to resort to heuristics (Intelligent rules of thumb based on experience) for a near optimal solution.

The subject of ‘OR’ is very complex and an attempt is made here only to give a broad view of the subject. You may refer to any standard textbook on ‘OR’ for an in-depth understanding of the techniques involved.

12.01.02 Characteristics of OR

1. System orientation.
2. Use of interdisciplinary teams (Mathematicians, Statisticians, Physicists, Psychologists, Economists, and Engineers are involved).
3. Application of scientific method.
4. Improvement in the quality of decisions.
5. Quantitative basis for decision making.
6. Use of computers to handle large data at high speed to solve a complex mathematical model.
7. Consideration of human factors.

12.01.03 Scope of OR Applications

OR techniques have a wide range of applications:

1. Industry: scheduling, blending, product-mix, sequencing, inventory control, transportation, forecasting etc…
2. Defense Operations: war-games, Intelligence, logistics etc…
3. Government / Planning: economic development, population studies, resource allocation, generation and transmission of power etc…

4. Agriculture: Optimum distribution of water, Allocation of land for various crops in accordance with climatic conditions etc…
5. Public Utilities: Queuing theory applied to reduce the waiting time at any queue e.g. railway reservation, Banks, hospitals etc…

12.01.04 Application of OR in Management

12.01.04.01 Production Planning

- Scheduling (Assignment model).
- Sequencing of production runs (Sequencing models).
- Project planning and control (PERT / CPM Technique).
- Blending of materials to optimize costs (Simplex technique).
- Maintenance (Queuing theory, Replacement theory).

12.01.04.02 Supply Chain Management

- Economic order quantity (EOQ Technique).
- Safety stock, reorder levels, Min / Max stock Levels (Inventory models).
- Optimizing cost of transportation (Transportation Model).

12.01.04.03 Marketing

- Demand Forecasting (Regression analysis, Exponential smoothing etc…)
- Selection of Advertisement Media (Dynamic programming).
- Optimum Product Mix (Linear programming).

12.01.04.04 Finance

- Capital Budgeting (Integer linear programming).
- Optimal replacement decisions (Replacement Theory).
- Profit planning (Linear programming).

12.01.04.05 Personnel

- Staff replacement / Recruitment (Replacement Theory).

12.01.04.06 Research and Development:

- R&D Projects (Decision Theory).
- Product development (PERT / CPM Technique).

12.01.05 Role of Computers in OR

In most OR techniques computations are so complex that manual calculations are virtually impossible. Many software packages have been developed for solving problems using OR techniques such as scheduling, inventory management, simulation, queuing, networking (PERT / CPM) etc…

12.01.06 Limitations of OR

- Mathematical models do not take into account human / emotional factors.
- Qualitative factors which can not be quantified find no place in OR.
- OR techniques are applicable only to specific category of problems.
- OR is very complex and requires specialized training for its application and need fast computers and software packages.

12.02.00 Linear Programming (LP)

12.02.01 Introduction

Linear programming deals with the optimization – maximum or minimum – of a function of variables known as objective function, subject to a set of linear equations and/or inequalities known as constraints. The objective function may be profit, cost, production capacity or any other measure of effectiveness, which is to be obtained in the best possible or optimal manner.

12.02.02 Requirement for a Linear Programming Problem:

1. There must be a well define objective function (profit, cost, production quantities, etc.) which is to be either maximized or minimized and which can be expressed as linear function of decision variables.
2. There must be constraints which can be expressed as linear equations or inequalities of variables.
3. The decision variables must be interrelated and non-negative.
4. Decision variables are continuous i.e. they can take any non-negative value that satisfy the constraints.
5. Coefficients in objective function and the R.H.S. coefficients of the constraints and resource values in the constraints are certainly and precisely known and their values do not change with time.
6. There must be finite number of alternative course of action for a final decision.
7. Resources must be in limited supply.

12.02.03 Properties of LP model:

1. Variable in both the objective function and the constraints to be directly proportional to the value of variable.

2. *Additivity*: This property requires the total contribution of all the variables in the objective function and in the constraints to be the direct sum of the individual contributions of each variable. E.g. The total profit of a company having 2 components of profit is the sum total of the profits of the individual components. However if the two products compete with each other for higher market share, the additive property is not satisfied and the model is no longer linear.

3. *Certainty*: All the objective and constraint coefficients of the LP model are deterministic i.e. they are certainly and precisely known constants and do not change with time.

4. *Proportionality*: This property requires the contribution of each decision.

12.02.03 Applications of linear programming

12.02.03.01 Product- mix Problems

A manufacturing plant may be engaged in manufacture of various products. However, there are resource-constraints in terms of men, material, machines etc. which are in limited supply. There can also be constraints in marketing certain products in terms of quantity. We need to find a solution (Product-Mix) maximizing profit given the following data:

1. Selling price of each product.

2. Profit margin for each product.

3. Resources required per unit of manufacture.

4. Maximum or minimum quantity that can be marketed.

We can find an optimal solution using LP technique.

12.02.03.02 Blending Problems

These problems arise when a product is made from a variety of raw materials having different prices and availability of each of them is restricted. The problem would be to

optimize (minimize) the cost of the product. This can be solved by application of LP technique.

12.02.03.03 Production Scheduling Problems

This situation arises when there are many jobs to be done using alternative interchangeable manufacturing resources to make a product such as machinery, each having different operating cost. The objective is to meet demand at minimum cost. This problem can be solved by LP technique.

12.02.03.04 Make or Buy Decisions

In absence of certainty of demand pattern, it is not advisable to build up additional production capacity in a manufacturing unit. Some times, we have to make decisions regarding the products to be manufactured with own resources and the products to be off-loaded so that total cost is minimized.

12.02.03.05 Media Selection Problem in Marketing

This problem involves the selection of advertizing mix among different types of media such as TV, radio, magazines, newspapers etc. that will maximize public exposure with in the constraints of advertisement budget.

12.02.03.06 Transportation Problem

If there are ‘m’ number of sources (e.g. factories) and ‘n’ number of destinations (e.g. warehouses) located in different geographical locations, involved in distribution of a product, the problem is to optimize (minimize) the total cost of transportation, given the applicable freight rates, physical locations of sources and destinations (distances), and the quantity of material (or the number of truck loads) to be transported.

12.02.03.07 Assignment Problems

They are concerned with allocation of facilities (men or machines) to jobs. Time required by each facility to perform each job is given and the problem is to find the optimum allocation (one job to one facility) so that the total time to perform the jobs is minimized.

12.02.04 Example

Operations Research (OR) / Linear Programming (LP)

A company uses 3 types of machines viz. ‘A’, ‘B’, and ‘C’ to produce two types of parts viz. P1 and P2. The following table gives the machining times required to process the parts.

Type of machine	Machining time (min) for part P1	Machining time (min) for part P2	Max available minutes per week
A	12	6	3,000
B	4	10	2,000
C	2	3	900
Profit / Unit	Rs 40	Rs 100	

Let the quantity of part P1 = X1 and quantity of part P2 = X2.

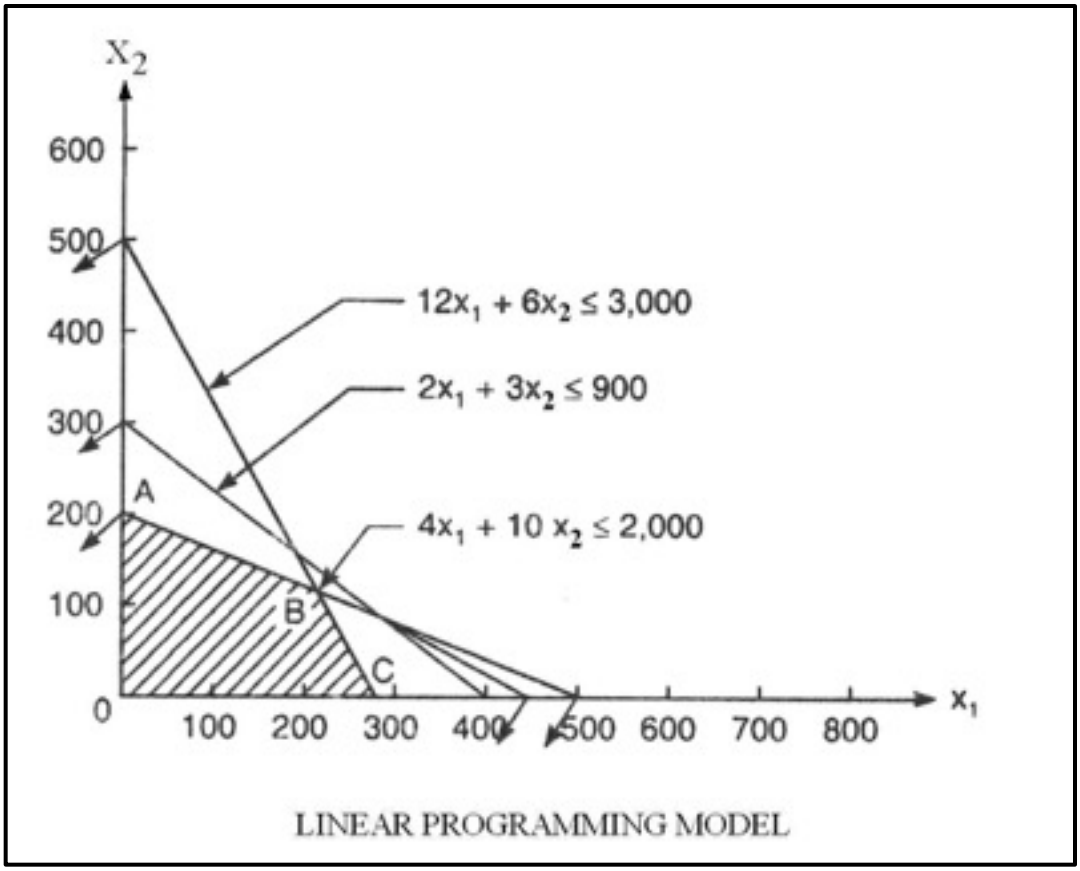
The problem is to determine the number of parts P1 & P2 to be manufactured per week to maximize the profit.

Profit ‘Z’ = 40 $\times X1$ + 100 $\times X2$

Where X1, X2 $\leq$ 0

Constraints are the time available on each machine.
For machine ‘A’ : 12X1+6X2 ≤ 3,000
For machine ‘B’ ; 4X1+10X2≤ 2,000
For machine ‘C’ : 2X1+3X2≤ 900

Thus, the problem is to determine the values of X1 and X2 which meet the non-negativity condition (X1, X2 $\leq$ 0), satisfy maximization equation (Profit ‘Z’ = 40 $\times X1$ + 100 $\times X2$), and the constraint equations. The shaded area in the following figure satisfies these conditions.



LINEAR PROGRAMMING MODEL

The four vertices of the convex set OABC are O(0,0); A(0,200); B(187.5,125); C(250,0). Values of the objective function 'Z' = 40 $\times X1$ + 100 $\times X2$ at these vertices are:

Z(O)=0; Z(A)= Rs 20,000; Z(B)= Rs 20,000; Z(C)= Rs 10,000

The maximum value of profit 'Z' occurs at two vertices A and B on the shaded region OABC. There is no unique solution. In fact, any point between A and B on line AB can be taken as an optimal solution with profit of Rs 20,000/-.

Only graphical solution is enumerated here for the sake of simplicity.
A more advanced analytical solution is possible by Simplex technique, which is beyond the scope of this book.
We have now dealt with the most important OR technique viz. "Linear Programming" in some detail.
We shall now outline the other OR techniques briefly.

12.03.00 The Transportation Model

12.03.01 Introduction

If there are ‘m’ number of sources (e.g. factories) and ‘n’ number of destinations (e.g. warehouses) located in different geographical locations, involved in distribution of a product, the problem is to optimize (minimize) the total cost of transportation, given the applicable freight rates, physical locations of sources and destinations (distances), and the quantity of material (or the number of truck loads) to be transported.
Transportation problems may also involve movement of a product from warehouses to distributors, wholesalers to retailers, and retails to customers.

12.03.02 Assumptions in the Transportation Model:

- The quantity of the item available at different sources is equal to the total requirement at different destinations.
- Item can be transported conveniently from all sources to all destinations.
- The unit transportation cost of the item from all sources to destinations is certainly and precisely known.
- The transportation cost on a given route is directly proportional to the number of units shipped on that route.
- The objective is to minimize the total transportation cost for the organization as a whole and not for individual routes.

Matrix of a transportation problem:

A simple matrix of transportation model indicating the sources, destinations and the transportation quantities is given below.

12.03.03.00 Example

Destination ► (Warehouses) Source (Plants) ▼	X	Y	Z	Supply Qty ▼
A	50	20	40	110

B	100	30	60	190
C	20	10	100	130
Demand Qty ►	170	60	200	430

Matrix terminology:

The matrix used in transportation model consists of squares called ‘cells’, which when stacked form *columns* vertically and *rows* horizontally.
The cell located at the intersection of a row ‘i’ and a column ‘j’ is called Cell (i,j)
Cost figures of transport per unit from source ‘i’ to destination ‘j’ termed Cij are placed in the respective cells at a corner.

A general form of the matrix of a transportation problem is as follows:

Destination ► Source ▼	1	2	3	…j…	n	Supply ▼
1	C11 X11	C12 X12	C13 X13	C1j X1j	C1n X1n	A1
2	C21 X21	C22 X22	C23 X23	C2j X2j	C2n X2n	A2
3	C31 X31	C32 X32	C33 X33	C3j X3j	C3n X3n	A3
…i…	Ci1 Xi1	Ci2 Xi2	Ci3 Xi3	Cij Xij	Cin Xin	Ai
m	Cm1 Xm1	Ci2 Xm2	Ci3 Xm3	Cmj Xmj	Cmn Xmn	Am
Demand ►	B1	B2	B3	...Bj …	Bn	∑ Ai (i=1 to m) = ∑ Bj (j=1 to n)

Cij = Cost of transport per unit from source ‘i’ to destination ‘j’
Xij = Quantity shipped from source ‘i’ to destination ’j’
Cost of transportation of quantity X from source ‘i’ to destination ‘j’ = Cij × Xij

$\sum_{i=1}^{m} Ai = \sum_{j=1}^{n} Bj$ is the necessary and sufficient condition.

Total cost of transportation Z = $\sum_{i=1}^{m} \sum_{j=1}^{n} CijXij$

An algorithm of transportation model is used to determine the quantities to be shipped from any source to any destination (all Xij quantities in the matrix) so as to minimize the total cost of transportation. Any text book on OR would contain the details of the algorithm.

12.04.00 The Assignment Model

12.04.01 Introduction

We had earlier discussed about linear programming technique which could involve complex and laborious calculations. There are some special cases of linear programming problems whose solutions can be obtained by special techniques, which are easy to apply and greatly reduce computational work. Assignment problem is such a case, which finds many applications in allocation and scheduling problems.

Some of the applications are:

1. Assigning salesmen to different regions.
2. Assigning products to factories.
3. Assigning jobs to machines.
4. Assigning contracts to bidders.
5. Assigning projects to R&D teams etc…

The assignment problem may be defines as follows:

Given n facilities and n jobs and given the effectiveness of each facility for each job, the problem is to assign each facility one and only one job so as to optimize the given measure of effectiveness.
The following table represents the assignment of n facilities to n jobs. Cij is the cost of assigning ith facility to jth job, and Xij represents the assignment of ith facility to jth job. If ith facility can be assigned to jth job, Xij = 1, otherwise zero. The objective is to make assignments to minimize the total assignment cost or maximize total gain.

Job► Facility▼	1	2	3	…i…	n	Ai (Supply) ▼
1	C11	C12	C13	C1i	C1n	1
2	C21	C22	C23	C2i	C2n	1
3	C31	C32	C33	C3i	C3n	1
i	Ci1	Ci2	Ci3	Cij	Cin	1
n	Cn1	Cn2	Cn3	Cni	Cnn	1
Bj ► (Demand)	1	1	1	1	1	

Thus, an assignment problem can be represented by n x n matrix which constitute 'n!' possible ways of assignment. If 'n'=10, there would be 10! (3,628,800) ways of assignment and it is impractical to make the calculations to find an optimal solution. There is a need for an efficient and easy computational technique for solving such problems.

12.04.02 Mathematical Representation of Assignment Model

Let Xij denote the assignment of facility 'i' to job 'j'.
Xij = 0, if the ith facility is not assigned to jth job.
Xij = 1, if the ith facility is assigned to jth job.

Then the objective is given by:

Minimize Z = $\sum_{i=1}^{n} \sum_{j=1}^{n} CijXij$

Subject to constraints:

$\sum_{j=1}^{n} Xij = 1, i = 1, 2, 3, \ldots\ldots, n$ (one job assigned to ith facility)

$\sum_{i=1}^{n} Xij$ = 1, j =1, 2, 3,…….,n, (one facility is assigned the jth job)

and Xij = 0 or 1.

We can follow the standard algorithm of assignment model to find an optimal solution to the stated problem.

12.04.03 Example:

A company has 4 machines and has the jobs A, B, C, and D for execution at minimal cost. How should the machines be loaded?

Given below is a matrix, showing the costs (Rs) of executing these jobs on the available 4 machines.

Machine ► Jobs▼	1	2	3	4
A	20	36	31	17
B	24	32	40	12
C	22	40	38	18
D	36	39	35	16

By following the algorithm of assignment model we will find the following solution.

Job A to Machine 3 at Rs 31

Job B to Machine 2 at Rs 32

Job C to Machine 1 at Rs 22

Job D to Machine 4 at Rs 16

Total cost = Rs 101

12.05.00 Sequencing Model

12.05.01 Introduction:

The sequencing problem involves the determination of an optimal order or sequence of performing a series of jobs by a number of facilities – that are arranged in a specific order – so as to optimize the total time or cost.
The sequencing can be formed into two groups:

12.05.01.01 'n' jobs and 'm' Machines

In the first group, there are 'n' different jobs to be performed, where each job requires processing on some or all 'm' different types of machines.

The order in which these machines are to be used for processing each job is given; e.g. each job is processed through machines A, B, and C in that order.

Also the processing time for each job on each machine is known.

The problem is to optimize the total time or cost of execution, within a technologically feasible sequence of carrying out a job. A job may require the sequence A➔B➔C and another job may require a sequence B➔A ➔C.

We can determine the effectiveness for a given sequence of jobs at each of the machines and we wish to select from the innumerable theoretically feasible alternatives, the one which is both technologically feasible and optimizes the effectiveness measure; e.g. minimizes the total elapsed time from the start of the first job on the first machine to the completion of the last job on the last machine as well as idle time of machines.
If there are 4 jobs and 5 machines i.e. n=4 and m=5, the total number of theoretically possible different sequences will be $(4!)^5$ = 7,962,624 possible sequences.

Obviously it is not practical to handle such voluminous computations. The sequencing model reduces the burden of this labor.

12.05.01.02 Job shop with Several Machines and a Dynamic List of Jobs

The second group of problems deals with job shops having a number of machines and a big list of jobs to be performed. The list of jobs also keeps changing as some orders are

executed and some new orders flow in. When a job is completed on one machine the next job has to be loaded on the same machine under these conditions. This is a complex situation and any analytical method is not feasible. We need to follow some empirical rules to find a near optimal solution.

12.05.02 Examples

12.05.02.01 Example 'n' jobs on one machine

The following scheduling data is available:

Job	Processing time (days)	Due date (days hence)
A	2	7
B	4	6
C	3	5
D	1	2
E	6	6

We can follow the following priority rules:

1. First Come First Served basis (FCFS).
2. Shortest Operation Time (SOT); Load the job with shortest operation time.
3. DDATE basis; Run the job with earliest due date first.
4. Slack Time remaining (STR); STR = Difference between time remaining to due date and the remaining process time; Load the job with the least slack time remaining.
5. Critical Ratio (CR); It is the ratio between time remaining and the work remaining. CR = [Due date – Today's date] ÷ [Remaining process time];

   Load the job with least CR first.
6. Last Come First Served basis (LCFS).

7. Longest Processing Time (LPT); Load the job with LPT first.

We can work out the starting and finishing dates for all the jobs by following each of the above methods and arrive at an average delay in execution of the jobs A, B, C, D, and E with respect to due-dates. Comparison of results from different methods is as under:

Scheduling Method	Sequence	Average Delay (Days)
FCFS	A-B-C-D-E	4.4
SOT	D-A-C-B-E	3.0 * (Least Delay)
DDATE	D-C-B-E-A	3.8
STR	E-D-B-C-A	5.8
CR	E-B-C-D-A	6.8
LCFS	E-D-C-B-A	5.6
LPT	E-B-C-A-D	7.0

SOT basis (Running the job with shortest operation time first) is found to be an optimal solution i.e. minimizing the average delay in execution of the jobs.

Likewise, similar methods have been devised in the following situations:

‘n’ jobs and 2 machines (each job having same sequence of processing)

‘n’ jobs and 2 machines (each job having different sequence of processing)

‘n’ jobs and ‘m’ machines.

The situation becomes more complex as the number of jobs and the numbers of machines get larger.

12.05.02.02 ‘n’ jobs on 2 Machines (Process times / days are given in the matrix)

Job	Machine 1	Machine 2
A	5	2

B	1	6
C	9	7
D	3	8
E	10	4

We find that the sequence B➔D➔C➔E➔A is optimal - (Methodology is not shown here)

12.05.02.03 'n' jobs on 'm' Machines [Process times (hours) are given in the matrix]

Job	Machine A (Cutting)	Machine B (Planing)	Machine C (Lathe)	Machine D (Milling)	Machine E (Grinding)
1	4	3	7	2	8
2	3	7	2	8	5
3	1	2	4	3	7
4	3	4	3	7	2

In this case we follow a heuristic method as it is not possible to devise a mathematical model, the situation being very complex. The heuristic method is enumerated below.
In this method we define Job Value (JV) for each job.

JV = $\{k \div [$ Min of (Duration on station 1+Duration on station 2)], (Duration on station 2 + Duration on station 3), … (Duration on station m-1 + Duration on station m)$]\}$

Where k = +1 if duration on first station is larger than the duration on last station and k= -1 if duration on first station is less than duration on last station.
In case of a tie, compare duration on second station with duration on second last station and so on.

Now let us evaluate Job Values for all the jobs.

JV of Job1 = $\{(-1) \div [\text{Min } (4+3=7), (3+7=10), (7+2=9), (2+8=10)]\} = -1/7$

Likewise we calculate:
JV of Job2 = - 1/9
JV of Job3 = - 1/3

JV of Job4 = +1/7

Sequencing the jobs in increasing order of job value we get the following optimal solution.

Job3 ➔ Job1 ➔Job2 ➔Job 4

12.06.00 Dynamic Programming

12.06.01 Introduction

While considering the situations of allocation, transportation, assignment, scheduling and planning, it was assumed that the values of decision variables do not change over the planning horizon. The problems were static in nature and were solved as specific situations at a given point of time. However, there could be a number of situations where the decision variables vary with time, and these situations are considered dynamic in nature. The technique of dealing with such situations is called dynamic programming. Any multistage situation in which a series of decisions are to be made is considered a dynamic programming problem. In optimization problems involving a large number of decision variables or inequality constraints, it may not be possible to use the methods of calculus for obtaining a solution. The natural method is to split up the original large problem into small sub-problems involving fewer variables. This process is called dynamic programming. The outcome of the decision at one stage affects decisions at the remaining stages.

12.06.02 Characteristics of Dynamic Programming

1. It involves a multistage process of decision making.
2. The out come of decisions in ach stage depend on a small number of variables.
3. A stage decision does not alter the number of variables on which the outcome depends, but only changes the numerical values of these variables. No variable is dropped or added.
4. An optimal policy (a sequence of decisions) has the property that whatever the initial state and decisions are, the remaining decisions must constitute an optimal policy with regard to the state resulting from the first decision. It is implied that wrong decisions taken at any stage do not prevent optimal decision making for the remaining stages.
5. Recursive equations (involving a process that continues to be repeated again and again) are developed to take optimal decision at each stage. A recursive equation expresses subsequent state conditions and it is based on the fact that

a policy is optimal if the decision made at each stage results in overall optimality over all stages.

6. Dynamic programming provides a systematic procedure wherein starting with the last stage of the problem and working backwards one makes an optimal decision for each stage of the problem.

12.06.03 Dynamic Programming Approach

The first concept is stage.
The problem is broken into sub-problems and each sub-problem is referred to as stage. A stage signifies a portion of decision problem for which a separate decision can be made. At each stage there are a number of alternatives and decision making process involves the selection of one feasible alternative which may be called stage decision. The stage decision may not be optimal for the considered stage, but contributes to make an overall optimal decision for the entire problem.

Procedure of Dynamic Programming:

1. Define the problem variables, determine the objective function and specify the constraints.

2. Define the stages of the problem. Determine the state variables whose values constitute the state at each stage and the decision required at each stage. Specify the relationship by which the state at one stage can be expressed as a function of the state and decisions at next stage.

3. Develop the recursive (involving a process that continues to be repeated again and again) relationship for the optimal return function which permits computation of the policy at any stage. Decide whether to follow the forward or the backward method to solve the problem. Specify the optimal return function at stage-1, since it is generally somewhat different from the general optimal return function for the other stages.

4. Make a tabular representation to show the required values and calculations for each stage.

5. Find the optimal decision at each stage and then the overall optimal policy. There may be more than one such optimal policy.

12.06.04 Formulation of Dynamic Programming Problems

Consider a situation wherein a certain quantity 'R' of a resource (such as men, machines, material, money, moments etc) to be distributed among 'n' number of activities. The return 'P' depends upon the activities and quantities of resources allocated to them and the objective is to maximize the total return.

If $P_i(R_i)$ notes the return from the ith activity with the resource R_i, then the total return may be expressed as :

$P(R_1, R_2, \ldots R_n) = P_1(R_1) + P_2(R_2) + \ldots + P_n(R_n)$. ….Equation-1

The quantity of resource R is limited, it give rise to the constraint:

$R = R_1+R_2+\ldots..+R_n$, $R_i \geq 0$, $i= 1,2,\ldots..n$. Equation-2

The problem is to maximize the total return given by Equation-1 subject to constraints in Equation-2.

12.06.05 Applications of Dynamic Programming

Following are some examples of dynamic programming application.

12.06.05.01 Allocation of resources: e.g. allocation of sales persons to different zones to maximize sales of a company

Example: A company has divided area of operations into 4 zones (East, West, North, and South). The amount of sales is dependent on the number of sales persons deployed in a zone. The company has collected data over the past few years regarding sales volume vs. number of sales persons deployed in these zones (ranging from 0 to 20 sales persons in a zone). The problem is to decide on allocation of these salesmen to these 4 zones to maximize the sales of the company, having only a total of 20 sales persons.

12.06.05.0 2 Selection of advertisement media to maximize exposure in the market

Example: A consumer product company is interested in selecting the advertising media for its product and the frequency of advertizing in each media. The company has collected past data regarding the frequency of advertising per week in media types (TV, Newspapers, and radio) vis-à-vis and the related sales. Cost per advertisement for different media types is known. The problem is to determine the optimal combination of advertising media and the advertising frequency, given the total budget provision.

12.06.05.03 Capital budgeting to maximize returns on investment

Example: A company has several product lines. The company has data on the cost of capital investment vis-à-vis returns expected in each of the product lines. The problem is to allocate the amount of money to be invested – out of the total capital budget of the company – to each of these product lines to yield maximum returns for the company.

12.07.00 Decision Theory

A systematic analysis of problems helps managers to plan, organize, and control the operations. Decision-making is the process of selection from among various alternative courses of action.

Decision making process: Steps involved are:

1. Recognition of a problem.
2. Identification of alternatives.
3. Selection of criteria for decision-making.
4. Identification of variables involved.
5. Measurement of impact of the variables on the organization.
6. Evaluation of alternatives using modeling techniques.
7. Selection from among the alternatives / Decision-making.
8. Implementation of the decision.
9. Obtain feedback after implementation.
10. Modify the decision if need be.

This subject had been dealt with in detail in an earlier chapter under the sub-chapter titled **"Decision Making"** under the main chapter titled **"Production and Operations Management".** Please refer to this chapter for relevant details.

12.08.00 Queuing Models

12.08.01 Introduction

Waiting lines are or queues are all-pervading. Businesses of all types, schools, hospitals, restaurants, banks, post offices, theatres, railway reservation counters, seaports, airports – all have queuing problems.
Waiting line problems arise when there is too much of demand on facilities in some situations stated above. Operations research can effectively analyze such queuing or congestion phenomena. An understanding of queuing theory is required to tackle such problems.

The basic characters of queuing phenomena are:

1. Units arrive at regular or irregular intervals, at service centers such as ships arriving at port, passengers arriving at ticket booking counters, diners waiting for tables at restaurants etc…
2. One or more service channels / counters are available at the service centers. The waiting time for a service depend on the length of the queue and the number of service channels / counters. Waiting time increases with increasing demand at a limited number of service channels / counters.

Terminology:

Customer: The arriving unit that requires some service to be performed.

Queue: The number of customers waiting for service.

Service channel: The facility performing the service.

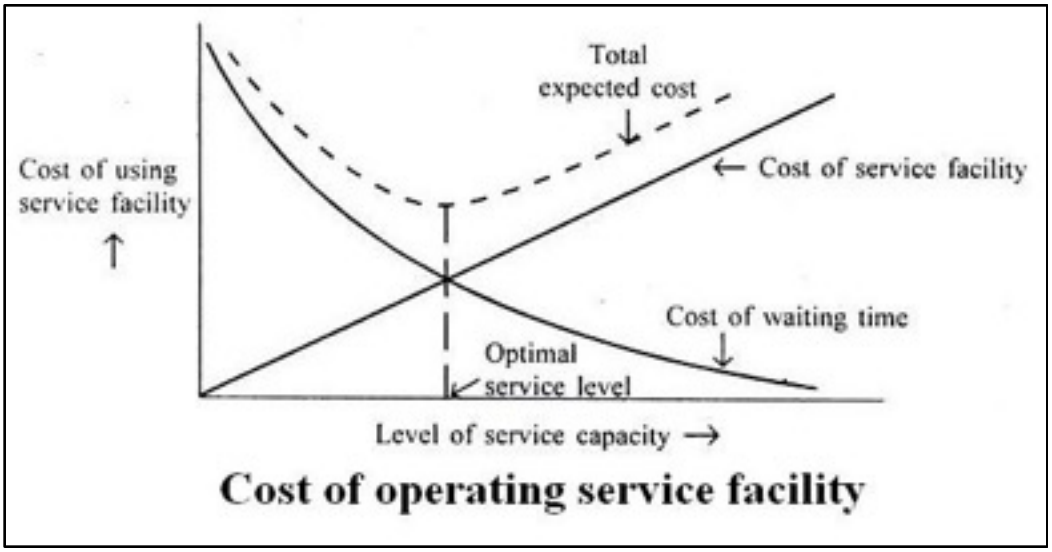
12.08.02 Elements of a Queuing System

A queuing system is specified by 7 main elements:

1. Input or arrival distribution pattern: Inter-arrival time pattern.
2. Output or departure distribution pattern: Inter-departure time pattern or service time.

3. Service channels: Single or multiple channels of service.
4. Service discipline: First come first served basis or priority customers given preferences.
5. Maximum number of customers allowed in the system.
6. Calling source generating arrivals or population.
7. Customer behavior viz. customers not joining log queues, impatient customers leaving a queue, restless customers switching parallel queues etc…

12.08.03 Optimal Service Level



Cost of service includes cost of investment in labour and facilities.
Cost of waiting time includes the cost of loss in business, or loss of repeat customers.
The above graph indicates the optimal service level required.

12.08.04.00 Classification of Queuing Models

12.08.04.01 Probabilistic Model

Random / Discrete arrivals follow Poisson distribution. Poisson distribution pattern has been enumerated in the chapter titled “Business Statistics”. Poisson distribution is a

discrete probability distribution which predicts the number of arrivals in a given time interval. The Poisson distribution involves the probability of occurrence of an arrival.

12.08.04.02 Deterministic Model

Inter arrival and service times are fixed and known with certainty.

12.08.04.03 Mixed Queuing Model

Here arrival time follows Poisson distribution and service time is deterministic.

12.08.05 Example

On an average, 6 customers reach a telephone booth every hour to make calls. Determine the probability that exactly 4 customers will reach in half an hour period assuming that arrivals follow Poisson distribution pattern.

[illegible] = Mean arrival time = 6 customers per hour.
t = 0.5 hour
n = 4
[illegible]t = 6x0.5 = 3 customers

The probability of 4 customers arriving in 0.5 hour
= $[(\lambda t)^{n} \cdot e^{(-\lambda t)}] \div n!$
= $[(3)^{4} \cdot e^{-3}] \div 4!$
= 81x0.0498 / 24

Probability that exactly 4 customers will reach in half an hour period = 0.168.

12.09.00 Replacement Models

12.09.01 Introduction:

All industrial equipment gets worn out with passage of time and usage and it functions with decreasing efficiency. Quite often repair / maintenance cost increase with usage and time and it become more economical to replace the entire item. It is therefore necessary to monitor the cost of maintenance vis-a-vis the cost of replacement in order to take an optimal decision on replacement at appropriate time.

12.09.02 Group Replacement Policy

Quite often a system consists of a large number of identical, low cost items which are more and more likely to fail. The labor cost of individual replacement may be more expensive than the item itself. It may be economical to replace all such items at fixed intervals. Such a policy of replacement is called group replacement policy and is particularly suitable when the cost of individual items is comparatively small.

Some examples are:

- Replacement of street light bulbs.
- Replacement of bearings and oil seals in a machine.

Thus, in these situations there is a need to formulate a replacement policy to determine the frequency of group replacement. This is done by comparing the cost of individual part replacement on actual failure over a period of time vis-à-vis the cost of group replacement.
The solution to optimize group replacement can be worked out based on the probability of failure of the individual items vs. the period of usage.

12.09.03 Methodology

Replacement of items whose maintenance and repair costs increase with time:
Let us first consider a simple situation which consists of minimizing the average annual cost of equipment whose maintenance cost is a function increasing with time and whose scrap value is constant. The calculation is based on average annual cost.
Given below is the derivation of the applicable formula.
Let C = Capital cost of the item,

S = Scrap value of the item,
T_{ave} = Average annual total cost of the item,
n = Number of years the item is to be in use,
$f(t)$ = Operating and maintenance cost of the item at time t.

Annual cost of the item at any time t = Capital cost – Scrap value + Maintenance cost at time t.

Now total maintenance incurred during n years = $\int_0^n f(t)dt$.

Total cost incurred during n years, TC = C-S+$\int_0^n f(t)dt$.

Average annual cost incurred on the item,
ATCn =$\frac{1}{n}\left[\text{C-S+}\int_0^n f(t)dt\right]$

It is desired to find the value of n for which ATCn is minimum.
Differentiating ATCn w.r.t. n we get:

$\frac{d}{dn}$ (ATCn) = -1/n^2(C-S) -1/n^2 $\int_0^n f(t)dt$ +$\frac{1}{n}f(n)$

For $\frac{d}{dn}$ (ATCn) = 0

We get $f(n)$ = $\frac{1}{n}\left[\text{C-S+}\int_0^n f(t)dt\right]$ = ATCn

Thus the item should be replaced when the average annual cost to date becomes equal to the current maintenance cost. Using the result we can decide when to replace an item provided an explicit expression is given for the maintenance and repair costs

12.10.00 Inventory Models

12.10.01 Introduction

An inventory consists of usable but idle resources such as men, machines, materials etc. When resource is material, the inventory is called stock.

12.01.01.01 The total inventory comprises:

1. Stock in stores.
2. Work-in-process.
3. Stock in transit.
4. Stock on order.

12.10.01.02 Holding inventory involves the following costs:

1. Cost of money locked up in inventories (Interest etc…)
2. Storage cost (including cost of preservation, cost of storage facilities, cost of record-keeping etc…)
3. Cost of deterioration of material on long storage (e.g. Rusting of material etc.)
4. Cost of pilferage.
5. Obsolescence cost (Some of the material stored for long may turn out be obsolete due to technological / design changes etc…)
6. Ordering cost (including cost of administration, inspection, material handling etc…

12.10.01.03 Maintaining inventory is necessary for the following reasons:

1. To maintain uninterrupted production.
2. To provide timely service to the customers.

3. To achieve economical batch production of components.
4. To comply with minimum order quantity stipulations by suppliers.
5. To counter the uncertainties in the rate of material consumption.
6. To handle the fluctuating demand for the product etc…

12.10.02 Inventory Models

This subject has been dealt with earlier under the chapter titled “Production and Operations Management” with sub-title “Supply Chain Management”.
Please refer to this chapter for details.

12.11.00 Simulation Techniques

12.11.01 Introduction

The technique of simulation has long been used by designers and analysts in physical sciences. Scale models of machines are used to simulate the plant layout and airplanes are tested in wind tunnels to assess the aerodynamic characteristics. It has become an important tool in dealing with complicated problems of managerial decision-making. Simulation determines the effect of a number of alternate policies without disturbing the real system. It helps in selecting the best policy with prior assurance of success. Simulation is an imitation of reality. This imitation of reality which may be in a physical form or in the form of mathematical equations is called *simulation.*

12.11.02 Merits of Simulation Techniques

1. We can test a hypothesis with out disturbing the real system.
2. It is useful when a situation is so complex that it defies any mathematical analysis / model.
3. We can foresee the problems that might be encountered while implementing a new policy.
4. Simulation technique is free from complicated mathematics and easily understood and used by managers.
5. Simulation techniques are usually flexible and can be adapted to suit changing environmental conditions of the real situation.
6. Computer simulation can compress the performance of a system over several years into a few minutes of processing by computers.
7. Simulation is useful in training of personnel without laying hands on the real system which could be risky. Even experienced persons such as airlines' pilots can use simulation techniques for practicing.

12.11.03 Demerits of Simulation Techniques

1. Simulation can not produce optimal results.

2. Simulation can not handle too many variables.
3. Quantification of variables that affect the behavior of a system is difficult.
4. It may not always be cheap. It requires fast and expensive computers.

12.11.04 Application of Simulation

Simulation is quite versatile and commonly applied technique for solving decision problems.

12.11.04.01 Industrial Applications

- Design of computer systems.
- Inventory control.
- Design of queuing systems.
- Communication networks.
- Scheduling of industrial processes.

12.11.04.02 Business and Economic Problems

- Customer behavior.
- Price determination.
- Economic forecasting.
- Portfolio selection.
- Capital budgeting.

12.11.04.03 Social Problems

- Population growth.
- Environmental effects.
- Group behavior.

12.11.04.04 Defense Problems

- War strategies and tactics.
- Design of weapon systems

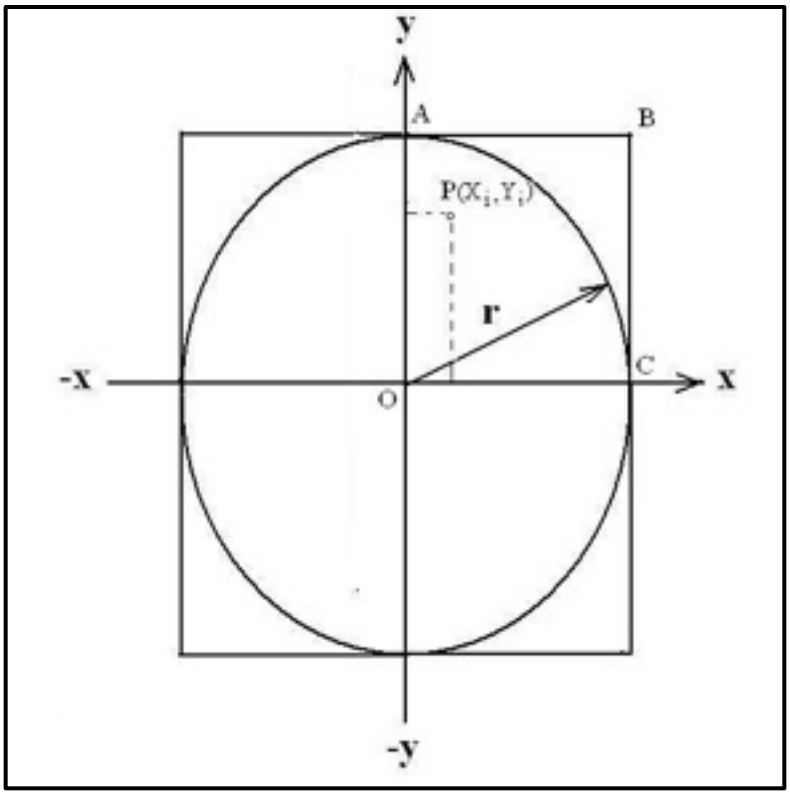
12.11.05 Monte Carlo Simulation

The technique employs random numbers and is used to solve problems that involve probability and wherein physical experimentation is impracticable and formulation of mathematical models is impossible. It is a method of simulation by sampling technique.

The steps involved in carrying out Monte Carlo Simulation are:

1. Select the measure of effectiveness of the problem (objective function). It is to be either maximized or minimized; e.g. it may be idle time of service facility in queuing problem or the number of shortages in an inventory control problem.
2. Identify the variables that affect the measure of effectiveness significantly; e.g. it may be the number of facilities in a queuing problem.
3. Determine the cumulative probability distribution of each variable selected in step-2. Plot these distributions with values of the variables along X-axis and cumulative probability values along the Y-axis
4. Get a set of random numbers.
5. Consider each random number as a decimal value of the cumulative probability distribution. Enter the cumulative distribution plot along the Y-axis. Project this point horizontally till it meets the distribution curve. Then project the point of intersection down on the X-axis.
6. Record the value (or values if several variables are being simulated) generated in the previous step-5. Substitute in the formula chosen for measure of effectiveness and find its simulated value.
7. Repeat the previous 2 steps 6 &7 until sample is large enough to the satisfaction of decision maker.

This section uses an example to demonstrate the Monte Carlo technique. The objective of the example is to emphasize statistical nature of simulation experiment.



Equation of the circle: $x^2 + y^2 = 1$

Radius = 1 inch
Area of the square = 1x1 = 1 Sq inches.

Select any two random numbers, say 0.2068 and 0.7295.

Let **X**1 = 0.2068 and **Y**1= 0.7295.

Similarly select several pairs of random numbers without repetition and determine several points with coordinates Xi and Yi in the rectangle ABCO (containing the quarter circle).

If $x^2 + y^2 = 1$, the point lies within the quarter circle

If $x^2 + y^2 > 1$, the point lies outside the quarter circle but within the square ABCO.

In this manner, hundred of pairs of random numbers are selected and it is ascertained whether the points representing them lie in / on the quarter circle or beyond the quarter circle but within the square.

Suppose N is the total number of points, out of which n points lie within / on the quarter circle;

$$\frac{n}{N} = \frac{\text{Area enclosed by the quarter circle}}{\text{Area of the square ABCO}} = \frac{\pi (1)^2}{4} \quad \ldots (1)$$

$$\text{or } \pi = \frac{4n}{N}$$

The accuracy improves with increasing size of the sample size 'N'. We can derive the area of a circle from the area of the square containing it using the ratio $\left[\frac{n}{N}\right]$

12.11.05.02 Application of Monte Carlo Simulation – Queuing Problem

Statement of the problem:

Two persons X and Y work on a two station assembly line handling an item. The distribution of activity times at their stations are tabulated as under:

Time in seconds	Time frequency for X	Time frequency for Y
10	4	2
20	7	3
30	10	6
40	15	8
50	35	12
60	18	9
70	8	7
80	3	3

a) Simulate operation for 8 items on assembly line.

b) Assuming Y must wait until X completes the first item before starting work, will he have to wait to process any of the other seven items? What is the average waiting time of items for Y?

c) Determine the inventory of items between the two stations.

d) What is the average production rate?

Use the following random numbers:

For X – 83, 70, 06,12, 59, 46, 54, and 04
For Y – 51, 99, 84, 81, 15, 36, 12, and 54

Solution – Monte Carlo Simulation:

a) The following table shows the cumulative distribution for X. Eight random numbers given for X are also fitted The serial numbers of the random numbers are shown in parentheses i.e. in order of their occurrence.

Time in seconds	Time Frequency for X	Cumulative Frequency for X	Range	Random numbers fitted In this range
10	4	4	00-03	06(3), 04(8)
20	7	11	04-10	-
30	10	21	11-20	12(4)-
40	15	36	21-35	-
50	35	71	36-70	70(2), 59(5), 46(6), 54(7)
60	18	89	71-88	83(1)
70	8	97	88-96	-
80	3	100	97-99	-

Thus 8 time for X are 60, 50, 10, 30, 50, 50, 50, and 10 respectively (Read from the last column)

Similarly, the 8 times for Yare derived from his cumulative distribution as follows.

Time in seconds	Time frequency for Y	Cumulative Frequency For Y (i)	Cumulative Frequency For Y(to make it 100) (ii) = ix2	Range	Random numbers Fitted in This range
10	2	2	4	00-03	-
20	3	5	10	04-09	-
30	6	11	22	10-21	15(5), 12(7)
40	8	19	38	22-37	36(6)
50	12	31	62	38-61	51(8), 54(8)
60	9	40	80	62-79	-

70	7	47	94	80-93	84(3), 81(4)
80	3	50	100	94-99	99(2)

b) The above times for persons X and Y are used to calculate the waiting time, if any. Data is tabulated as follows.

Item No	Person X		Person Y		Waiting time	Waiting time
	Time-in	Time-out	Time-in	Time-out	On the part of Y	On the part of item
1	0	60	60	110	60	-
2	60	110	110	190	-	-
3	110	120	190	260	-	70
4	120	150	260	330	-	110
5	150	200	330	360	-	130
6	200	250	360	400	-	110
7	250	300	400	430	-	100
8	300	310	430	480	-	120

Thus, person X will have to wait for the remaining seven items.

Average waiting time of items = (0+0+70+110+130+110+100+120) / 8 = 80 Seconds

c) In all there are 6 items waiting between the two stations.

d) Total time taken to process 8 items = 480 Seconds = 8 minutes

- Average production rate = 8/8 = 1 item / minute

12.12.00 Network Analysis – PERT / CPM

12.12.01 Introduction

Basically CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique) are project management techniques.
PERT / CPM or Network Analysis, as the technique is sometimes called, has been developed along two parallel streams, one industrial and the other military.
PERT was first devised in 1958 for the POLARIS missile program by US navy, assisted by Lockheed Missiles Systems and the consultant firm of Booz-Allen & Hamilton. The calculations were so arranged that they could be carried out on the IBM Naval Ordnance Research Computer (NORC) at Virginia.
Planning, scheduling and control are considered to be the basic managerial functions, and PERT / CPM has been rightfully accorded due importance in the literature on Operations Research and Quantitative Analysis. This has also become an essential tool for monitoring progress of a project and evaluation of performance of teams and individuals involved in the project management.

PERT / CPM can answer the following important questions.

1. How long will the entire project take to be completed?

2. What are the bottlenecks?

3. Which are the critical activities or tasks in the project which can delay the entire project if they were not completed in time?

4. Is the project progressing as per schedule, behind schedule, or ahead of schedule?

5. What is the crash-cost vs. benefits if we need to speed up the project?

12.12.02 Framework for PERT / CPM

The procedure of the technique is enumerated as follows:

1. Define the project and all the significant activities involved in completion of the project.

2. Develop relationship among all the activities. Decide which activities must precede and which must follow others.

3. Draw a network connecting all the activities. Each activity must have unique event numbers. Represent activities with arrows and draw dummy arrows with dotted line (having 0 time for the activity) – if required– to avoid giving same numbering to two activities.

4. Assign time and / or cost estimates to each activity.

5. Compute the longest path through the network, which is called critical path.

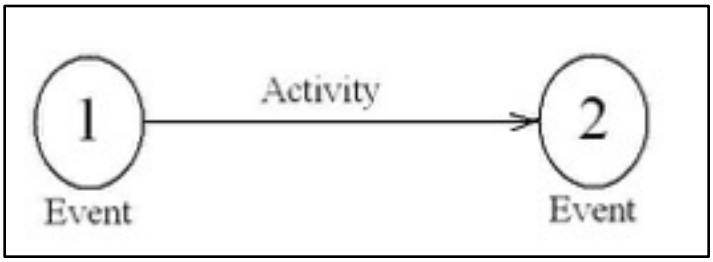
6. Use the network to plan, schedule, monitor, and control the project.

The key concept used by PERT / CPM is that a small set of activities, which make up the longest path through the activity network control the entire project. If these critical activities could be identified, managerial resources can be allocated appropriately so the project could be completed on time.
Some activities are serially linked and some run concurrently.
Preparing a network involves the following questions.

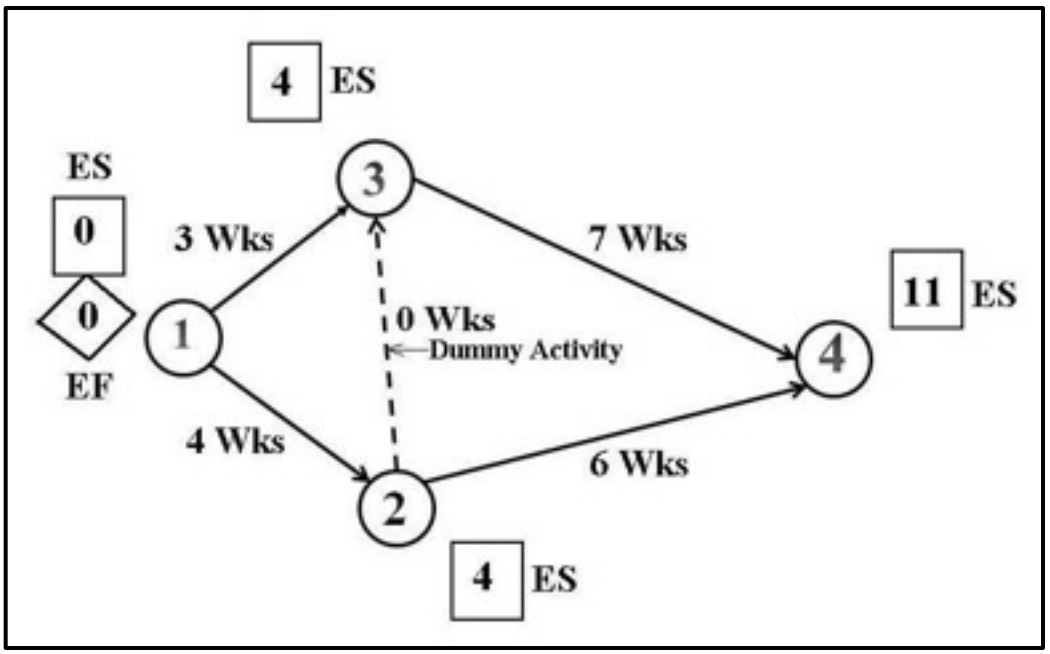
1. Is this a start-activity?
2. Is this a finish activity?
3. What activity precedes this?
4. What activity follows this?
5. What are concurrent activities?

12.12.03 Drawing the PERT / CPM Network

Each activity in a PERT / CPM Network is represented by an arrow symbol. Each activity is preceded and succeeded by an event, represented as a circle and numbered.



ES_i = Earliest starting time of event 'i'
EF_i = Earliest finishing time of event 'i'
LS_i = Latest starting time for event 'i'
LF_i = Latest finishing time of event 'i'
$FLOAT_i = LS_i - ES_i$



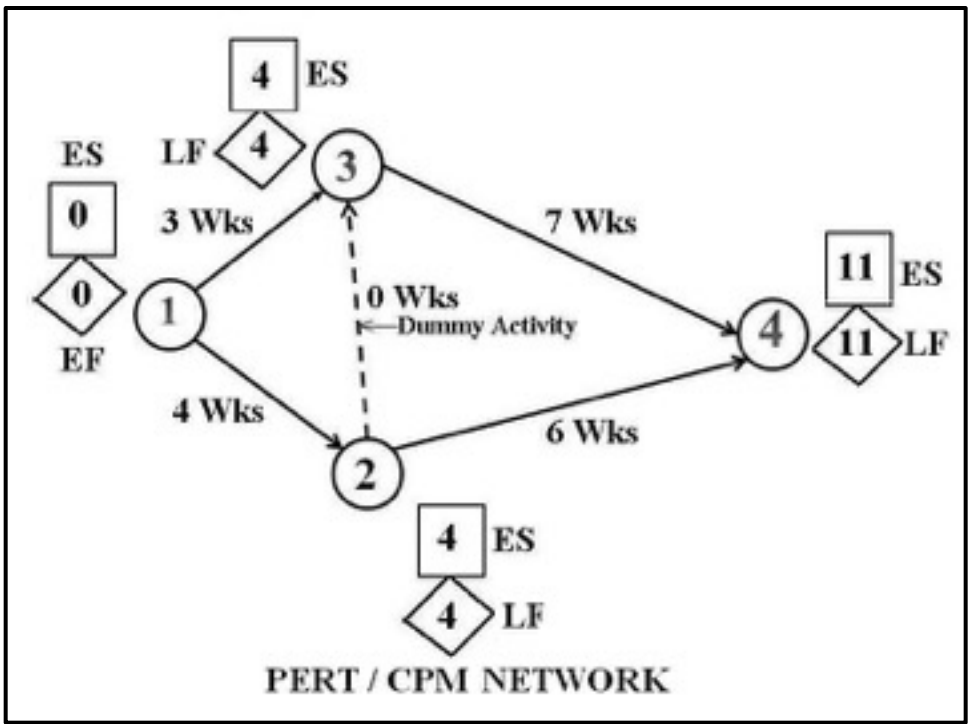
At event 3, we have to evaluate two predecessor activities. Both activity 1-3 and activity 2-3 are the predecessor activities. Activity 1-3 gives us an earliest start of 3 weeks on event 3. However; activity 2-3 also has to be completed before the event 3 can begin. Along this route, the earliest start would be 4+0 = 4. The rule is to take the longer of the two earliest starts. So the earliest start at event 3 is 4 weeks.
Similarly, at event 4, we find w have to evaluate two predecessor activities viz. activity 2-4 and activity 3-4. Along activity 2-4, the earliest start at event 4 would be 10 weeks,

but along activity 3-4, the earliest start at event 4 would be 11 weeks. We have to select the longer of the two, which is 11 weeks.

We have now found the longest path through the network. It will take 11 weeks along activities 1-2, 2-3, and 3-4. This is the critical path. (1-2-3-4)

The backward pass- Latest Finish rule:

To make the backward pass, we begin at the sink or the final event and work backwards to the first event.



At event 3, there is only one activity 3-4 in the backward pass, and we find that the value is 11-7 4 weeks. However, at event 2 we have to evaluate 2 activities viz 2-3 and 2-4. We find that the backward pass through 2-4 gives us a value of 11-6=5 weeks while 2-3 gives us a value of 4-0=4. We take smaller value of 4 in the backward pass.

We are now ready to tabulate the various events and calculate the earliest and latest start and finish times. We are also now ready to compute the slack or total float, which is defined as the difference between the latest start and the earliest start times.

Event Col-1	Duration (Wks) Col-2	Earliest Start Col- (ES) Col-3	Earliest Finish (EF) Col-4 (2+3)	Latest Start Col- (LS) Col-5 (6-2)	Latest Finish (LF) Col-6	Total Float (Slack) (LS-ES) Col-7
1-2	4	0	4	0	4	0
2-3	0	4	4	4	4	0
3-4	7	4	11	4	11	0
1-3	3	0	3	1	4	1
2-4	6	4	10	5	11	1

The earliest start is the value in the rectangle near the tail of each activity.
The earliest finish = Earliest start + Duration
The latest finish is the value in the diamond at the head of each activity.
The latest start = Latest finish – Duration.
Total float = Latest start – Earliest start
Note: Activities with zero float are on the critical path.
Free float is the spare time available when all preceding activities occur at the earliest possible times and all succeeding activities occur at the earliest possible times.
When an activity has zero total float, free float also will be zero.

12.12.04 The PERT – Probabilistic Approach

So far we have discussed about projects, where there is high certainty about the outcomes of activities. This is true in many engineering projects with some exceptions. However, in many projects such as R&D, Social Projects etc, we can not be sure of the activity timings.

In such cases PERT approach is useful, because it can accommodate the variation in event completion times, based on an expert's estimates / opinions.

For each activity, three time estimates are considered in such situations.

t_o = The most optimistic time

t_m = The most likely time

t_p = The most pessimistic time

The duration of an activity is calculated using the following formula derived from statistical theory (Beta Distribution).
Expected Time = $t_e = [t_o + 4t_m + t_p] \div 6$

Standard deviation = $[t_p - t_o] \div 6$

We can draw the network in the same manner using expected times (t_e).

We also can estimate the probability of completion of the project by due date arrived at from the network – critical path.

We can work out the probability as under:

Calculate 'z' value and refer to the standard normal table to read the associated probability figures.

'z' value = $[D - t_e] \div$

Where D = Due Date for which probability is to be found.

t_e = Expected time for completion of the whole project as per the network using activity expected times as per the formula; Expected Time = $t_e = [t_o + 4t_m + t_p] \div 6$

Let us consider the following figures for calculating the probability figure.
Expected time as per the network = 28 days.

We want to estimate the probability of completing the project in 25 weeks.
$z = (25 - 28) / 5 = -0.6$

By looking at the standard normal table, we see that the probability associated with z of -. 6 is 0.274.

Likewise we can calculate the probability of completing the job in 33 weeks.
$z= (33-28) / 5 = 1$

By looking at the standard normal table, we see that the probability associated with z of +1 is 0.84134

The subject of normal distribution had earlier been dealt with, in the chapter titled “Business Statistics”.

Chapter 13
Computer Management and Management Information Systems

13 Computer Management / Management Information Systems (MIS)

A computer lets you make more mistakes faster than any other invention in human history - with the possible exceptions exception of handguns and tequila.

... Ratcliffe, Mitch

Everybody gets so much information all day long that they lose their common sense.

... Gertrude Stein

Index:

13.01.00 A framework for Management Information Systems (MIS)

"What information consumes is rather obvious: it consumes the attention of its recipients. Hence, a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it."
-Herbert Simon

13.01.01 Introduction / Definition

A **management information system** (**MIS**) provides information that organizations require to manage themselves efficiently and effectively. Management information systems are typically computer systems used for managing.
The primary components of an MIS are:

- ➢ Hardware
- ➢ Procedures (design, development and documentation), and
- ➢ People (individuals, groups, or organizations)

MIS is a methodology which involves:

1. Collection, validation and recording of transactional data at operational level.
2. Processing data to provide information needed for monitoring and controlling operations; and allocation of resources at tactical level.
3. Providing information for long term planning at strategic level.

13.01.02 Benefits of MIS

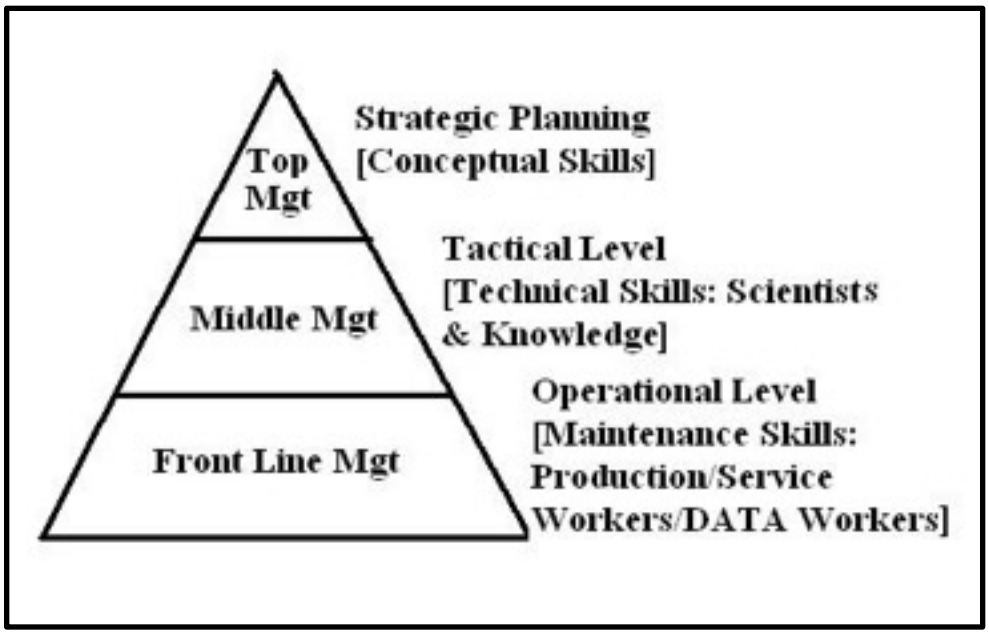
The following are some of the benefits that can be attained using MIS.

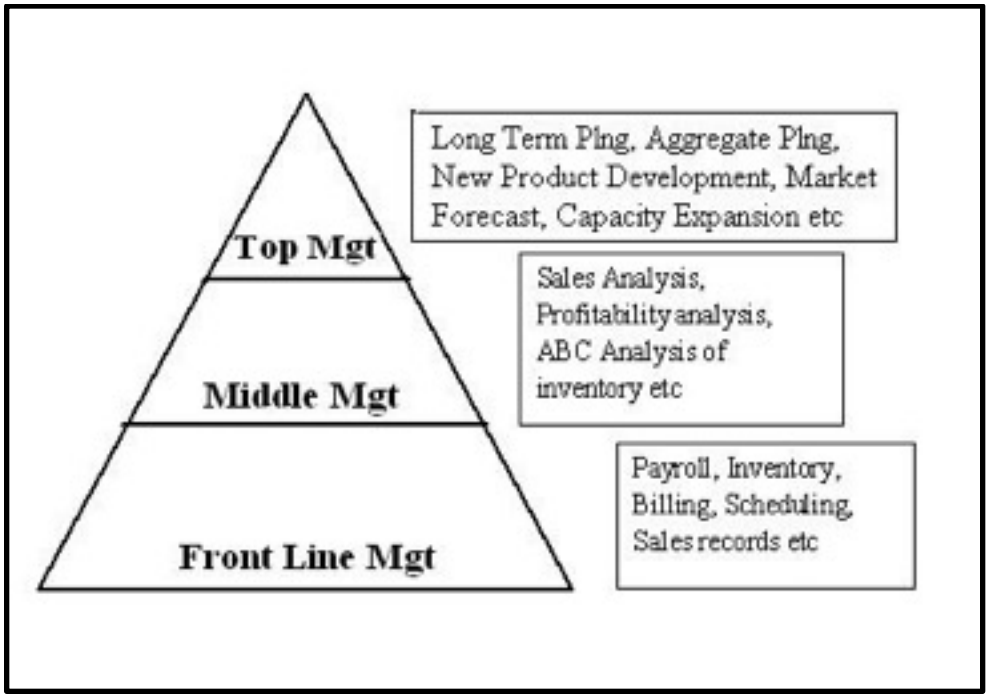
- Companies are able to identify their strengths, weaknesses, opportunities, and threats due to the availability of performance records in all aspects of business. Identifying these aspects can help a company improve its business processes and operations.
- Giving an overall picture of the company.
- Acting as a communication and planning tool.
- The availability of customer data and feedback can help the company to align its business processes according to the needs of its customers. The effective

management of customer data can help the company to perform direct marketing and promotion activities.

- MIS can help a company gain a competitive advantage in the market i.e. to do something better, faster, cheaper, or more uniquely than completion.

13.01.03 Levels of Management: THE PYRAMID STRUCTURE





13.01.04 Role of Management at various levels

13.01.04.01 Top Management Role

- Establish goals of the organization.
- Interact with external environment … e.g. Financial Institutions, Government, and Politicians.
- Long term planning e.g. Capacity expansion, Investments.
- Formulate strategies to achieve goals. Service policy, replacement policy etc…
- Introduction of new products.

13.01.04.02 Middle Management Role

- Implementation of strategies.
- Allocation of resources to meet objectives.
- Supervision.
- Budgeting.
- Planning.
- Technical support.

13.01.04.03 Front-Line Management Role

Conduct day-to-day routine operations
Machine maintenance, Material handling, Documentation, Billing, Scheduling etc
Each level of Management (TOP, MIDDLE & Front-line) requires specific type of Information.

13.01.05 Operational Systems

Collect, validate and record transactional data. e.g. Production, Finance, sales, personnel data.
Characteristics of operational system:

1. Repetitiveness.
2. Routine.
3. Emphasis on past statistics.
4. Detailed in nature.
5. Internal origin.
6. Highly structured.
7. High degree of accuracy.

13.01.06 TACTICAL SYSTEMS

Provide managers with information needed for monitoring and controlling operations; and allocation of resources.
Transactional data is summarized, aggregated, and analyzed.
Tactical systems generate a variety of reports.

Summary reports. E.g. Important totals (sales/production), averages and statistics.

Exception reports. E.g. High value inventory, Excess inventory.

Ad-hoc reports e.g. Excess overtime, Analysis of a quality problem, safety measures.

The tactical info system is not so much to execute tasks; but to control operations.
Characteristics of tactical system:

1. Periodic in nature. E.g. Overdue out-standings, Weekly sales reports.

2. Unexpected findings: Obsolescence of stocks.
3. Comparative in nature: e.g. Budget vs. Actuals (variance) statement.
4. Summary form: Not very detailed.
5. Info from both internal and external sources.

13.01.07 STRATEGIC Planning Systems

The strategic planning systems are designed to provide top managers, with info that assists them in making long term planning decisions.

When top mgt uses budgeting information to plan long term activities of an organization, budgeting becomes strategic planning activity.

Characteristics of strategic planning systems:

1. Ad-hoc basis-sometimes: E.g. Market info to decide on new product introduction, business expansion (More production capacity, larger distribution network).
2. Unexpected info. E.g. Market survey / change in market behavior.
3. Periodic in nature. E.g. Market forecast.
4. Summary form E.g. Aggregate planning (Total no of cars rather than model-wise breakup).
5. External data. E.g. Demographic info, General economic conditions, Investment opportunities, New technology, Borrowing- sources / rates of interest.
6. Unstructured format and more qualitative. E.g. Opinions of dealers, Buyers.
7. Subjectivity: Decisions based on rumors, discussions with industry observers, discussion with industry personnel.

13.01.08 Role of Information Systems in Business

There has been an enormous investment in IT sector all over the world in 21st Century.

- Cell phones, email, teleconferencing have become essential tools of business.
- 40 million dotcom internet sites were registered in 2005.
- 2005: FEDEX moved 100 million packages, mostly overnight.
- 30 million Americans read BLOGs and 10 million write BLOGs.
- E-Commerce and internet advertisement are booming.
- Online sales are increasing rapidly.
- Globalization of Business demands use of computers and Internet.
- Use of MRP, MRP II, and ERP.
- Application of Operations Research techniques.

- Application MIS for organizational efficiency and performance review.

13.02.00 Systems and organizations

13.02.01 Definition

A system is an integrated set of components or entities that interact to achieve a function or goal.

13.02.02 Characteristics

13.02.02.01 System Boundaries

Boundaries define the scope of activities. The boundary delineates an area of responsibility. E.g.: A planning manager may be responsible for production planning and control. A materials manager may be responsible for procurement, inventory control etc.

13.02.02.02 Systems and Subsystems

A system may comprise many sub systems.
Sub-systems perform specialized tasks related to overall objectives of the total system.
E.g. Purchase system and stores/inventory control system are sub-systems of Materials management.

13.02.02.03 Outputs and Inputs

The data inputs may be processed to produce an output which may comprise information.
E.g. Material transactions viz. material issues and receipt documents may form inputs.
A sock statement may be the output.
A production plan, bill of material, and a stock statement may be inputs to generate an output in the form of material requirement plan (MRP) / shortage lists.

Likewise, a production plan, process times, and machine capacity details may be inputs to produce an output such as capacity planning statement giving details of required machine hours vis-à-vis available hours to plan for in-loading or offloading (sub-contracting.

13.02.02.04 Open and Closed Systems

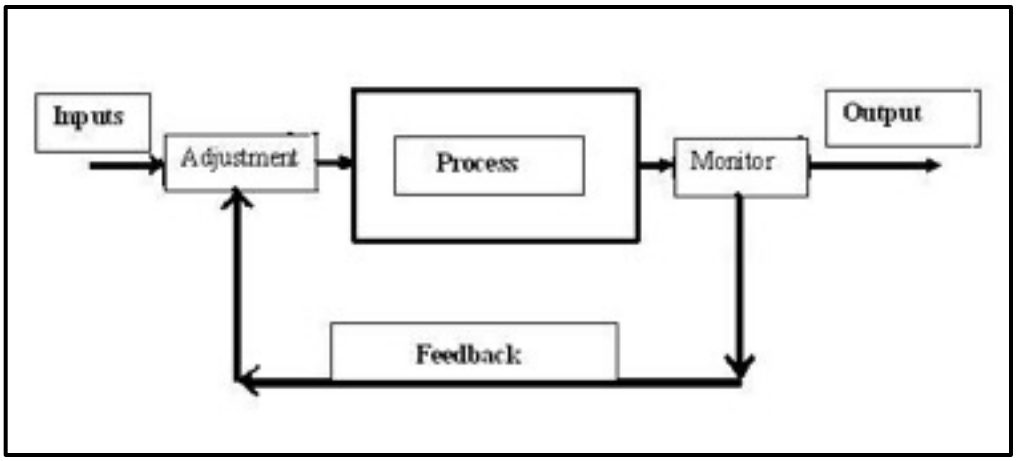
Open systems interact with an external environment: E.g. Online sales.

Closed systems are self contained and do not interact with external environment: An internal staff training program. This may not take in to account, the changes in business environment.

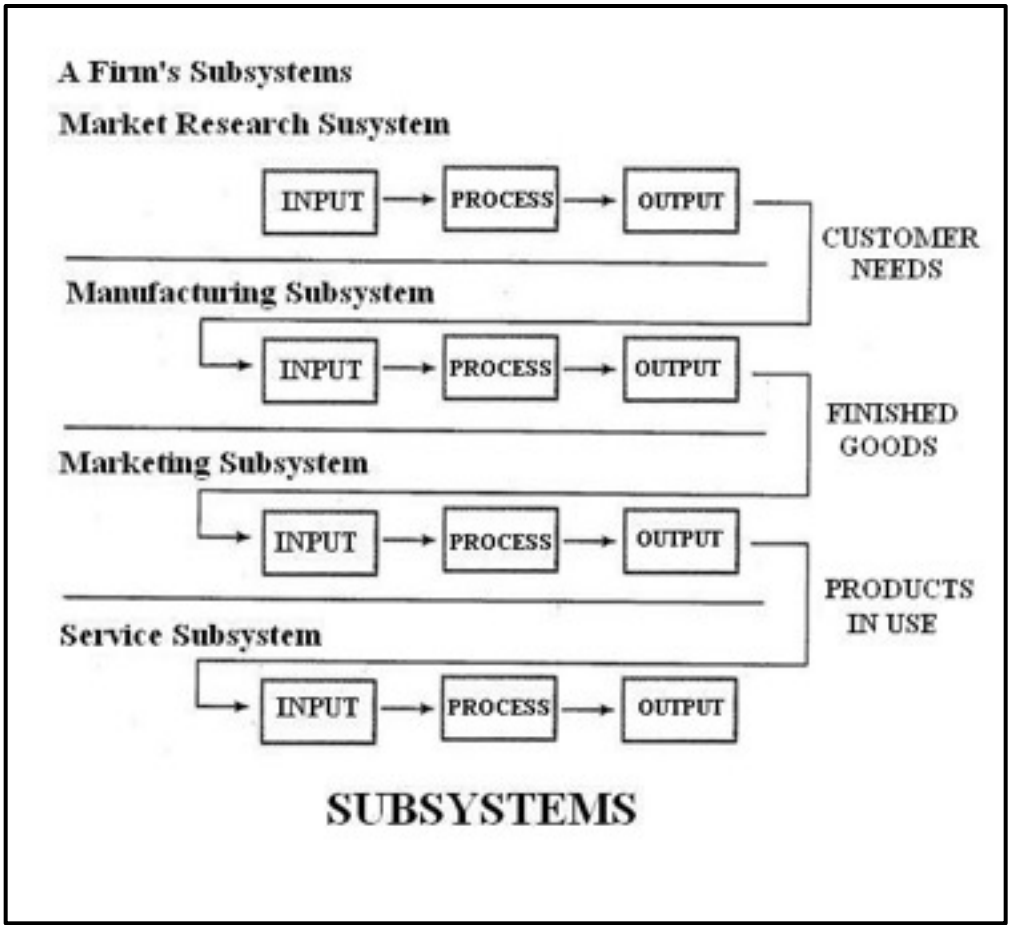
13.02.03 System Feedback

Output is measured with respect to standards and feed back is given regarding variations in order to make corrections to the inputs for achieving prescribed results.

E.g. Production of a component on a machine – Flow Chart:
If there is a dimensional error, tools may be changed to get the desired output.

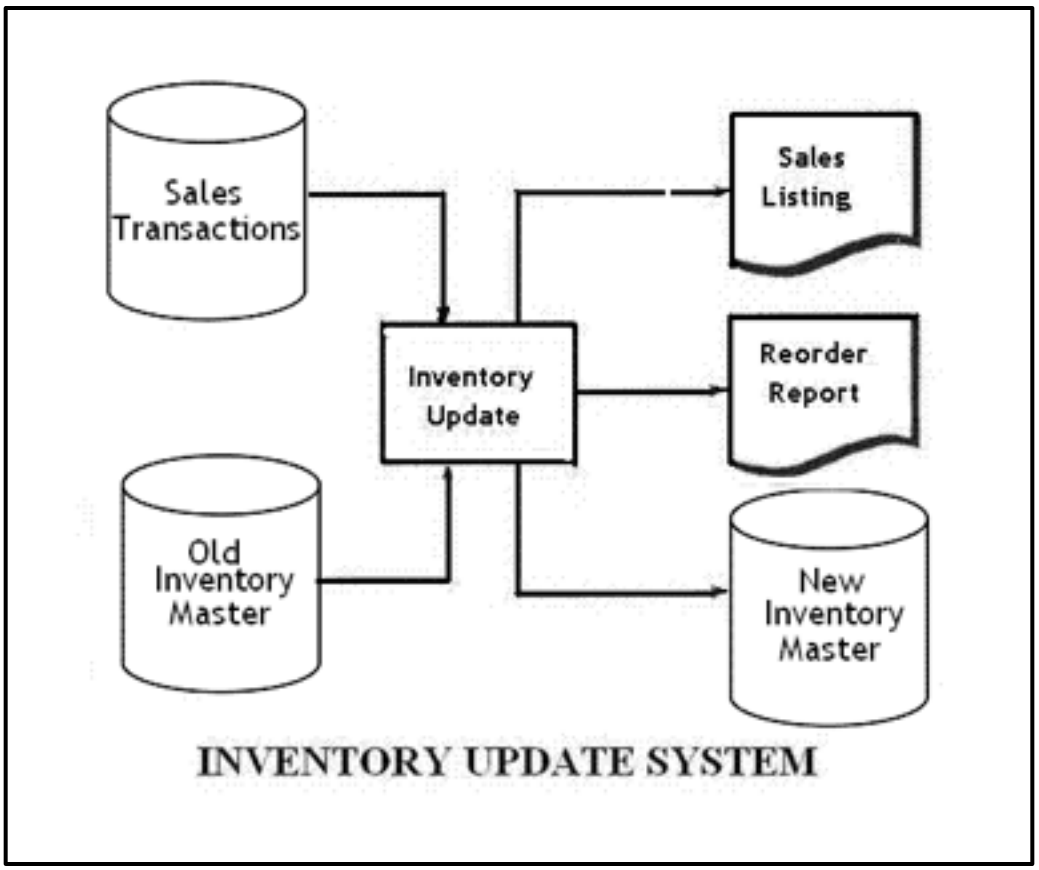


13.02.04 Sub systems



13.02.05 Inputs and Outputs in a Subsystem viz. Inventory Update System.

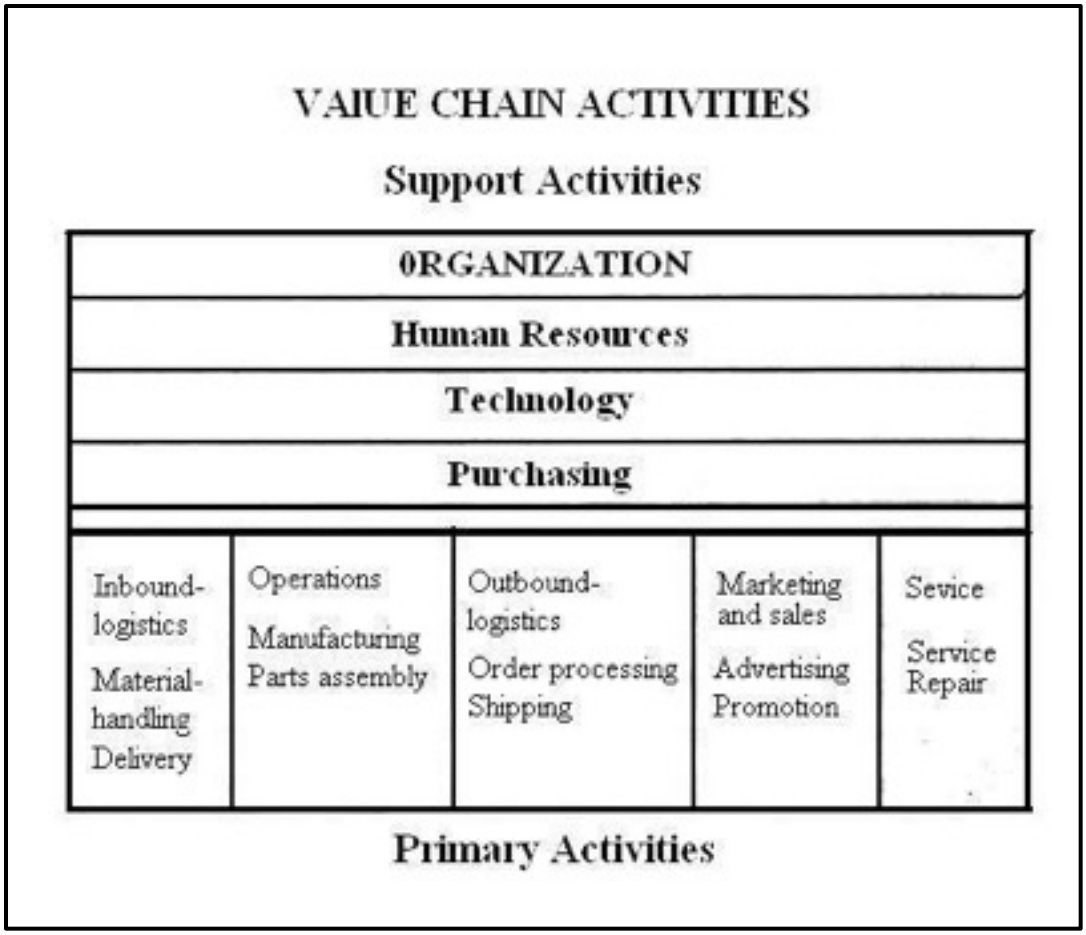
The following diagram shows a system of updating an inventory master file by inputting transactions. Outputs such as sales-listing, reorder-report etc. are generated in the subsystem.



13.03.00 Strategic use of information technology

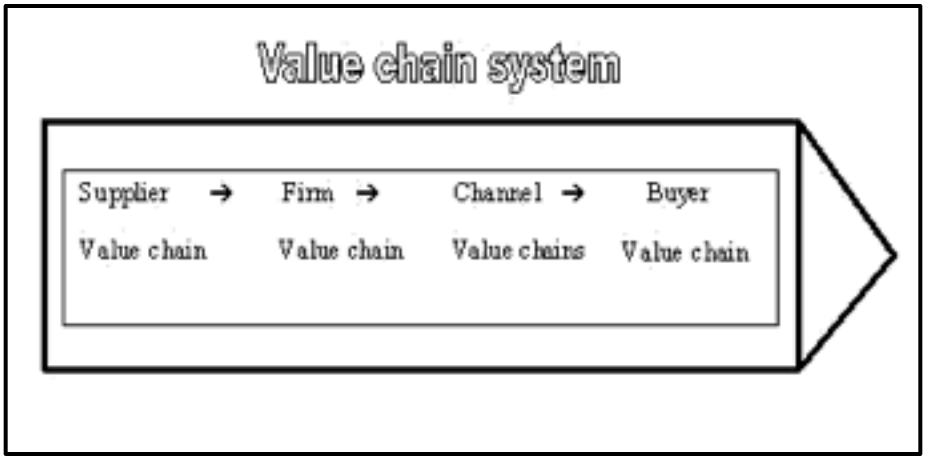
13.03.01 Value Chain

Value chain helps explain which business activities can be analyzed and transformed with IT. The value chain divides a company's activities into value activities, the distinct activities it must perform to do business.
Value activities consist of primary activities and support activities.



The firm's organization, which includes activities such as general management, legal functions, accounting, supports the entire value chain.
The value chain is a system of inter-dependant linkages. The way one activity is performed may affect the other activities in the system. Investment in superior material and expensive product design may reduce after sales service problems.
Value system: includes the value chain of suppliers, of the firm, of the distribution channels, and of the ultimate buyers.

The company's products and services pass through channel value chains, on their way to ultimate buyers. A channel value chain occurs between a supplier and a buyer. E.g. a car dealer, with an MIS system of his own, would be able to locate a particular model in stock anywhere in the region to suit a customer's requirement in terms of specification, color and delivery requirement.



The information system that links suppliers and buyers, manufacturers and distributors; and distributors and buyers are known as;

INTER ORGANIZATIONAL SYSTEM (IOSs):

Each value activity is supported by information processing thro Information Technology.

E.g. Wal-Mart has a system that supports inbound logistics to implement JIT system for items such as toilet papers, pampers to optimize inventories.
The following figure shows how IT supports secondary activities:

Secondary activity	**Use of IT**
Communications	Electronic mail
Human resources	Online skill data base of employees
Technology	CAD, CAM (CNC AND FMC)
Procurement	Online access to supplier's inventory files.

13.03.02 USING Information Technology for Competitive Advantage

Three level effect of IT:

INDUSTRY LEVEL	**IT changes an Industry's:** • Products and services (E.g. Speed of new product introduction, Increasing the speed of distribution, video conferencing in Hotels) • Production economics (E.g.. Distribution network) • Markets (E.g. ATMs, Online Banking etc)
FIRM LEVEL	**IT affects key competitive forces:** Buyers (Vendor data base, SQC) Suppliers (SQC) Substitute products (Development of alternate and superior material at lower cost) New entrants (deter new entrants by creating entry barriers by huge investments and flooding the markets) Rivals (Compete with rivals- E.g. Efficient Airlines reservation system, Cost control, new technology)
STRATEGY LEVEL	**IT supports a firm's strategy:** Low cost leadership (Low cost of Mfr Through JIT systems, CAM / CNC-FMS systems) Product differentiation (Product or service superior to competition) Market specialization (Niche product E.g. Apple I-Pad)

13.04.00 Business Process Reengineering

13.04.01 Overview

Business process reengineering is also known as BPR, Business Process Redesign, Business Transformation, or Business Process Change Management.

BPR seeks to help companies radically restructure their organizations by focusing on the ground-up design of their business processes.

Business process reengineering is also known as BPR, Business Process Redesign, Business Transformation, or Business Process Change Management.

Business Process Reengineering (BPR) is the practice of rethinking and redesigning the way work is done to better support an organization's mission and reduce costs

Business process reengineering (BPR) began as a private sector technique to help organizations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs, and become world-class competitors.

A key stimulus for reengineering has been the continuing development and deployment of sophisticated information systems and networks. Leading organizations are becoming bolder in using this technology to support innovative business processes, rather than refining current ways of doing work.

13.04.02 The role of Information Technology

Information technology (IT) has historically played an important role in the reengineering concept. It is considered by some as a major enabler for new forms of working and collaborating within an organization and across organizational borders.

- Shared databases, making information available at many places.
- Expert systems, allowing generalists to perform specialist tasks.
- Telecommunication networks, allowing organizations to be centralized and decentralized at the same time.
- Decision-support tools, allowing decision-making to be a part of everybody's job..

- Wireless data communication and portable computers, allowing field personnel to work office independent.
- Interactive videodisk, to get in immediate contact with potential buyers.
- Automatic identification and tracking, allowing things to tell where they are, instead of requiring to be found.

13.04.03 Case Studies

BPR, if implemented properly, can give huge returns. BPR has helped giants like General Motors Corporation, DELL Incorporated, Ford Motor Company etc…

General Motors Corporation:

General Motors Corporation implemented a 3-year plan to consolidate their multiple desktop systems into one. It is known internally as "Consistent Office Environment". This reengineering process involved replacing the numerous brands of desktop systems, network operating systems and application development tools into a more manageable number of vendors and technology platform. This saved GM 10% to 25% on support costs, 3% to 5% on hardware, 40% to 60% on software licensing fees, and increased efficiency by overcoming incompatibility issues by using just one platform across the entire company.

DELL Incorporated:

Michael Dell is the founder and CEO of DELL Incorporated, which has been in business since 1983 and has been the world's fastest growing major PC Company. Michael Dell's idea of a successful business is to keep the smallest inventory possible by having a direct link with the manufacturer. When a customer places an order, the custom parts requested by the customer are automatically sent to the manufacturer for shipment. This reduced the cost for inventory tracking and massive warehouse maintenance

Voltas Ltd:

Material handling equipment unit of Voltas Ltd, Mumbai was initially manufacturing most of the components in-house for production of Fork-Lift-Trucks. This involved excessive labor and capital deployment, besides its inability to increase volume of production. The critical / major items viz. gear box, drive Axle, and trail axle were manufactured using conventional machines such as horizontal boring, vertical boring, and

radial drilling machines using elaborate toolings. This process involving too many operations, countless toolings, and excessive set-up time put a limitation on the production capacity besides resulting in long lead-time for deliveries. In a major BPR initiative, it was decided to offload most of the non-critical components to sub-contractors and CNC machines were installed to manufacture the critical / major components. This radical change enabled the company to double the production volume, halve the delivery lead-time, and double the profit.

13.05.00 MRP (Material Requirement Planning) / MRP II (Manufacturing Resources Planning)

13.05.01 MRP

MRP– Material Requirement Planning - is a computer based information system for scheduling production and purchases of dependent demand items.
Economic order quantity models assume that the demand for an item is relatively constant and independent of demand for any other item.
When demand for material-- components and raw material-- is directly dependent upon the demand for other products, notably on production plan for end products, then we say the items have a “dependent demand pattern”.

The basic philosophy and mechanics of MRP are simple. The system assumes that the end-product is made-up of a hierarchy of assemblies, sub-assemblies, components and raw material. Basically, the computer explodes the Bills of material for various products/ main assemblies and generates item wise gross and net material requirement(s) in line with a master production plan for end products/parts. Using end product requirements, product structural data (Bill of Material) and lead time information, the MRP system traces back when assemblies, sub-assemblies, and components must be produced or ordered so that the items are available at appropriate time for further processing/ for subsequent production steps, but no earlier than necessary to avoid excess inventories.

This subject had been detailed in an earlier chapter under the head “Production and Operations Management”.

13.05.02 Illustration of MRP

Basically a material requirement plan – period wise – is generated by MRP system by matching: Production Plan, Product Bill of Material, and Stock in stores / transit.
Given below is a simple illustration of MRP inputs and output. In a practical situation we need to handle huge volumes of data which is made possible by electronic data processing.

INPUT SPECIMENS:

1. Production Plan:

Code	**Description**	**Production Plan Qty**
XXXX	Gear Box	10

2. Bill of Material:

Part Code	Description	**Qty/ Unit**
A	Gear Case	1
B	Gear 01	2
C	Gear 02	2
D	Bearing 01	1
E	Bearing 02	1

3. Inventory Master Data:

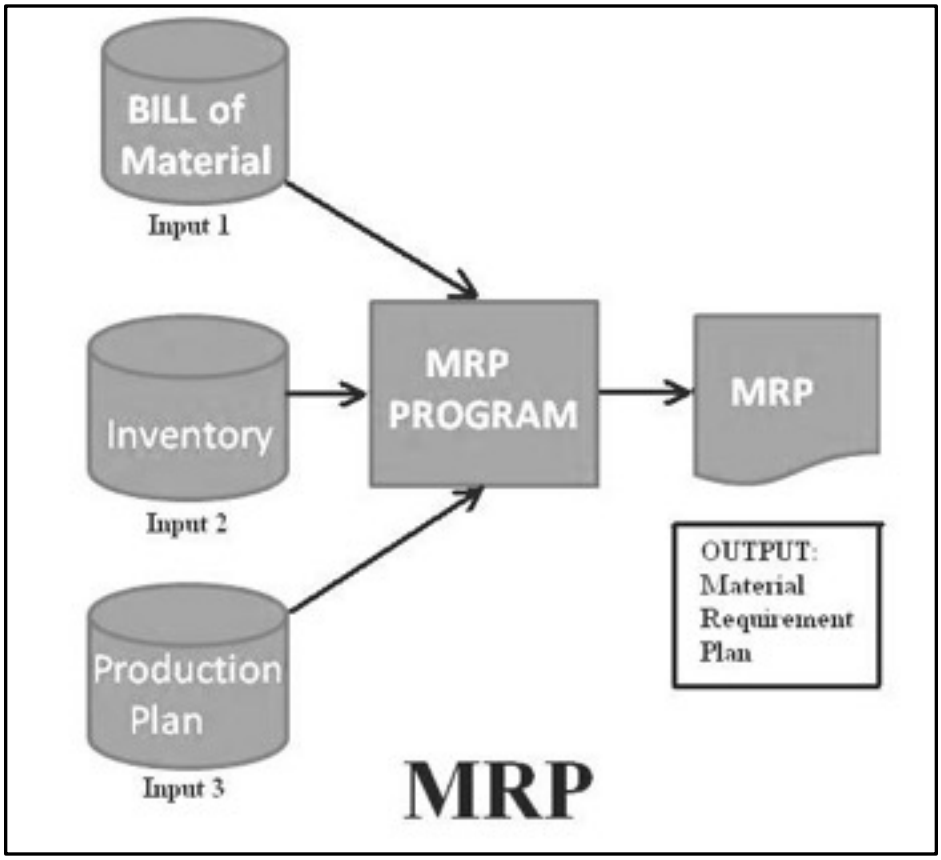
Part Code	**Description**	**Stock Qty**
A	Gear Case	3
B	Gear 01	6
C	Gear 02	10

D	Bearing 01	6
E	Bearing 02	12

MRP OUTPUT SPECIMEN:

Part Code	**Description**	**Gross Reqt Qty**	**Stock Qty**	**Net Reqt Qty Gross Reqt Qty (minus) Stock Qty**
A	Gear Case	10	3	7
B	Gear 01	20	6	14
C	Gear 02	20	10	10
D	Bearing 01	10	6	4
E	Bearing 02	10	12	Nil

The power of computer would be evident when we have a multiple product situation with a dynamic demand pattern, having a complex hierarchy, much commonality of items across various products, and huge volumes of data.
Given below is a systems flow chart for MRP.



13.05.03 Manufacturing Resources Planning (MRP II)

13.05.03.01 Introduction

While MRP that has grown out of traditional production and inventory management does an excellent job of planning for material, it cannot be fully effective in achieving the organizational objectives unless it takes into account all the resources of manufacturing organization.

Therefore, planning for requirement of material has to take into consideration:

- The business plans.
- The financial plans.
- The human resources.
- The available production facilities (Machinery/Equipment).
- The logistics (Shipping etc…)

Because of these needs and considerations there evolved an integrated manufacturing management system called “manufacturing resources planning (MRP II).”

13.05.03.02 Definition of MRP II

MRP II has been defined by “American production and inventory control society” (APICS) as:

“MRP II is a method of effective planning of all resources of manufacturing company. Ideally it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer “What if?” question.

It is made up of a variety of functions each linked together: Business Planning, Production Planning, Master Production Scheduling, Material requirement Planning, Capacity Requirements planning, and the execution system for capacity and priority. Outputs from these systems integrated with financial reports, the business plan, the purchase commitment report, shipping budget, inventory etc.”

13.05.03.03 Role of Information Technology

The advanced Information Technology has made this integration of entire manufacturing function, rather than addressing just a single task within that function in isolation, possible.

13.05.03.04 MRP II Concepts / Modules

The newer system, called MRP II, contain the classical MRP scheduling function as their centerpiece.

MRP II system may include a **module** that collects sales and customer order data and generates an **MPS** (Master Production Schedule), using a **forecast model.**

In addition, an MRP II system may convert information from the material requirement plans into specific work schedules for departments and machines, evaluate department work loads and capacity conditions, generate shipping documents and customer invoices, and produce **management reports on production and financial performance.**

MRP II systems are an expansion of **MRP** to inter connect with and support other activities, but the basic method used to generate material requirement plans is the same. In our earlier examples enumerated in chapter 05 – Para 05.14.06, we have a module that integrates "Material Requirements Plan **(MRP)"** and "Capacity Requirement Plan **(CRP)".**

13.05.04 ERP - Enterprise Resource Planning

This subject is covered in the chapter 05 – Para 05.15.02.01.
The role of computers in MIS made it possible to integrate an enterprise-wide system.

Such an enterprise-wide system of management is known as the "ENTERPRISE REOURCE PLANNING (ERP)"
ERP software is an integrated software program, that allows various functional departments to share information and communicate with each other, on a common platform.

ERP provides a holistic view and enables an organization to look at itself as well as outwards in to the Market, globally.

All the departments in an company viz. production, materials, personnel, finance, sales, marketing etc. that were islands once are effectively interconnected with the introduction of **ERP.**

Let us recapitulate the case study mentioned earlier in Chapter 05 - Para 05.15.04.

13.05.05 ERP Case Study

Let us take the case of an export oriented unit dealing in specialized silk fabric.
When an enquiry for a large order arrives from a foreign country, we need to quote quickly and confirm the order immediately on receipt.
We need to collate the information regarding stock in warehouse, power loom capacity, dying unit's present load and capacity, availability of a particular grade of silk yarn, delivery lead times and capacity of suppliers.
In addition, the price has to be quoted in foreign currency considering price fluctuations for raw material in the international market, the internal cost of production, and the costs of dispatch and delivery. Statutory taxes also need to be considered carefully while quoting and invoicing.
Of course, the price has to be competitive in the international market to bag the order.

On receipt of the order, we also need to take all actions to deliver the consignment(s) in proper time, for credibility as also to secure further orders from the customers in future. Order fulfillment with adequate profit margins is the key success factor.
The whole process of order receipt and order execution has to be carried out in an interactive way.

ERP could make all this possible.

Generally, ERP has a central database and a cross-enterprise interface facility shared by all functions of the enterprise. ERP offers a total solution by virtue of seamless integration across all functions and divisions of an enterprise.
In this case of export of silk fabric, ERP enables us to act promptly at all stages of order execution and take corrective actions when ever required, by virtue of having access to relevant and reliable information, almost instantaneously.
We could monitor progress of order execution closely from start to finish.

13.06.00 DBMS Data Base Management System

13.06.01 Data Management Systems

1) Data dictionary: A data directory contains names and descriptions of all data elements.
2) Data Languages: Programmers use a special language called the data description language (DDL) to describe the characteristics of data elements.
3) Teleprocessing Monitors: teleprocessing monitor is a communication software package that manages communications between the database and terminals.
4) Application Development Tools: An application development tool is a program designed to help programmers develop application programs that use the database.
5) Security Software: A security software package provides a variety of tools to shield the database form unauthorized access and from malicious software.
6) Archiving Backup and Recovery System: Archiving programs provide database managers with tools to make copies of databases for retrieval if need be.
7) Query Languages: A query language is a set of commands used primarily for accessing data from a database.

13.06.02 The Data Hierarchy

A computer system organizes data in a hierarchy that starts with bits and bytes and progresses to fields, records, files, and database.
For instance an Inventory Master ***File*** contains the following data fields:

Each item in stores has a ***record*** containing several **fields** as under.

- Part Code:
- Description:
- Unit of Measure: (Kg, Lit, Nos etc)
- Source code: (Shop made, bought out component, bought out Raw Material etc)
- **ABC** code: ("**A" for high value, "B" for medium value and "C" for low value item**)
- Criticality code: **("V" for very critical, "E" for essential and "D" for desirable)**
- Buyer code
- Material class code: (Castings, Forgings, Steel Raw material, components, consumables, spares, hardware, proprietary items etc)
- Lead time for manufacture/purchase:
- Buffer/Safety Stock in days/weeks/months:
- Standard cost:
- Project Code:
- Store Location:
- Stock Qty:

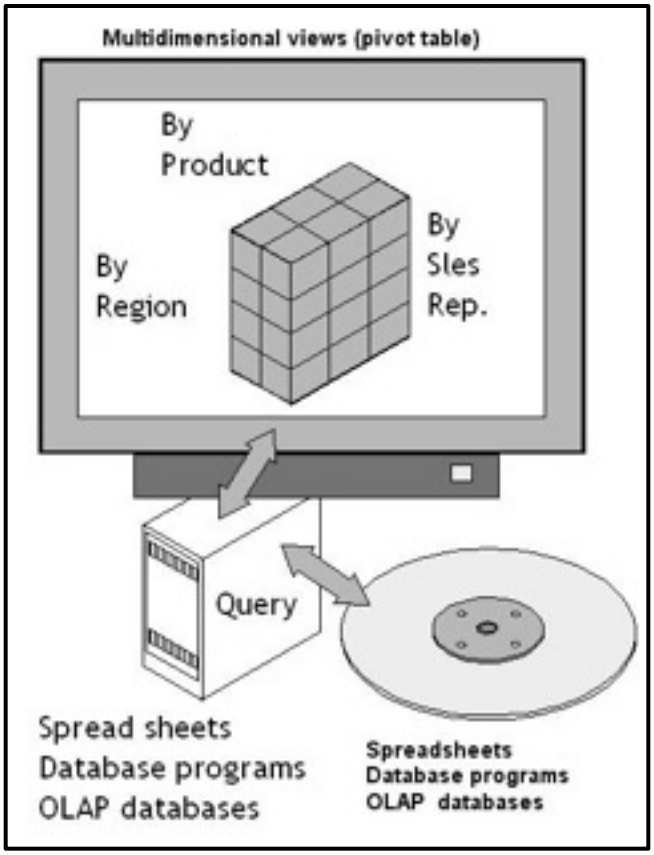
Data Hierarchy:

DATABASE (e.g. Inventory, Bill of Material, Vendor Data etc.) ➔ FILES (e.g. Inventory master file comprising a set of records as above) ➔ RECORDS (Comprising data fields for each item) ➔ FIELDS (e.g. ➔ BYTES (e.g. 01001001 – Letter in ASCII Code) ➔ BIT (0 or 1)

13.06.03 Data Mining

Traditional database queries answer such questions as,
"What were the sales of Car model 'X' in the year xxxx?"

OLAP (Online Analytical Processing) supports much more complex requests for information such as,
"What were the sales of car model 'X' in the year xxxx, relative to the plan and actual sales in the previous year?"
Another example: What were the sales of car model 'X' sold in Mumbai by sales rep John?



Data mining is more discovery-driven. Data mining provides insight into corporate data that can not be obtained with OLAP, by finding hidden patterns and relationships in large databases and inferring rules from them to produce future behavior. The patterns and rules are used to guide decision making and forecast the effect of these decisions. The types of information obtainable from data mining include associations, sequences, classifications, clusters, and forecasts.

Associations are occurrences linked to a single event. E.g. " Only 75% of diners were ordering soup" in the hotel.

In sequence, events are linked over time. E.g. "Purchasers of new houses bought refrigerators within two months, 70% of the time; and a washing machine within 9 months, 60 % of the time"

Classification recognizes patterns that describe specific group behavior. E.g. “What kinds of customers end up with delinquent credit cards?” This information can be used for making a decision on introducing a special promotion scheme.

Clustering works in a manner similar to classification when no groups have yet been defined. This helps finding affinity groups for credit cards such as regional groups, profession wise groups etc.

Forecasting is useful in special predictions. Predictive analysis uses data mining techniques, historical data, and assumptions about future conditions to predict outcome of events, such as the probability a customer will respond to an offer or purchase of a specific product.

13.07.00 HARDWARE

13.07.01 Major Classification of Computers

01.01 Super Computers: are very powerful and specialized computer systems.
01.02 Mainframe Computers: are large computers frequently used in large organizations.
01.03 Minicomputer Systems: are smaller than mainframe computers used in small organizations or departments in large organizations for their computing needs.
01.04 Micro Computer Systems: are used by small organizations, executives, professionals, students, householders etc.

13.07.02 Computer Hardware Selection

Adhoc selection of computers and peripherals across the organization can pose problems. The following factors are to be considered.
1. Compatibility across the organization.
2. Expandability.
3. Reliability.
4. State of the art..
5. Installation and maintenance; modifications to the existing building / facilities.
6. Procurement basis:

- Renting option (Least risk of obsolescence).
- Leasing option (Less capital ; Less risk of obsolescence).

- Buying option (Economical in the long run ; More capital expenditure; Risk of obsolescence).

13.07.03 Computer Hardware Constitution

13.07.03.01 Computer Architecture

The central processing unit contains a control unit and arithmetic and logic unit. The control unit obtains instructions from the computer system's memory, interprets them, and notifies the other components of the system to carry them out. The arithmetic and logic unit processes data obtained from memory under direction of the control unit. The arithmetic and logic unit basically is able to process data in two ways.
1. Arithmetics: [+ (plus)], [- (minus)], [/ (division)] , [*(multiplication)].

2. Logically, such as by comparing some data with another viz.

i. **A=B;**
ii. **A is not equal to B;**
iii. **A < B (A is less than B);**
iv. **A > B (A is greater than B);**
v. **A is les than or equal to B;**
vi. **A is greater than or equal to B**

The above seemingly simple operators have the astonishing ability to control space ships, create pictures or music and emulate some human thought process. Or, it may simply print salary cheques at the end of the month.
In some computers, the circuitry of a control unit / logic unit is contained in a single silicon chip called micro processor. The circuitry comprising chips is called the mother-board, constitutes the heart of CPU (Central Processing Unit).
Main memory is volatile; it contains data and programs only as long as the system is on. This is also called RAM (Random Access Memory) and is fast. Main memory is also called primary memory. Each data memory location has an address which facilitates the program to access data. Large data needs auxiliary memory which is slow and less expensive; called secondary storage. All data is stored in binary code. Most commonly used codes are ASCII (American Standard Code for Information Interchange). ASCII is a seven digit code – one parity bit used for checking purpose. EBCDIC (Extended Binary Coded Decimal Interchange Code) uses 8 digit codes – one parity bit.

Character	EBCDIC Code	ASCII Code
0	11110000	0110000
1	11110001	0110001
9	11111011	0111011
A	11000001	1000001
Z	11101001	1011010

The internal memory of a computer system contains read-only memory called ROM. ROM usually contains programs that help computer system start up and operate. RO can only be read (can not be altered by user) and is not lost when computer is shutdown.
PRM = Programmable Read-only Memory that allows the manufacturers read and program into it.
EPROM = Erasable Programmable Read-only Memory (can be altered with special equipment)

13.07.03.02 Computer Power

Word-Size? How many bits of data it can transfer between main memory and CPU at one time. E.g. A 32-bit word-size can pass a 32-bit path; which is a set of wires through data between CPU and its components. 16 bit is like a two- lane highway. 32 bit is like a four-lane highway.

Another way to measure the power of a computer is the speed at which the CPU completes its internal processing task. The speed is referred to as the computer system's clock-speed and it is measured millions of clock-tics per second; megahertz (MHz). Another way to measure the power a computer is to express the number of instructions the CPU can process in a second; millions of instructions per second – MIPS. All these measures are only guidelines. There are many other factors that affect the output of a computer.

The real measure is the through-put or time taken to do a job. Many computers use co-processors to assist them, by offloading some tasks to them.
Some computers have multi-processing capabilities, by using more than one CPU. They can run several programs simultaneously.

There are two types of processing viz. batch processing and On-Line-Transaction-Processing (OLTP)

13.07.03.03 Storage Media and Devices:
We use secondary storage media and devices when RAM is not adequate; such as disc drives, tape drives, floppy diskettes, sealed hard Winchester drives, CDs, and DVDs.

13.07.03.04 Input and output devices (Peripherals)
Some peripherals are: scanners, digital cameras, mouse pointers, LCD monitors, pointers, voice synthesizers, computer output microfilm recorders etc.

13.08.00 Software

13.08.01 System Software

A computer system has a number of resources that need to be managed.
The resources are: Hardware components such as CPU, Memory and peripherals viz. storage devices and printers etc.
The system software is a set of instructions, which coordinate the hardware components for efficient performance of the system.
The system software acts as a linkage / interface between the computer system and the application programs of the users.

System software includes many different types of programs:

- Operating system software.
- Communications software.
- system utility software.

13.08.02 Operating Systems

An operating system is a set of programs that manages and controls computer resources including: CPU, peripherals, main memory, and secondary storage.
Activities of the system software:

1. Scheduling jobs to be run.
2. Queuing jobs.
3. Allocating memory to various job tasks.
4. Communicating status of the jobs to the computer operator.

Before the development of the system software, the computer operators were doing these jobs manually; such as scheduling jobs, loading program and data for each job, preparing devices (printer etc) to receive inputs and outputs. When human operators are slow, the computer idles for some time as a result.

Operating systems typically include:

1. Supervisory programs which are resident programs in the main memory (to manage computer resources such as main memory, disc storage, CPU processing time and peripherals).
2. Job management programs (Select, initiate, and terminate jobs scheduled as required).
3. Input/output management programs (Interact with input and output devices; Exchange data between the CPU and the input/output devices and secondary storage devices).

13.08.03 Multi Programming

This allows more than one program and associated data to reside in the main memory. Several jobs are seemingly carried out simultaneously.
Each program and associated data are stored in different compartments of main memory. CPU is faster than Input/output (I/O) devices. The disc speed may be measured in terms of millisecond (one-thousandths f a second) while the CPU performance is measured in terms of nanoseconds (One billionth of a second). It is possible that CPU, by virtue of its superior speed, handles a different program when the hard discs or printers are busy doing the previous job.

13.08.04 Time-sharing

It offers each program a brief slice of time to perform.
The system moves form program to program so rapidly, that the user thinks that the computer is working for him exclusively.

13.08.05 Multiprocessing

Multiprocessing operating systems permit the simultaneous processing of several application programs by controlling more than one CPU at a time.
The CPUs work together sharing memory and peripheral devices.

Asymmetric multiprocessing: Each program is processed by a separate CPU dedicated to one program.

Symmetric multiprocessing: One CPU acts as a controller of other CPUs; and assigns any CPU any application task. The main CPU also controls I/O tasks.

13.08.06 Parallel Processing

This system uses more than one CPU to permit many tasks from one program, to be completed simultaneously through parallel processing. That is, several steps in a program are processed in parallel using multiple CPUs.

13.08.07 Virtual Storage

If main memory is not adequate, the computer stores parts of a program – not required immediately- in a secondary storage such as a disc, and load them back into main memory just before they are needed.

13.08.08 Communications Software

Communication software is really an extension to the operating system of a computer. Communication software supervises such functions as communicating with remote terminals, monitoring communication equipment and lines, managing traffic on communication lines, diagnosing communication problems etc. Communication software permits a micro computer to connect to a local or remote network. A PC can talk to a Mainframe, a minicomputer or another microcomputer.

13.08.09 Utility Software

These are used to carry out repetitive functions such as sorting, merging, compressing files and providing security etc.

13.08.10 MICROCOMPUTER O/S (Operating System)

Single or multitasking O/S: Windows, Macintosh, UNIX, DOS etc

Task switching: We may suspend one program and operate another at any point of time.

Kernel: On a micro computer, the frequently used portion of the O/S is called the ***kernel.*** It is the ***kernel*** that is loaded into the main memory; the remaining portion of O/S and utilities are stored in a hard disc to be called in as and when required.

Utilities in a microcomputer:

- Copy a file from one disc to another.
- Delete file in a diskette.
- View the contents of a file.
- List the file names contained in a diskette.
- Compress data.
- Security measures; such as asking for a password.

13.08.11 Third Party Software

E.g. Compression utility program – PKZIP;
Norton utilities.

Graphical user interface:

To talk to the computer O/S we use graphical user interface such as:
Mouse, drop-down menu, icons, scroll bars, pop-up menu, pointers /light pens, touch screens.

13.08.12 Application Software

We use programming languages to develop application programs.

Examples:

- Word processors.
- Payroll programs.
- Spread sheets / templates (useful in preparing budgets and maintaining investment portfolios etc…)

Sources for application software:

- Supplied along with OE (Original Equipment).
- Custom-made vs. commercial software.
- Shareware downloaded over the internet and freeware. (Public domain software).

13.08.13 Development of Software

13.08.13.01 Programming Languages

System programmers, who develop systems programs, and application programmers who develop application programs, use programming languages to create and maintain their programs.

These languages consist of programming commands and other words that are put together into programming statements that tell the computers what to do and when to do it.

Programming statements are called *program code*, and the process of writing programming statements is referred to as ***coding.***

13.08.13.02 Machine Languages

At the first level is ***machine language*****,** which is a language that the computer systems actually read and understand. The program statement in ***machine code*** might look like this.

01011000 01000000 00100011

This means load register 1 with 0.
The statements written in all other programming languages must be translated into machine language so that the computer can execute them. This is done by compilers.

13.08.13. 03Assembly Languages

To relieve a programmer from the tedious machine language, a higher evel of language is used.
First of these languages used mnemonics as symbols for machine language.
Examples:
L means ➔ load
ST means ➔ store
AR 1, 2 means ➔ Add register 1 to register 2.
Assembly languages are machine specific and a programmer can not function different computer environments.

13.08.13.04 Third Generation Languages

They use commands, which look more like English and easy to remember. The programmer needs less knowledge of any specific computer system.
E.g. COBLOL, FORTRAN, BASIC, C, PASCAL etc.
These programs spell out detailed steps and in a specific order; and are known as procedural languages.

Example of a COBOL statement:
MULTIPLY EMP-HOURS BY EMP-RATE GIVING GROSS-PAY ROUNDED.
IN COBOL, we need to write 4 divisions of codes for simplest of applications:
1) Environment division (Computer system details) 2) Data division, 3) File division and Procedure division

13.08.13.05 Fourth generation languages: (Written at very a high level)
They are user-friendly. E.g. FOCUS, DBASE IV etc. These programs may not require programmers to spell out steps and the sequence the computer has to follow. They are called non-procedural languages.

Programmers need to tell the computer what they want without telling it how to do it. The non-procedural languages develop the programming code to get the job done. Fourth generation Programs can be written faster compared to third generation programs.

13.08.13.06 Query Language

This is easy to learn. A query language is a set of commands through which end-users can ask questions to retrieve data from the computer files.

E.g. SELECT CUSTNAME FROM CUSTFILE WHERE CITY=CHICAGO
This statement opens a file called CUSTFILE and displays all customers located in the city of Chicago.

13.08.13.07 Report Generators

These are user friendly. We can simply get a prescribed repot from drop-down menus; without knowing about programming.

13.08.13.08 Application Generators

They can produce a set of programs for a complete application. The generator creates an input screens to specify data required. This can be used by non-programmers.

E.g. Payroll accounting.

13.08.13.09 CASE Tools

COMPUTER AIDED – SOFTWARE- ENGINEERING ➔ CASE

A bundle of CASE tools help programmers do develop software faster and more accurately.

E.g. program code generator, a library routine developer, a data descriptor, data flow diagramming feature. They also assist a programmer in planning, analyzing, designing and testing.

13.09.00 Decision support systems: (DSS) And Expert Systems

Introduction: Decision support systems are designed to support managers' information needs to make decisions about how to organize and control resources effectively.

Managers themselves design these systems with the help of data processing professionals.

13.09.01 Characteristics of Decision-Making Process

Phases of decision making process: First phase is recognition of opportunities, called ***"intelligence-phase";*** *next* phase is to identify the alternatives, called ***"design –phase***"; next phase is selecting the best alternative ***"choice".***

13.09.02 Types of Decision Problems

Some may be structured and some un-structured.
We use ***algorithms*** are a set of standard operations that guarantee a solution.
We may also use ***"heuristics"*** **–** rules of thumb based on experience and logic.
In organizations, managerial decision problems are semi-structured due to uncertain, complex and unstable environment.

13.09.03 Attributes of Decision Maker

These attribute include:

- Perceptual ability.
- Information capacity.
- Risk-taking propensity.
- Aspiration level.

13.09.04 Strategies for Decision Making

a) Maximizing strategy: When alternatives and probabilities are well established, managers try to maximize the desired outcome.
(OUTCOME x PROBABILITY=EXPECTD VLUE)
b) *Satisficing* strategy: In uncertain situations managers take a less than maxima-decisions, but settle for satisfactory decisions.
c) Incrementalizing strategy: Manager moves in small steps towards the goal.

13.09.05 Important Features of a DSS

a) Support of semi structured decisions: Eg Budget preparation is semi-structured due to uncertainties. Budget analysis is a structured process.

b) Support for database access and modeling: DSS attempt to combine the use of models or analytical techniques with traditional data access and retrieval functions.

c) Support for all phases of decision-making: Support during the phases of intelligence, design and choice.

d) Support for communication among decision makers: Provide inter-action among the decision makers. Example: Senior management may approve additional advertisement budget, say increase by 20 %. Middle managers may choose media types. Junior managers may decide on frequency and timing of advertisement. The MIS must provide a common database for interaction among all levels in an organization.

e) Availability of memory aids: E.g. A budget may be recorded in a spread sheet, for reference while making a rolling sales plan.

f) Availability of control features: A final important feature of a DSS is the availability of control aids for training and system use. E.g. Help screens, menus, prompts are valuable software features in this respect.

13.09.06 Components of Decision Support Systems

a) Data components: Need organized and verified data gathered from transactional data.

b) Building a data warehouse: Must be meaningful, consistent and accurate

c) Data mining and intelligent agents

d) Model components:

- Statistical models e.g. regression analysis, Exponential smoothing.
- Accounting models: Tax planning or cost analysis.
- Marketing models: Analysis of advertising strategy, consumer switching behavior.

Algorithms, heuristics, simulation, transportation, linear programming etc are among the methodologies used to build models.

13.09.07 The tools of decision support

THE TOOLS OF DECISION SUPPORT

The tools of decision support include database query, modelling, data analysis, and display software. Examples of software tools falling into 4 categories are given in the following figure.

Software Tools for Decision Support Systems

DATA BASED SOFTWARE	MODEL BASED SOFTWARE	STATISTICAL BASED SOFTWARE	DISPLAY BASED SOFTWARE
ACCESS PARADOX	EXCEL LOTUS-123	SASS-PC SPASS-PC	POWER POINT

13.09.08 Benefits of Decision Support Systems

Ability to make better decisions:
Managers are able to consider alternatives that they may not have explored before. Managers can explore complex issues and take informed decisions for an optimal result.

13.09.09 Expert Systems

An expert system: is software that attempts to provide an answer to a problem, or clarify uncertainties where normally one or more human experts would need to be consulted. Expert systems are most common in a specific problem domain. This technique is a traditional application and / or subfield of artificial intelligence **(AI).**

A wide variety of methods can be used to simulate the performance of the expert; however, common to most or all are:

1) the creation of a knowledge base which uses some knowledge representation structure to capture the knowledge of the Subject Matter Expert (SME);
2) a process of gathering that knowledge from the SME and codifying it according to the structure, which is called knowledge engineering; and
3) once the system is developed, it is placed in the same real world problem solving situation as the human SME, typically as an aid to human workers or as a supplement to some information system. Expert systems may or may not have learning components.

Expert systems were among the first truly successful forms of AI software. The topic of expert systems also has connections to general systems theory, operations research, business process reengineering, and various topics in applied mathematics and management science.

13.09.09.01Articicial Intelligence (AI) and Expert Systems

AI is concerned with the creation of computer programs that do tings that require intelligence. In other words, artificial intelligence means programming a computer to perform activities that if done by a person would be thought to require intelligence. The field of artificial intelligence includes the area of natural language processing, robotics, machine vision, and ***EXPERT SSTEMS.***

Natural language processing means the computer understands a human language.

E.g.

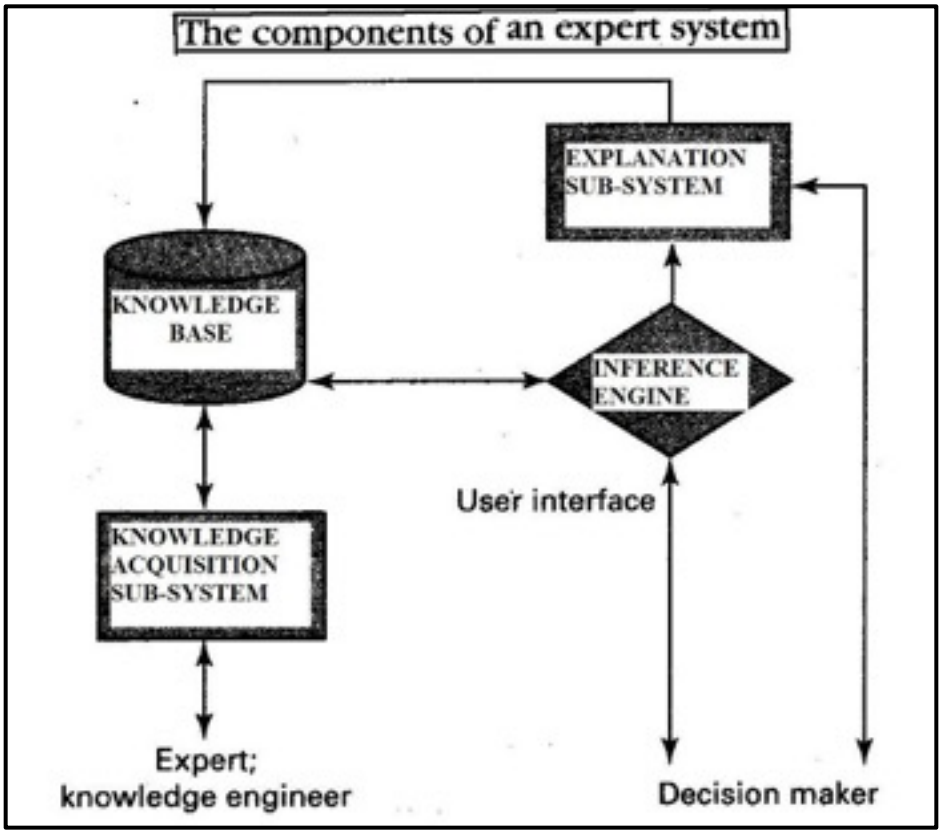
A customer may ask a computer in a bank “What is my bank balance?”
The Computer asks “What is your account number?”
The Customer says “three five seven nine two one four”.
Computer answers “Rupees seven thousand six hundred twenty two”

13.09.09.02 Expert systems and DSS (Decision Support Systems)

Mangers build DSS to obtain data they need to solve unstructured problems. Many of these applications use database query and modeling tools to generate reports. Expert system tools and techniques can be built into DSS in order to improve the quality of decision-making process. One way to improve this process is by including heuristic modeling techniques that replicate the reasoning process of an expert and allow the system address poorly structured problems more effectively.

Expert systems are generally developed to address a specific area of expertise.

13.09.10 The components of an expert system



13.09.10.01 Knowledge Base: contains the information and the rules of thumb that the expert system uses to make decisions. This information should represent high level expertise gained from top experts in the field. In many expert systems, knowledge is represented by some rules. Different rules are applied in different order in different circumstances to give a decision. For instance we may have 10 rules in the system. We can not apply these rules in a rigid way. The system adopts different rules in different order to suit the circumstances eg For one situation , it may choose a sequence of rules as 2-5-8-1 for application. In another situation the system may choose sequence 8-4-3-5-1.

13.09.10.02 The Inference Engine: is the CPU. The inference engine conducts the dialogue with the user, asking for information. The inference engine represents both knowledge base and the procedure to be used for a particular situation.

13.09.10.03 Knowledge acquisition sub-systems: These evolve over time. Rules are added or deleted to the system, based on past experience and demonstration of the system. The system is improved by iterative process.

10.04 Explanation sub-system**:** The explanation sub system explains the procedures that are being used to reach a decision. In this way the user can keep track of the methods being used to solve the problem and can understand how the decision is reached.

13.10.00 MIS Planning

13.10.01 Introduction

First step in MIS planning is to determine the information needs for the business.
E.g. In materials management, we need information on stock quantity, Stock valuation, ABC analysis, Vendor data, Pending order status etc.

Then we need to decide the nature of inputs / transaction documents.

We may choose a methodology for planning the MIS.

- CSF (Critical success factors) Method.
- BSP (Business Systems planning) Method.
- E/M (End/Means) Analysis Method.

13.10.02 CSF Method (Critical Success Factors) Method:

Purpose ➔ To define critical success factors:

E.g. Efficient inventory management may be a CSF in an engineering Industry.
Prompt delivery may be a CSF for a courier service.
Quality may be a CSF in food industry,
Speed of issuing tickets may be a CSF in Railways.
Timely departure may be a CSF in Airlines.
The MIS should focus on the critical success factors.

13.10.03 BSP Method (Business Planning Systems) Method

BSP method assists a business in developing MIS that support both short-term and long-term needs. Top management must be closely involved in developing MIS. One of the underlying objective of BSP is to develop a data architecture that supports MIS development activities. E.g. Customer related data may be required in 20 reports and data stored in 10 different data bases. If the address of a customer changes we need to change the data in 10 different files which is not desirable. The data architecture must be so designed as to synchronize the data, with minimal inputs for multiple applications.

The major activities that are involved in a BSP are these:

- Make commitment.
- Prepare for study.
- Hold a kick off meeting.
- Define business process.
- Define data classes.
- Assess business problems.
- Define information architecture.
- Determine input / output requirement.
- Determine priorities.
- Develop MIS.
- Review the system.
- Maintain the system.

13.10.04 End / Means (E/M) Analysis

The purpose of E/M analysis is to determine effectiveness criteria for outputs and to specify efficiency criteria for processes used to generate the outputs.
First question: What is the end, goods, service provided by business?
Second question: What makes these goods or services to the customer. Prompt delivery?

Final question: What information is required to evaluate the effectiveness? Delivery period compared to competition? Delay in delivery compared to delivery schedule?
Let us take the activity of order processing. Ask these questions.
What are the key processes in order execution?
What constitutes the efficiency in this process?
What information is needed to assess the efficiency?

Please study the following examples / tables for E/M method, CSF method and BSP method:

Critical Success Factors for Order Processing

Critical Success Factors	Information
Adequate inventory to fill customer orders	Percentage of orders filled on time, by customer and by product
Prompt shipment of orders	Delivery - overall and categorized by customer
High% of customer payments	Delinquency report on non-paying customers
Vendor promptly filling orders	Exception report of vendors not filled on time

Business system planning for order processing

Problems	Solution	Information
Out of stock too often	Better inventory	Out of stock and below minimum report
Ordering department allocates limited inventory to the least important customers / or customers with credit problems	Let warehouse know relative importance and credit status of different customers	Customer importance rating and credit rating

End / Means Analysis

Means	Efficiency	Information
Process orders	Low transaction cost	Cost / transaction statistics
Process credit requests	Low transaction cost	Cost / transaction statistics
Make shipments	Minimize shipping cost	Shipping cost categorized by order, customer, and region etc.

13.11.00 Systems Analysis and Design

13.11.01 The systems development process

The process of systems analysis involves a number of steps that can be applied to any study that is similar to problem solving.

These are the steps in systems study:

- Define the problem.
- Develop an understanding of the system.
- Identify and evaluate the alternatives to achieve the organization's objectives.
- Select and improve one of the alternatives.
- Evaluate the impact the changes have made.

13.11.02 The Systems Development Life Cycle

The steps followed in designing MIS are known as Systems Development Methodology. A system development methodology establishes a set of procedures to conform to life cycle. The systems development process involves a series of steps that must be accomplished to meet the information needs. The systems development life cycle provides a methodology for accomplishing these activities.

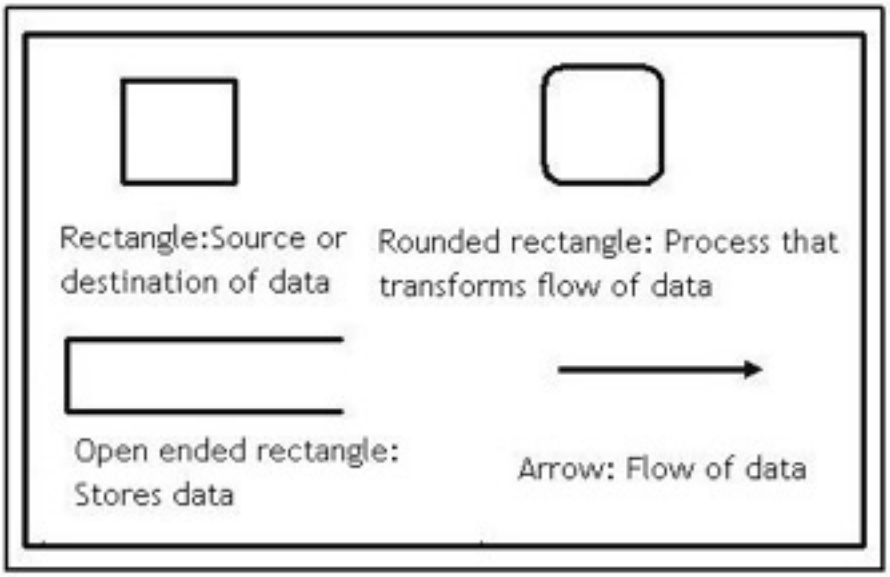
The life cycle begins with problem definition, during which the systems analyst works with the user to identify the nature and scope of current problems.
Table - The Systems Development Life Cycle: The steps are ➔

STEP	**System Development activities**
Problem definition	Examination and evaluation of the problems of current system
Feasibility study	• Development of objectives and logical model of the proposed system. • Preliminary analysis of alternate design options. • Make a tentative schedule estimate the costs involved.
Systems analysis	• Detailed study of the current system incl. procedures, information flows, work-organization and control. • Develop a logical model of current system.

Systems Design	• Development of objectives of the proposed system. • Develop a logical model of the proposed system incl. process logic definition, logical data dictionary, and logical database design. • Evaluation of alternative design options. • Conduct cost-benefit analysis of the alternative design options.
Detailed design	• Development of specifications for the physical system; incl. report- design, file design, input design, and forms' design. • Design Program specifications. • Development of implementation and test schedule.
Implementation	• Coding and documentation of programs. • Selection of hardware. • Development of security, audit, control, and test procedures. • Development of raining programs.
Maintenance	• Provide ongoing support, changes, and enhancement for the system. • Periodic review of the system and continuous improvement.

13.11.03 Logical Data Flow Diagram

Systems flow diagram: Symbols are shown as follows.



System Flowchart Example: Car Repair Garage

A car repair garage uses a computer system to produce invoices and keep track of the parts it has in stock. The system uses two files:

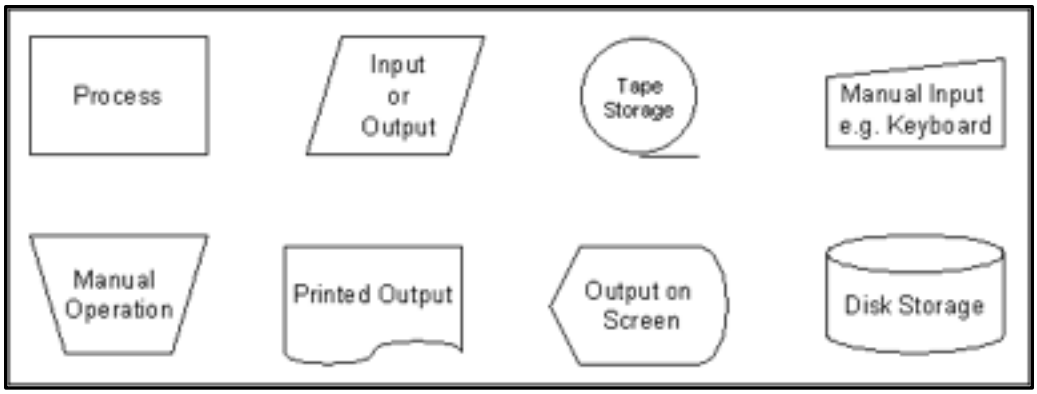
- Stock File: Contains details of all parts that are in stock.
- Orders File: Contains details of all parts that are on order.

When a repair is completed the mechanic records the parts that were used on a form. These parts are then entered into the computer by an operator. The list of parts that is entered is checked against the stock list to reduce the likelihood of the operator making a mistake. If the operator enters the name of a part that does not exist then an error report is displayed. When the parts list has been entered the cost of the parts is looked up in the stock file and an invoice (bill) is printed for the customer.

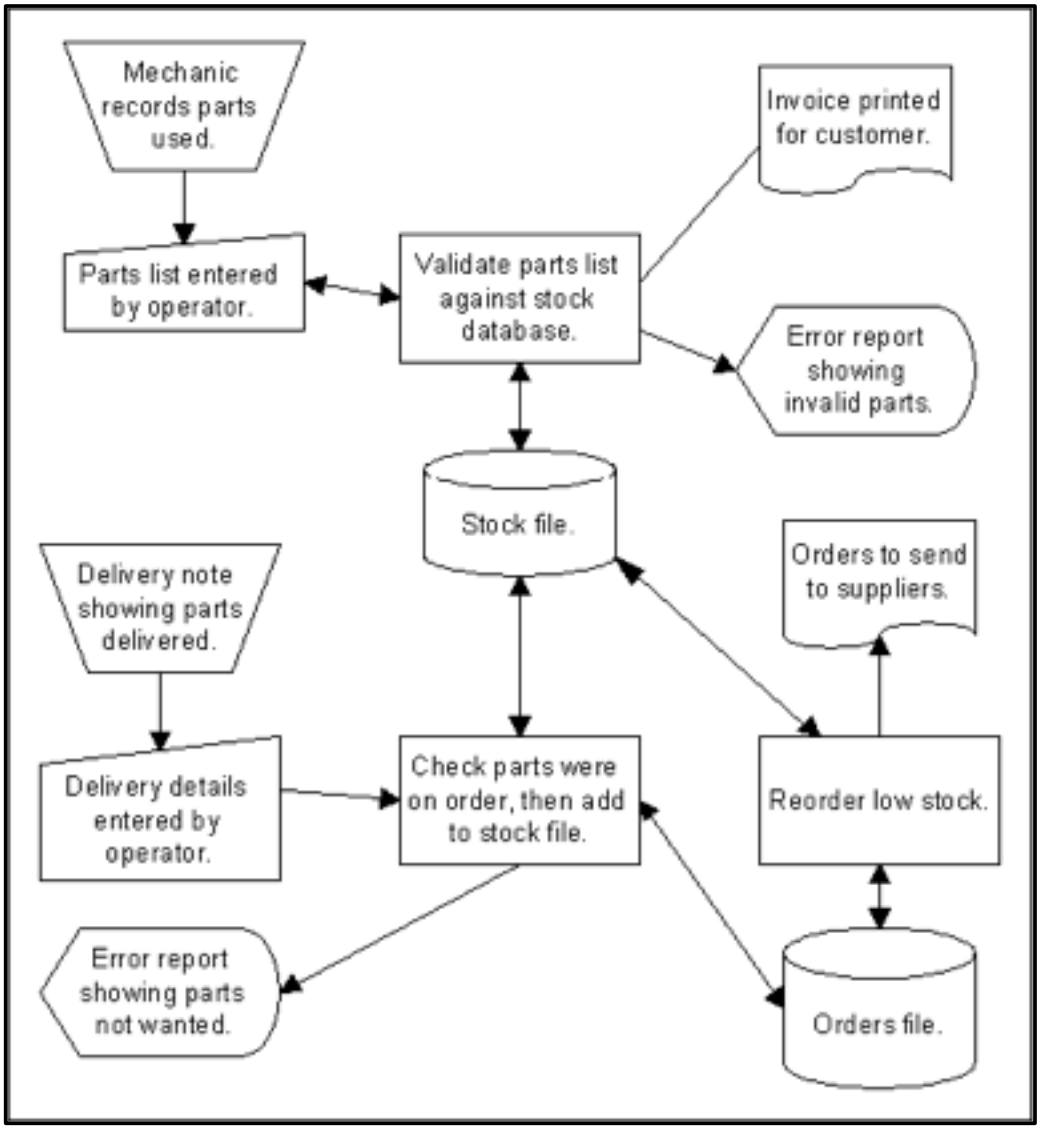
Every night the computer system checks the stock file. A report is printed to indicate which parts need to be ordered from the garage's suppliers. Details of any orders are placed in the orders file.

When a delivery of new parts is made to the garage the person making the delivery gives the garage a delivery note. The delivery note contains a list of the parts that have been delivered. The list of new parts is entered into the computer by an operator. If any parts have been delivered that were not ordered then an error report is printed. When an order is delivered the information about the order is removed from the orders file and the stock file is updated.

Symbols used in a systems flow chart:



The structure of this system can be shown using the following system flowchart:



13.12.00 Alternative Application Development Packages

13.12.01 Overview

Many companies experience software development backlogs. Under pressure from management to complete MIS projects as per schedule, MIS management has begun to explore alternative application development approaches, including software packages, user development, prototyping in systems design, and automated tools for software engineering. However, we need to consider the effects of these methods on the requirement of hardware. Once the system is frozen, modifications become difficult and costly.

13.12.02 Alternative Development Packages

Three alternative development strategies can substantially decrease system development bottlenecks. These are:

- ➢ Purchase of Software Packages.
- ➢ Use of Prototyping in System Design.
- ➢ Creation of User Development Systems.

For certain type of projects, each of these approaches can provide alternative to traditional development.

13.12.02.01 Software Packages

Software packages provide economies of scale in development and maintenance. In many cases in-house development would prove to be costlier and less efficacious.

13.12.02.02 Prototyping

Prototyping is the process of developing a model of the proposed system design and working with the user to modify it until the user's requirements are met.

13.12. 02.03 User Development of Information Systems

User managers have the opportunity to use micro-computer based spread sheet and data base software and main frame based Adhoc query and reporting languages to develop

their own information systems. These fall under ‘decision support systems” for the managers.

However we may face problems in the following areas:

- Data Security.
- Backup of data.
- Documentation.

If a manger leaves the company, other users of the system may not be able to use the system for want of adequate documentation.

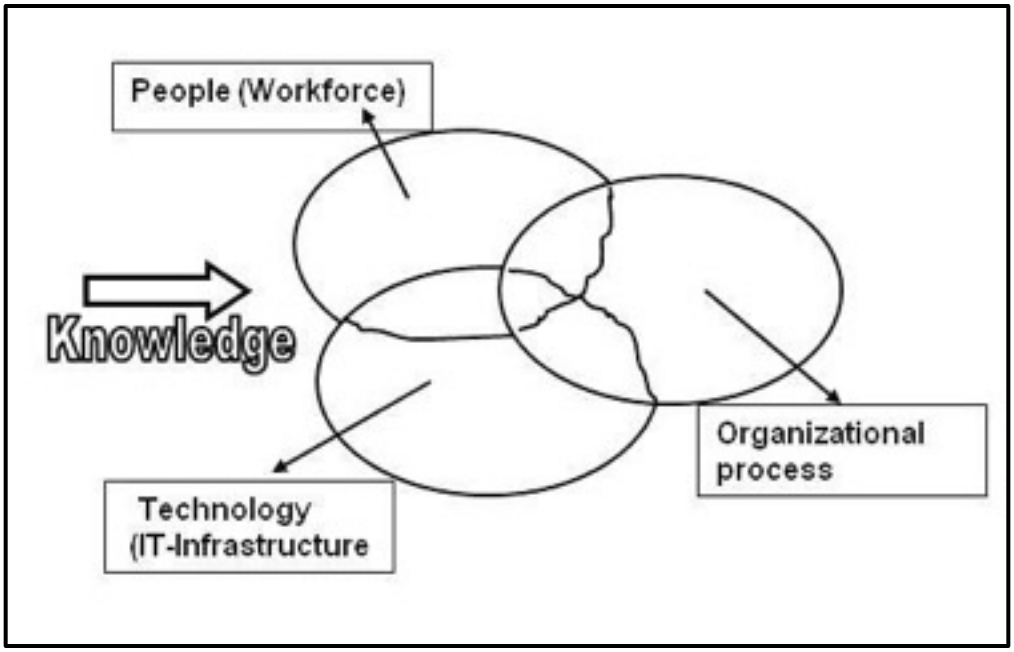
Chapter 14
Knowledge Management

14 Knowledge Management

INDEX:

14.01.00 The Basics of Knowledge management (KM)

KM is a new emerging, interdisciplinary business model that has knowledge within the framework of an organization as its focus.
It is rooted in many disciplines, including business, economics, psychology, and information management. It is the ultimate competitive advantage for today's firm.
Knowledge management involves people, technology, and process in overlapping parts.



Definition of KM:

KM is the process of capturing and making use of a firm's collective expertise anywhere in business - on paper, in documents, in databases (called explicit knowledge), and in people's heads (called tacit knowledge). In practice, however 90 % of knowledge is preserved in tacit form.

Various aspects of KM:

- Using accessible knowledge from outside sources.

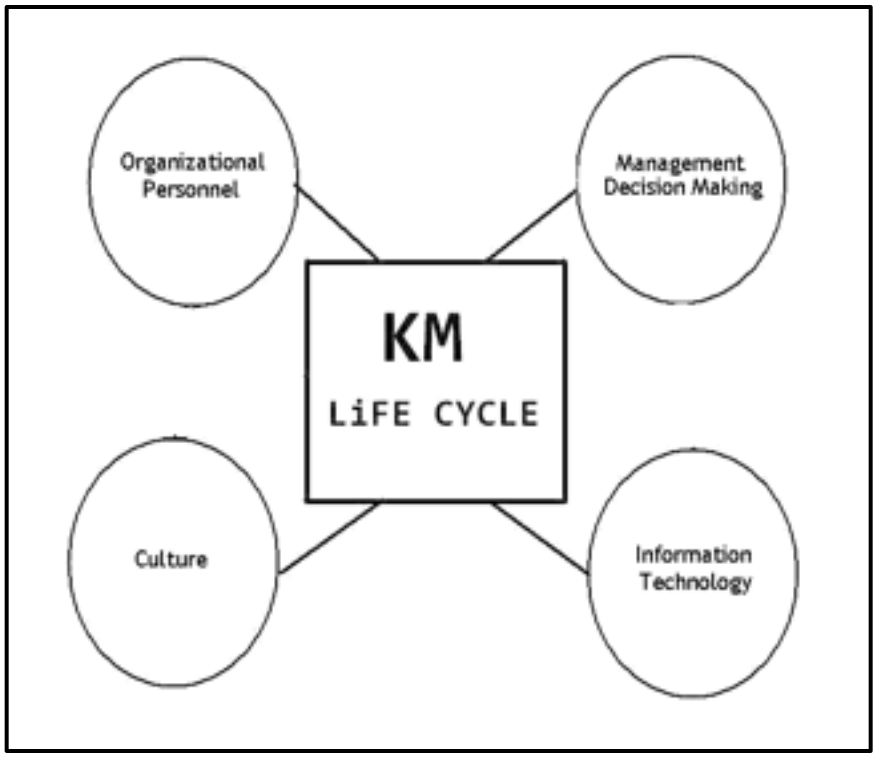
- Embedding and storing knowledge in business processes, products, and services.
- Representing knowledge in databases and documents.
- Promoting knowledge growth through organization's culture.
- Transferring and sharing knowledge throughout the organization.
- Assessing the value of knowledge assets and impact on a regular basis.

The four step processes are summarized in the following chart, including gathering/ capturing, organizing, refining and disseminating of knowledge.

TABLE: FOUR-STEP PROCESS VIEW OF KNOWLEDGE MANGEMENT

CAPTURING:	Capturing: Data Entry Scanning Voice input Interviewing Brainstorming
ORIGINATING:	Cataloging Indexing Filtering Linking Codifying
REFINING:	Contextualizing Collaborating Compacting Projecting Mining
TRANSFER:	Flow Sharing Alert Push

THE KM LIFE CYCLE AND THE ORGANIZATION:



This figure shows relationship between the KM life cycle and the four key areas in an organization. Taken together, one can understand a viable set of relationships between KM and management decision making, organization culture, organizational personnel, and information technology.

The key point is not to let stored knowledge sit idle in repository like database. It should be available to authorized users to contribute to the corporate competitive advantage.

14.02.00 Understanding knowledge

14.02.01 Knowledge

We define knowledge as “understanding – knowhow – gained through experience or study”.

It is an accumulation of the elements viz.

- A fact.
- A procedural rule.
- A heuristic, an intelligent rule of thumb gained through experience.

14.02.02 Intelligence

Intelligence refers to the capacity to acquire and apply knowledge. An intelligent person is one who has the ability to think and reason and takes good decisions.
Memory, the ability to store and retrieve relevant experience at will, is part of intelligence.

Learning is knowledge or skill that is acquired by instructions or study. It is the inevitable consequence of intelligent problem solving.

14.02.03 Common sense

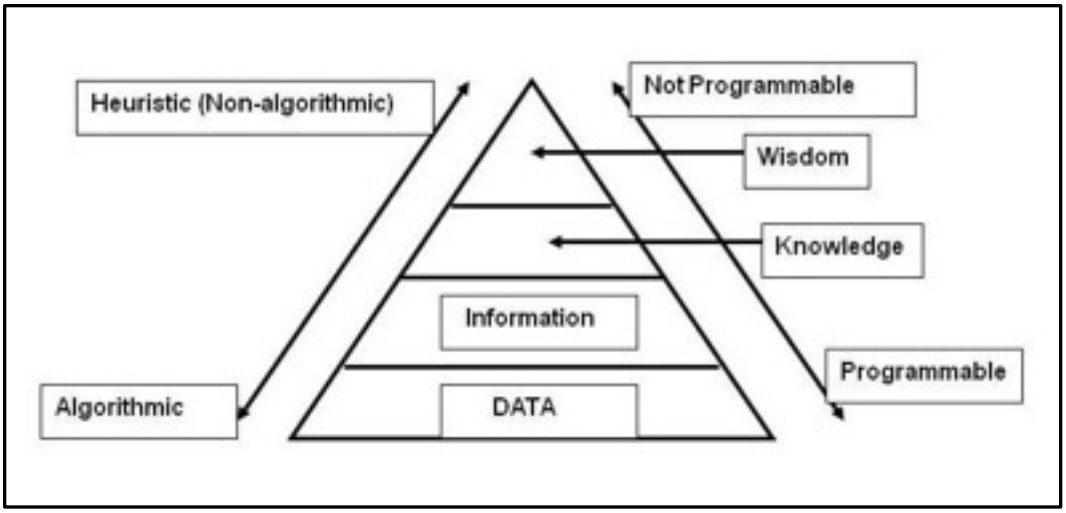
Common sense refers to the unreflective opinions of humans, which comes naturally even to a child of about 5 years of age.

14.02.04 Cognition and knowledge management

Cognition is knowing, perceiving as conceiving as an act or faculty distinct from emotion or volition (an exercise of the will).
Cognitive psychology provides an essential background for understanding of knowledge and expertise.
Cognitive science in general is the interdisciplinary study of human intelligence.
Cognition contributes to the performance of intelligent workers.
With these relationships in mind, we can see cognitive psychology’s contribution to KM.

14.02.05 DATA, INFORMATION, KNOWLEDE, and WISDOM

Wisdom ➔ has the highest level of abstraction, with vision and foresight…



14.02.05.01 Data

Data are unorganized and unprocessed facts. They are static. Data is a set of discrete facts about events – structured records of transactions.

14.02.05.02 Information

Information means shaping data to arrive at a meaning in the eyes of the perceiver. Information is an aggregation of data that makes decision making easier. It is also a kind of facts and figures based on reformatted or processed data.

14.02.05.03 Knowledge

Knowledge is “human understanding of specialized field of interest that has been acquired through study and experience. It is based on learning, thinking, and familiarity with the problem area in a department, a division, or in a company as a whole. Knowledge is not information, and information is not data. Knowledge is derived from information in the same way information is derived from data.

14.02.06 Types of Knowledge

14.02.06.01 Shallow and Deep Knowledge

Shallow ➔ surface knowledge, minimal understanding of the problem.

Deep ➔ Thorough knowledge gained through years of experience. Ability to solve complex problems.

14.02.06.02 Know-how Knowledge

Reasoning based on accumulated lessons of practical experience.
Experts represent their know-how in terms of heuristics.

14.02.06.03 Reasoning and Heuristics

Reasoning by analogy.
Deductive and inductive logic.
Heuristics is reasoning by intelligent rules of thumb formulated over years of experience.

14.02.06.04 Common Sense Knowledge

It is a collection of personal experiences and facts acquired over time.
What was the phone number of Emperor Asoka? The answer is based on common sense; No telephones were invented then!

14.02.06.05 Procedural, Declarative, Semantic, Episodic Knowledge

14.02.06.05.01 Procedural Knowledge

Eg: Stand in a queue to buy a train ticket.
Boil an egg in water for 10 minutes etc.

14.02.06.05.02 Declarative Knowledge

It is a routine and shallow knowledge. E.g. If the car stops, it may be due to empty fuel tank. It resides in a short-term memory.

14.02.06.05.03 Semantic knowledge

It resides in long-time memory. It is organized knowledge of concepts and facts and inter-relationships. E.g. Knowledge of Electrical wiring, battery, lights etc.
It is deeper than declarative knowledge.

14.02.06.05.04 Episodic Knowledge

Episodes are chunked in long-time memory. It is easy to recall and verbalize.

14.02.06.06 Explicit / Tacit Knowledge

Explicit knowledge ➔ Codified in documents ➔Can be easily retrieved. E.g. Electronic spread-sheet;

Tacit Knowledge ➔ Tacit knowledge is embedded in human minds, through experience and jobs.

14.02.06.07 Expert Knowledge

Specialized knowledge is stored in an expert's long-time memory as chunks. Knowledge compilation, or chunking, enables experts to optimize their memory capacity and process information quickly. Apart from quantifying soft information, experts tend to categorize problems on the basis of solution procedures. To become an expert in a specialized area, one is expected to master the requisite knowledge to be able to achieve exceptional level of performance with out formal preparation.

14.02.07.00 Implications for Knowledge Management

- Sustainable competitive advantage: Benefits to organizations in terms of added value, improved productivity, and innovation etc…
- 20 % knowledgeable people in an organization perform 80% of work.
- KM focuses on generating new knowledge, transferring knowledge, embedding knowledge in products and services, and processes; and sharing knowledge with authorized persons.

14.03.00 Knowledge Management Systems Life Cycle

Introduction

The building of knowledge management can be viewed as a life cycle that begins with a master plan and justification and ends with a system structured to meet KM requirement for the entire company.
A knowledge team representing the thinking of the firm and a knowledge developer with expertise in knowledge capture, knowledge design, and knowledge implementation ensure a successful system.
The most critical phase of the KM systems life cycle is identifying the near and long-term needs for the prospective system. This means reviewing the knowledge core of the existing employees; conducting a cost-benefit analysis of implementation of the candidate KM system and determining the tools and procedures to ensure the quality - accuracy, integrity, and completeness - and operational success of the installation.

KMSLC ➔ Knowledge **M**anagement **S**ystems **L**ife **C**ycle.

KMSLC centers around three questions:

1) Why is the KM warranted?

- What is the problem?
- How critical is the problem to the success of the firm?
- What is the gain to the firm?

2) What is the development strategy?

- Who is going to do it?
- When is he going to do it?

3) What process will be used to build the KM system?

The life cycle concept is not new. It is applied in many fields.
Some examples of life cycle system are:
College: Admission ➔ Education ➔ Graduation
Air Flight: Ticketing➔ Boarding ➔ Take-off ➔ Cruising ➔ Landing ➔ Disembarking
MIS: Problem definition ➔ Analysis ➔ Design ➔ Implementation

All these life cycles have some common characteristics:

- Discipline, Order, segmentation into manageable activities.
- Good documentation.
- Coordination.
- Management Review.

The following table lists the representative approaches for KMSLC:

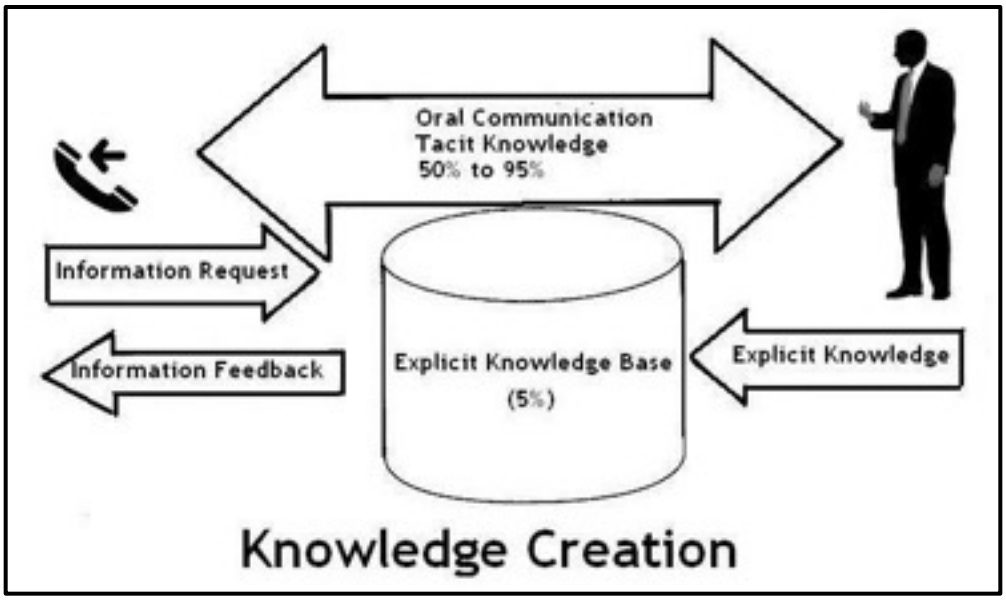
STAGE	KEY QUESTION (S)	OUTCOME
1 Evaluate existing infrastructure	What is the problem? Is the system justifiable? Is the system feasible?	Design of KM system Hardware / software implementation details
2 Form the KM team	Who should be on the team? How will the team function?	Standardized procedure for system development
3 Knowledge capture	What and whose knowledge should be captured? How would knowledge capture prceed?	Acqusition of knowledge core
4 design KM blueprint (Master plan)	How will knowledge be represented?	Design of KM system Hardware/software implementation details Test plan Security, audit, and operating procedures
5 Test the KM system	How reliable is the system?	Peer reviews, walk-throughs
6 Implement the KM system	What is the actual operation? How easy is it to use?	User-friendly system Training program
7 Manage change and reward structure	Does the system provide the intended dolutions	Satisfied users
8 Post-system evaluation	Shoud the system be modified?	Reliable and up-to-date system

KMSLC: Knowledge Management System Life Cycle

14.04.00 Knowledge creation and Knowledge architecture

14.04.01 Introduction

Today's knowledge cannot solve tomorrow's problems. It is necessary to update knowledge for future needs. Knowledge-update is creating new knowledge based on experience in a particular problem area and then using the new knowledge for sharing and application to solve problems optimally.



Conceptual structure of knowledge organization is shown in the following figure. The middle layer addresses KM life cycle – knowledge creation, capture, organization, refinement, dissemination, and maintenance. The outer layer is the environment of the organization – viz. Technology, culture, supplier / customer intelligence, competition and leadership of the organization.

A knowledge organization derives knowledge from several sources:

- Customer Knowledge - their needs, buying habits, purchasing power etc…
- Product Knowledge - products in the market, prices, customer-base etc…
- Financial Knowledge - capital resources, financial practices etc…
- Personnel Practices Knowledge – expertise available, quality of service etc…

14.04.02 Knowledge creation

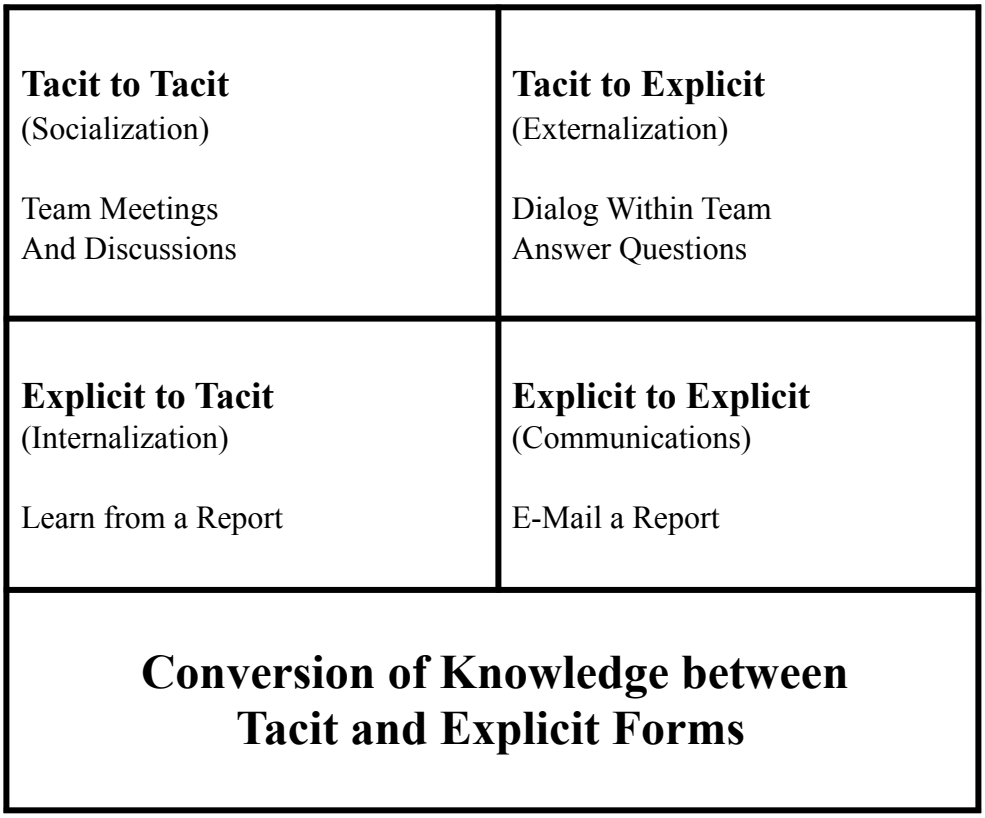
The knowledge is of two types ➔ Explicit and Tacit. Either type of knowledge can be created and must be captured.
Capturing explicit knowledge is done through DBMS, DATA-WAREHUSING, and DATA-MINING.
Capturing Tacit Knowledge will be dealt with in later chapter(s). KM is an activity enabled by technology.

Team formation and teamwork begin with experienced individuals working jointly on a project. Real knowledge continues to be held by individuals. In a team environment, shared exchange results in collaborative decision making and problem solving. So, when it comes to knowledge capture, the approach is to tap the individual's tacit knowledge, which could be single expert or multiple experts, as the situation warrants.

NANAKA's Model of Knowledge Creation and Transformation:

Nanaka coined the words: "Explicit Knowledge" and "Tacit Knowledge". Tacit knowledge is considered most valuable and difficult to capture.
The key to knowledge creation lies in the way it is mobilized and converted through technology.

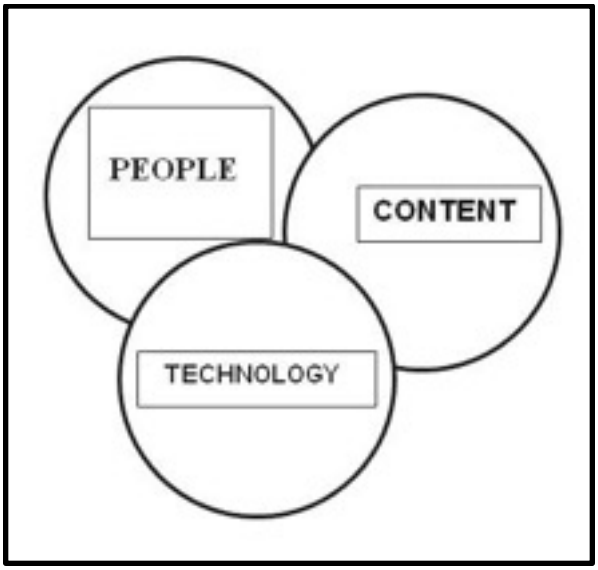
Conversion of knowledge between tacit and explicit knowledge is shown in the following figure.



14.04.03 Knowledge Architecture

Knowledge architecture is a pre-requisite knowledge sharing.
We view this infrastructure as a combination of people, content, and technology. As shown in the following figure, these components are interdependent and inseparable. People with knowledge provide content, relying on technology to transfer and share the knowledge.

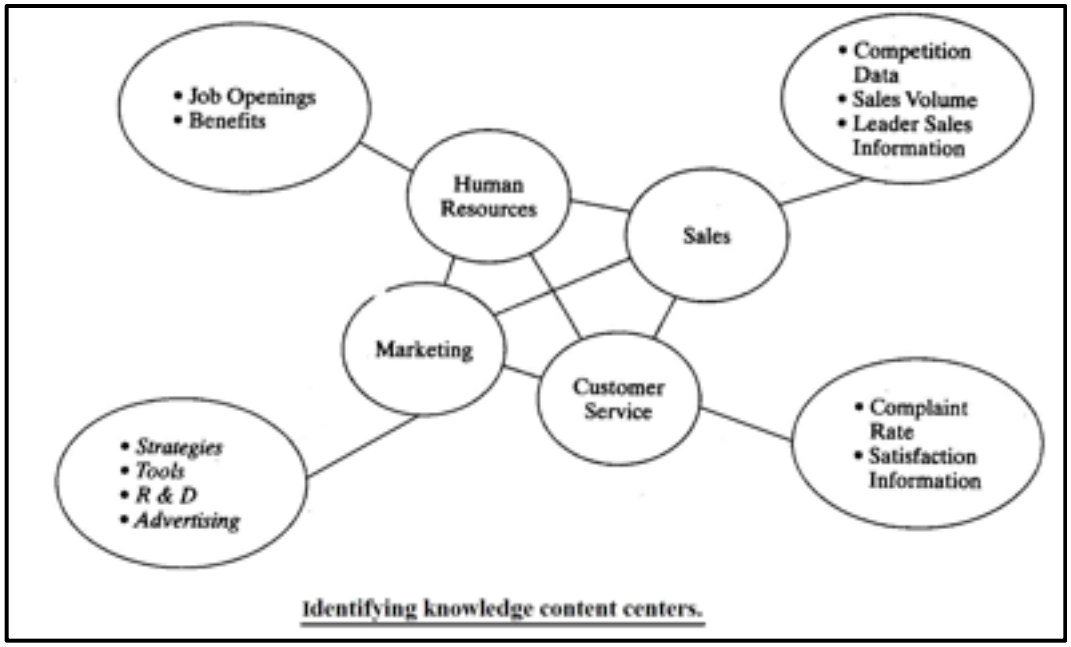
14.04.03.01 Conceptual View of Knowledge Management



14.04.03.02 The people core - Knowledge mapping

Steps:

- Identification of knowledge centers (E.g. Design, Production, Marketing etc…)
- Activating knowledge content satellites (Lower level center e.g. Customer support).
- Staffing experts over each knowledge center.

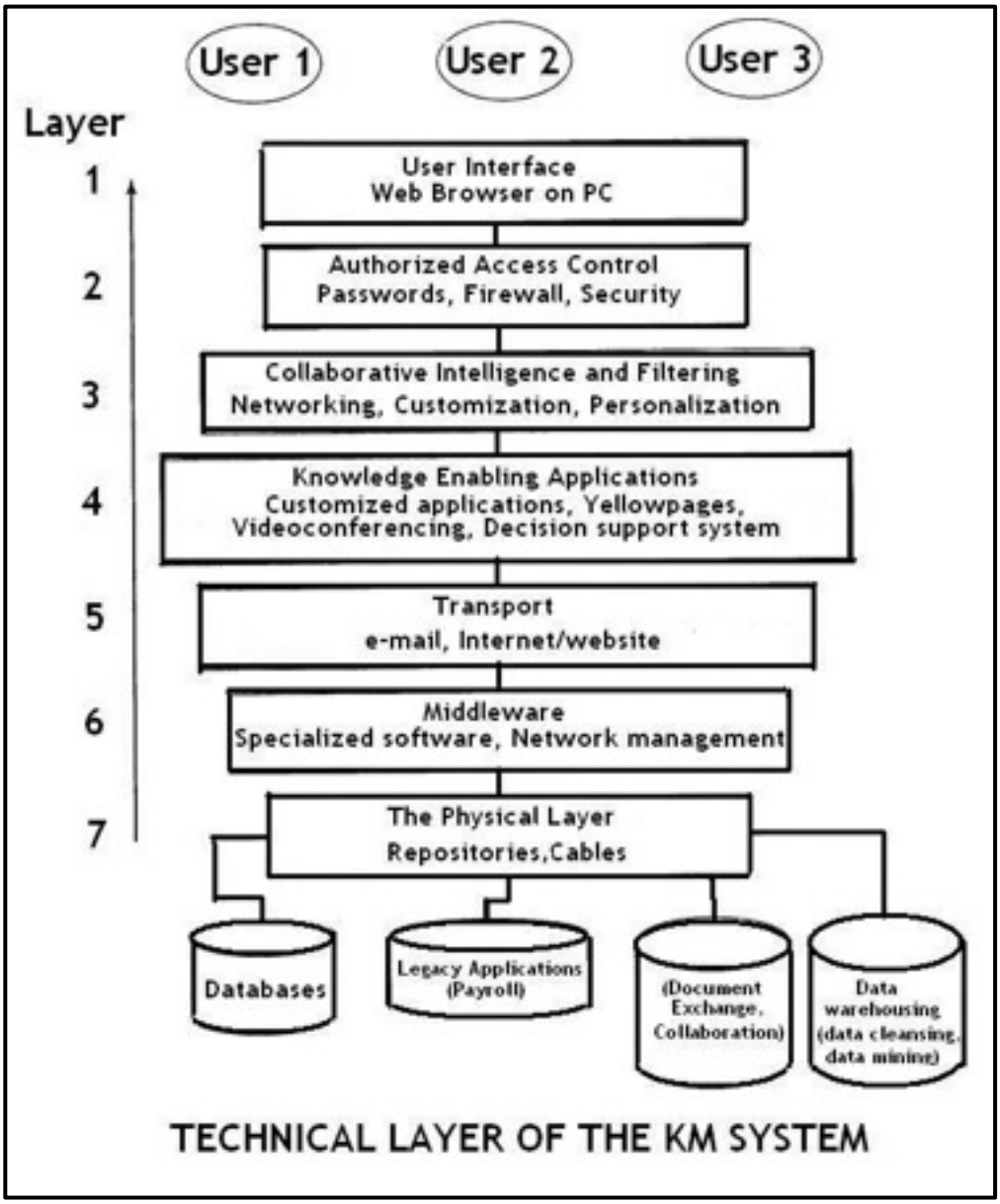


Identifying knowledge content centers.

14.04.03.03 Technical Core

The technical core here refers to the totality of hardware, software, specialized human resources possessing knowledge.
The first phase of the interface between the user and the KM system is , usually represented by a web-browser. It is the top layer of the KM system's architecture. To the user, beyond this layer is just a black box. The objective is to move the information and knowledge into and out of the KM system.

Given below is the Technical layer of the KM system:



14.05.00 Capturing Tacit Knowledge:

14.05.01 Introduction

Explicit knowledge capturing is relatively easy. It can be done through DBMS, Data warehousing, and Data mining.
Tacit knowledge resides in the minds of people- the experts in the department, division, firm or the industry / institutions.
The knowledge developer converts human ***"know-how"*** into machine ready ***"say-how",*** by using an iterative process of articulation, a series of refinement cycles, rapid prototyping, in which the computer's performance is compared to that of human effort.
In other words, tacit knowledge possessed by experts is captured and converted into rules that the computer can use in getting the information / knowledge into and out of the KM system.

Definition

We define knowledge capture as a process by which the expert's thoughts and experiences are captured. It may be thought of as "mind automation". Knowledge capture may also include capturing knowledge from other sources such as books, technical journals, and drawings. Knowledge capture is a process in which a knowledge developer collaborates with the expert to convert expertise into a coded program.

Steps involved are:

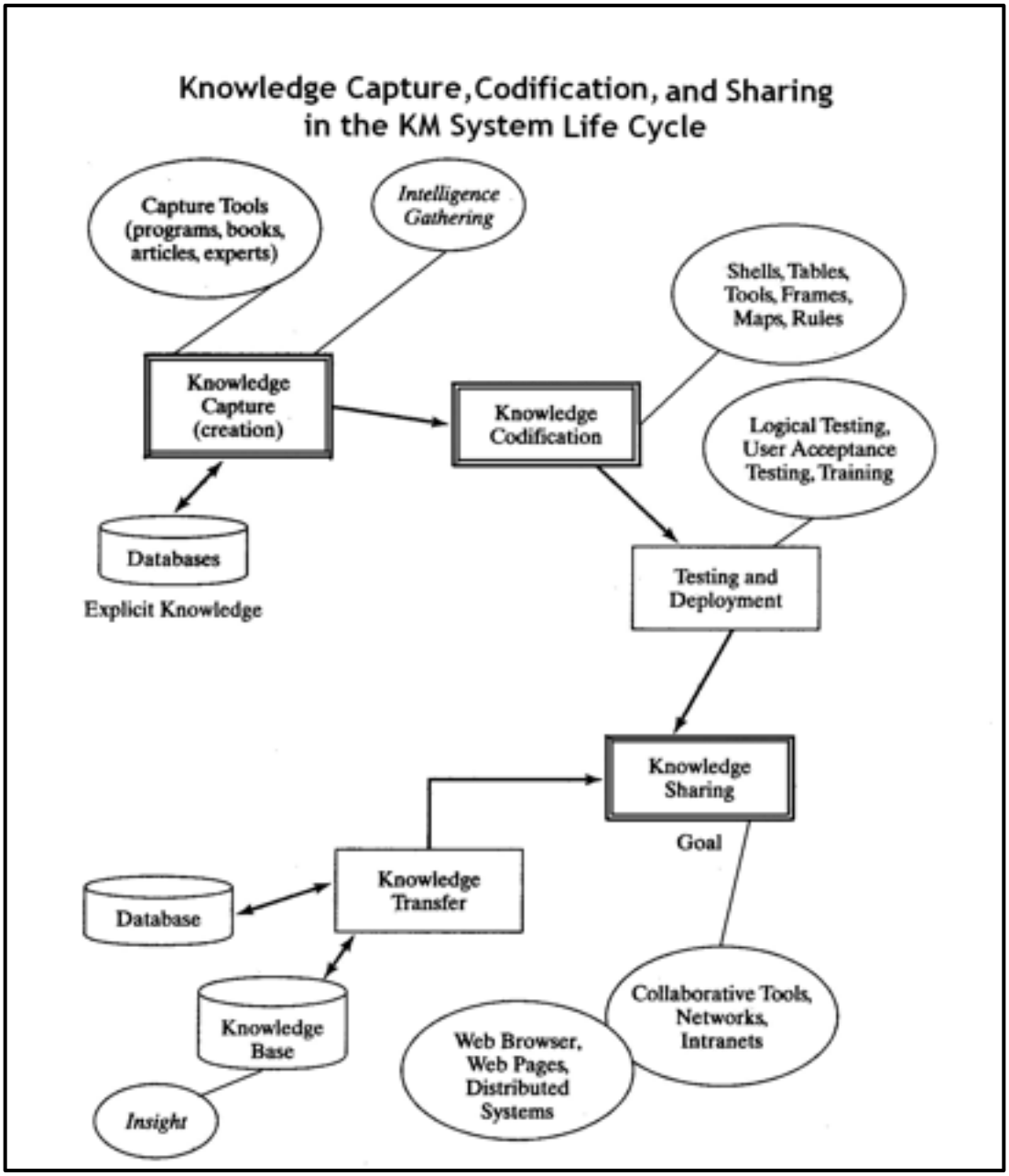
1. Using an appropriate tool to elicit information from the expert.
2. Interpreting the information and inferring the expert's underlying knowledge and reasoning process.
3. Using the interpretation to build the rules that represent the expert's thought process and solutions.

The KM system's task is not simply to display knowledge but also to codify it at different levels of reasoning and explanation.

The knowledge developer interviews the expert in the process of knowledge capture and asks questions such as:

What do you do as a first step?
What information do you consider next?
What are the constraints?
What is the logic?
How do you keep a record?
etc…

14.05.02 Capturing Tacit Knowledge and Knowledge Codification in the KM System Life Cycle



Knowledge Capture, Codification, and Sharing in the KM system life cycle

14.06.00 Knowledge Capture Techniques

14.06.01 Introduction

Acquiring knowledge from multiple experts requires experience and special techniques.

14.06.02 On-site Observation (Action protocol)

The knowledge developer observes the expert while in action and captures the knowledge.

14.06.03 Brain Storming

The knowledge developer invites two or more experts into a brain storming session in which a variety of ideas are thrown up. In brain storming session all options are given equal attention.

Steps:

- Introduction.
- State the problem.
- Prompt the experts to generate ideas
- Watch for signs of convergence on a possible solution.
- Capture the consensus ideas.

14.06.04 Electronic Brainstorming

Experts sit around a U-shaped desk with PCs networked through a software tool, to facilitate exchange ideas instantly. Software projects ideas on a big screen without mentioning the source, to avoid bias. The out come is a joint ownership.
Experts' ideas are prioritized that may lead to some convergence and evolution of a solution to the problem.

Steps:

- Expert ideas are projected without mentioning the source.
- Prioritization of ideas.
- Experts' convergence.
- Experts' specification.
- Joint ownership through consensus.

14.06.05 Protocol Analysis

Listen to an expert speaking while in action to capture the knowledge.

14.06.06 Nominal Group Technique (NGT)

Several experts with overlapping knowledge / experience are involved in the process.

Steps:

- Knowledge developer explains the problem to the panel.
- Each expert writes down on a paper to list a solutions and states *pros and cons.*
- The knowledge developer prepares a compiled list of *pros and cons* stated by all experts and copies are given to each one of them.
- Then follows an iteration process and a list of possible solutions is compiled.
- A group discussion follows, to work out the best possible solution.

14.06.07 Delphi Method

Exercise: Success or failure of a new product introduced in the market / sales forecast. Basically, it is survey of experts. The experts work anonymously.

Steps:

1. The knowledge developer / coordinator states the problem and issues a questionnaire to all participants independently.
2. The opinions are collected anonymously and shared with all the participants by the coordinator. All extreme estimates are deleted from the list.
3. Then a second round of the same process takes place.
4. The experts prepare a revised estimate based on the information gathered in the previous round.
5. The process of iteration continues until a consensus is arrived at.

14.07.00 Knowledge Codification

14.07.01 Introduction

In last chapter, we learned about knowledge capture. Next step in KM is to codify the knowledge in a manner amenable for easy access, explicit display, transfer and use by authorized persons. Getting the right knowledge to the right people at the right time is the whole idea behind knowledge codification.

14.07.02 What is knowledge codification?

Codification is converting tacit knowledge into explicit knowledge in a usable for the organizational members. It is about converting from undocumented to documented information. The knowledge is generally organized in the form of a decision tree, decision table, or a frame.

Codification is making corporate specific knowledge – tacit and explicit – visible, accessible, and usable for value-added decision making, no matter what form it ma take.

14.07.03 Why codify?

Every organization has to adapt to changed environment from time to time. Changes in customer preferences, technology, market volumes etc.
In codifying knowledge, the resulting updated knowledge base serves in several important training and decision-making areas.
Among these, important ones are the following:

14.07.03.01 Diagnosis

A diagnostic KM system is loaded with identifiable information through user's experience. Built into the system's knowledge base is a list of all the identifiable symptoms of specific causal factors.

E.g. Observed symptoms vs. a disease or vice-versa are built into the KM system.

E.g. Starting trouble in an automobile: What are the possible causes?

14.07.03.02 Instruction / Training

This is useful for training new recruits.

14.07.03.03 Interpretation

Interpretive codified knowledge systems compare certain aspects of an operation to present standards.

E.g. Sensor data is codified: If the water temperature in the automobile goes beyond 50% of maximum specification, a warning may flash “CHECK ENGINE OIL”

14.07.03.04 Planning and Scheduling

A planning KM system maps out an entire course of action to achieve a goal.

E.g. War strategy and schedule can be codified. The system creates detailed lists of sequential tasks necessary to achieve goals. For instance, we may plan to reduce enemy’s capability in five days, viz. US invasion of Afghanistan.

14.07.03.05 Prediction

Predictive KM systems infer the likely outcome of a given situation and flash a warning for corrective action. E.g. Weather prediction, Hurricane prediction etc

14.07.04 Codification Tools and Procedures

Codification schemes can be in several forms viz. Graphical, Tabular, or Descriptive statements.

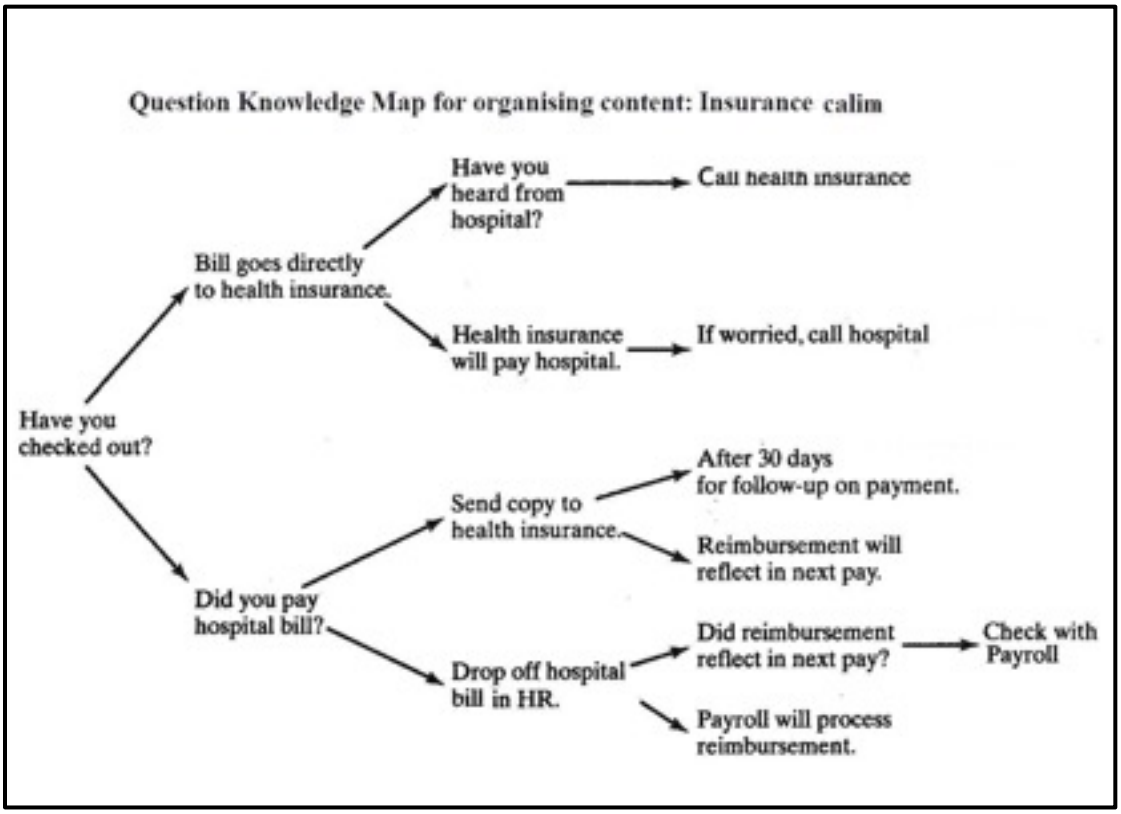
Codification schemes:

1. Knowledge maps.
2. Decision tables.
3. Decision trees
4. Rules.
5. **C**ase **B**ased **R**easoning (**CBR**).

14.07.04.01 Knowledge Maps

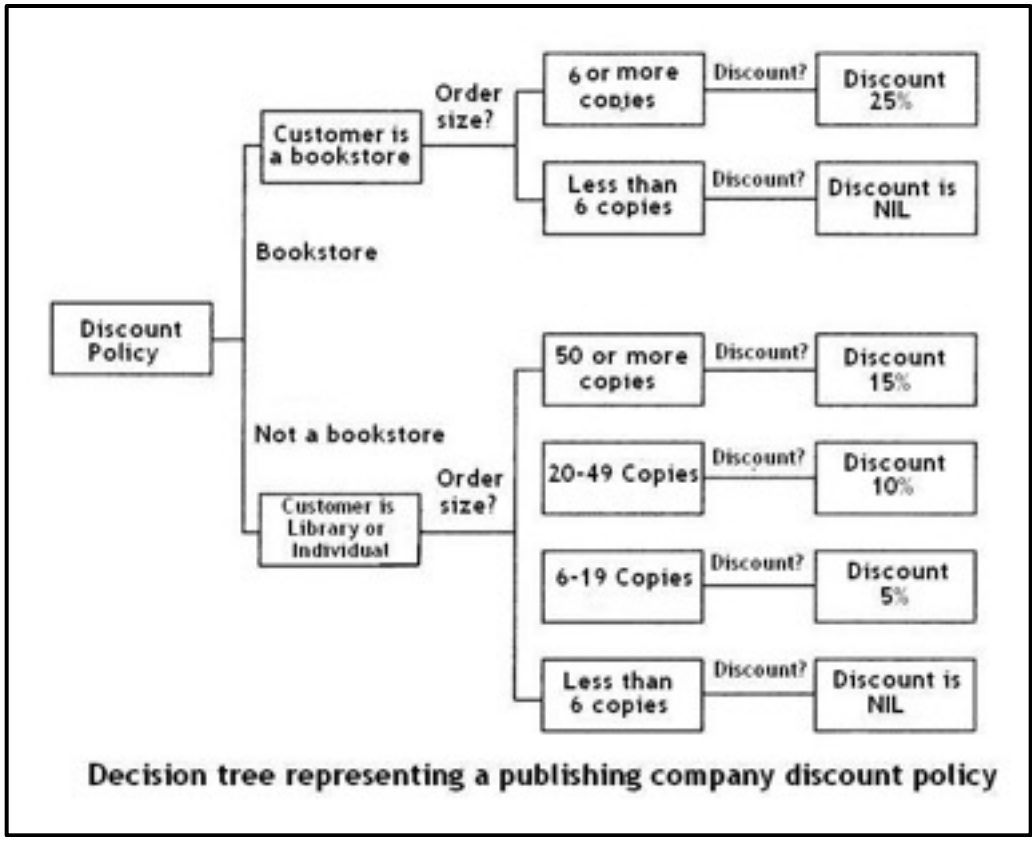
A knowledge map is a visual representation and not a repository.
Using is the aim of "knowledge maps" – Not capturing or storing.
A knowledge map is directory that points to people, documents, and repositories. he main purpose of the maps is to direct people, where to go when they need certain expertise.

E.g. Health insurance claim guidance map.



14.07.04.02 Decision Tables / Decision Trees

Given below is a decision tree representing the discount policy of a publishing company.



Decision tree representing a publishing company discount policy

14.07.04.04 Rules

A popular form of tacit knowledge is based on ***production rules***, commonly known as ***rules.*** Rules are conditional statements.
Syntax: **IF (premise) ……THEN (action)……**

Example: Loan sanctions' rules:

IF income is "average" and credit rating is good, **THEN** sanction the loan
Knowledge based rules differ from traditional if-then programming statements.
In knowledge-based systems, the rules are relatively independent of one another and are based on heuristics or experiential reasoning rather than algorithms.

14.08.00 System Testing and Deployment

14.08.01 Introduction

KM system reliability is an important testing issue. ***Reliability*** refers to how well the system delivers the information or solution with consistency, accuracy, and integrity.

The prime considerations behind reliability are:

A) Quality assurance.

B) Maintainability of the system.

14.08.02 Knowledge Testing

The most challenging part of KM systems is “testing”.
The basic motivation is to control performance, efficiency, quality of the knowledge base.

The two main systems of testing are:

- **Logical Testing** to ensure that the KM system gives correct info / solutions.
- **User acceptance testing** follows logical testing and checks the system’s behavior in a realistic environment.

14.08.03 Approaches to Logical Testing

What is circular error" If Rule#1 is = A<B, Rule#2 = B<C, and Rule#3 = C<A;
Then Rule#3 is circular and contains an error in logic.

Attributes to Logical Testing:

Attribute	Description
Circular	A situation where the action(s) of one piece of knowledge may lead back somehow to the condition statement of the same piece of knowledge.
Completeness	The system deals with a situation under all circumstances reasonably well.
Confidence	Level of trust and reliability.
Correctness	Described as accuracy.
Consistency	A check to ensure that the system produces similar answers to all input data at all times without any contradiction.
Redundancy	Duplication of knowledge, albeit in a different form.
Reliability	How well the system delivers solutions with consistency, accuracy, and integrity.
Subsumption error	The conclusions of 2 pieces of knowledge are the same, except that one piece of knowledge has fewer condition statements.

14.08.04 Select Criteria for User Acceptance Testing:

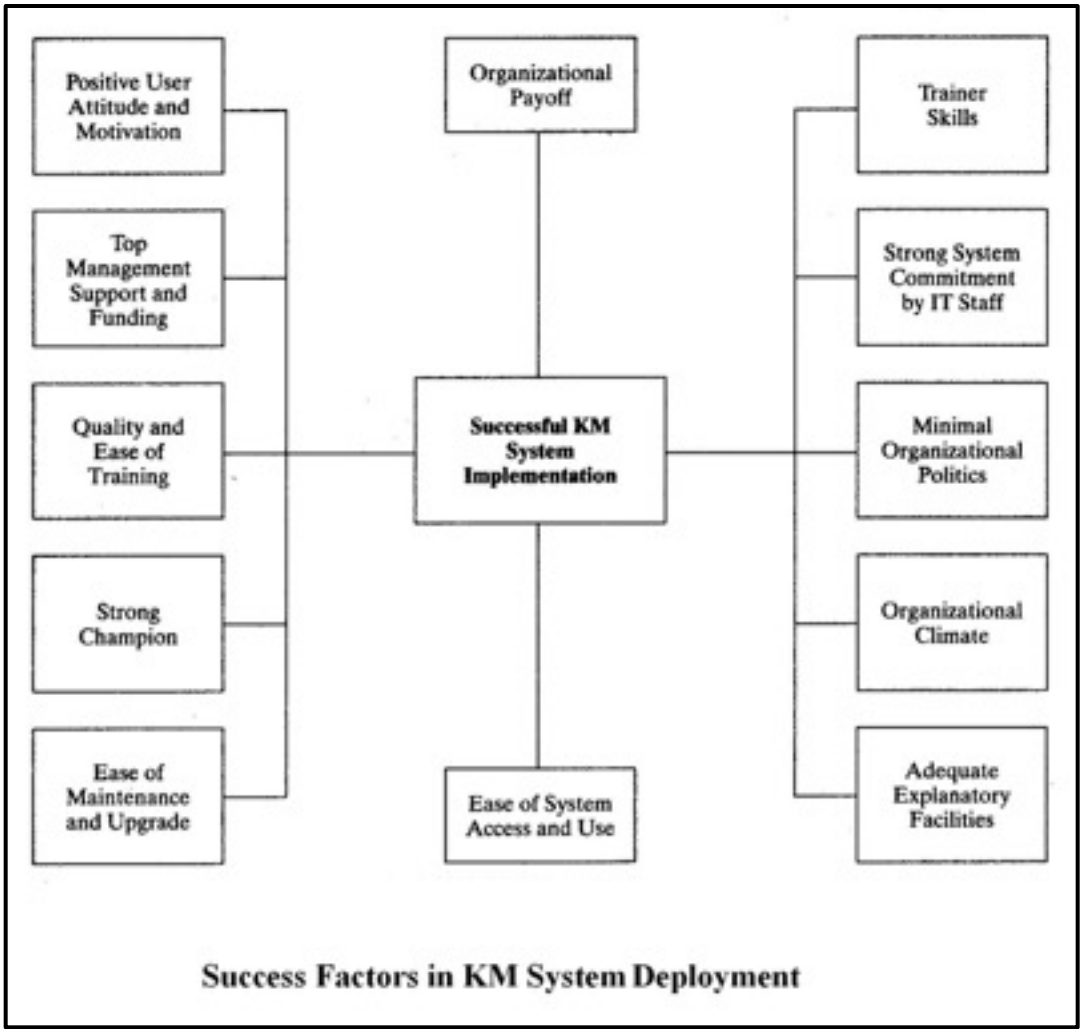
- Accuracy of the outcome.
- Adaptability of the system to changing situations.
- Ease of use.
- Credibility.
- Performance.
- Reliability.

14.08.05 KM System Deployment

The goal of every KM system is its successful deployment.

Deployment is affected by organizational, technical, procedural, behavioral, economical, and political factors especially in large organizations where existing technology is well established. KM system development is complex in such a case.

The success of KM system deployment has a great deal to do with the way the problem domain was selected. For example, if the domain was selected with end-user involvement, one can expect smooth and successful deployment.



Success Factors in KM System Deployment

14.09.00 Knowledge transfer and knowledge sharing

14.09.01 Introduction

We have seen that for knowledge to be shared, it must first be captured, codified and deployed in a format acceptable to the user. The goal is to turn knowledge into action or transform individualized learning into organizational learning.

It may come from knowledge bases, data bases, or via internet.

Knowledge may be transferred between persons and computers, computers and computers, teams and individuals, or between individuals.

14.09.02 Knowledge Transfer as a Step in the Process:

It is conveying the knowledge of one source to another source. Merely making knowledge available is not considered as knowledge-transfer. It is transmission and absorption of knowledge. The goal is to promote and facilitate knowledge sharing, collaboration, networking, cross-fertilization of knowledge, and create an organizational environment of excellence.
Knowledge transfer is done directly by working together, communicating, learning by doing, apprenticing, or embedding knowledge in documents.
Knowledge can be transferred from repositories to people, from teams to individuals, and between individuals.

E.g. When an IT employee asks another how create an HTML page (Web-page), it is a request for knowledge transfer.

14.09.03 Transfer Methods

Once knowledge is captured, codified, and becomes available, the final step is to transfer it for use by others. Recipients could be a team, a group, or individuals. Knowledge management implies formalized knowledge transfer and requires specific strategies to ensure successful transfer. Knowledge is transferred via documents, an intranet, groupware, databases, knowledge bases, and the like.

By far, the most efficient channel for knowledge transfer is face-to-face meetings in the business place.

Inhibitors of knowledge transfer:

- Lack of trust.
- Lack of time for meetings / conferences.
- Status of the knower (Higher the level, better it is).
- Quality and speed of transfer.

How knowledge is transferred?

14.09.03.01 Collective Sequential Transfer

An ongoing team specialized in one specific task moves from location to location and performs the same job. E.g. Plumbing work in buildings etc
Knowledge is transferred from one member to another in the field. There is no knowledge transfer from one team to another. Knowledge is transferred from one site to another.

14.09.03.02 Explicit inter-team Transfer

This type of knowledge transfer allows a team that has done a job on one site to share the experience with another team-working on a similar job on another site. Most of the explicit knowledge pertains to routine work and procedures are precise.

14.09.03.03 Tacit Knowledge Transfer

This type of knowledge transfer is unique in complex, non-algorithmic projects, where knowledge is mentally stored. The team receiving tacit knowledge is different by location, by experience, by technology, and by cultural norms. For instance, an expert team from USA may go to Kuwait to transfer tacit knowledge reg controlling a blow-out in an oil field.

14.09.04 Role of Internet in Knowledge Transfer

The internet is more about knowledge exchange, rather than technology.
Its reach is gigantic. Its speed is phenomenal. It can transfer knowledge to several users simultaneously.

Unique benefits of the internet:

- Aids doing business fast.
- Aids gathering of opinions and trying out new ideas.
- Provides Level playing field.
- Enables superior customer service (FAQ system).
- Enables speedy communication (Email etc…)
- Useful for online sales.
- Serves as an effective medium of advertisement

14.10.00 Knowledge transfer in the E-World

14.10.01 Introduction

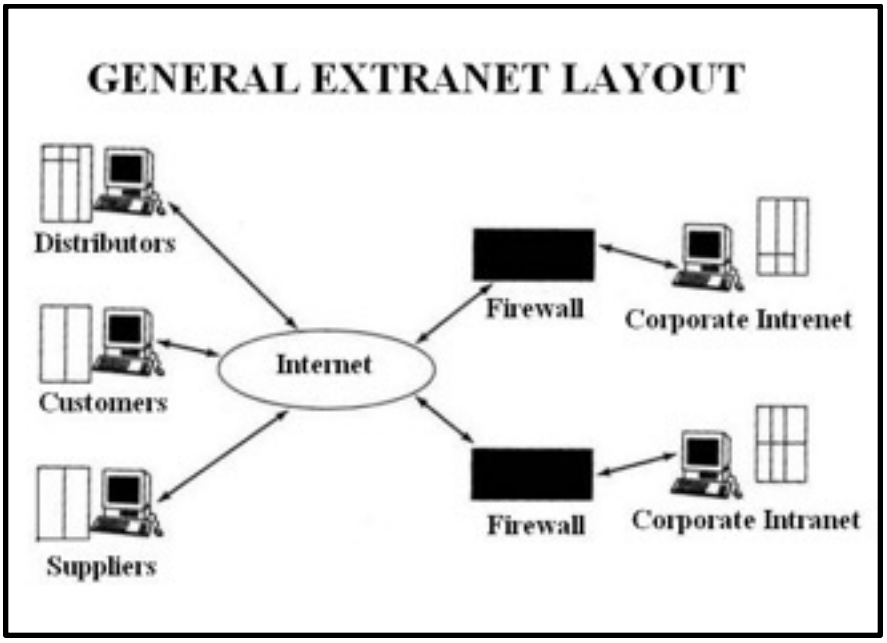
One area where knowledge transfer has gained popularity is in e-business and e-commerce. Today's electronic market places improve knowledge sharing between merchants and customers and promote quick, just-in-time deliveries.
By e-world, we refer to the electronic facilities available to a company that accommodate knowledge transfer and knowledge exchange, regardless of place, location, or dialogue. The facilities include the intranet, extranet, groupware, e-commerce, and e-business. These commonly used technologies address knowledge management solutions.

14.10.02 Intranet

Intranet is a term used when we apply internet technology to serve the internal needs of an organization. The web-browser is readily available and familiar access tool.
Intranets operate across platforms such as windows, UNIX, and Mac. An intranet facilitates knowledge transfer and knowledge sharing in intelligent applications, such as email and chat rooms.

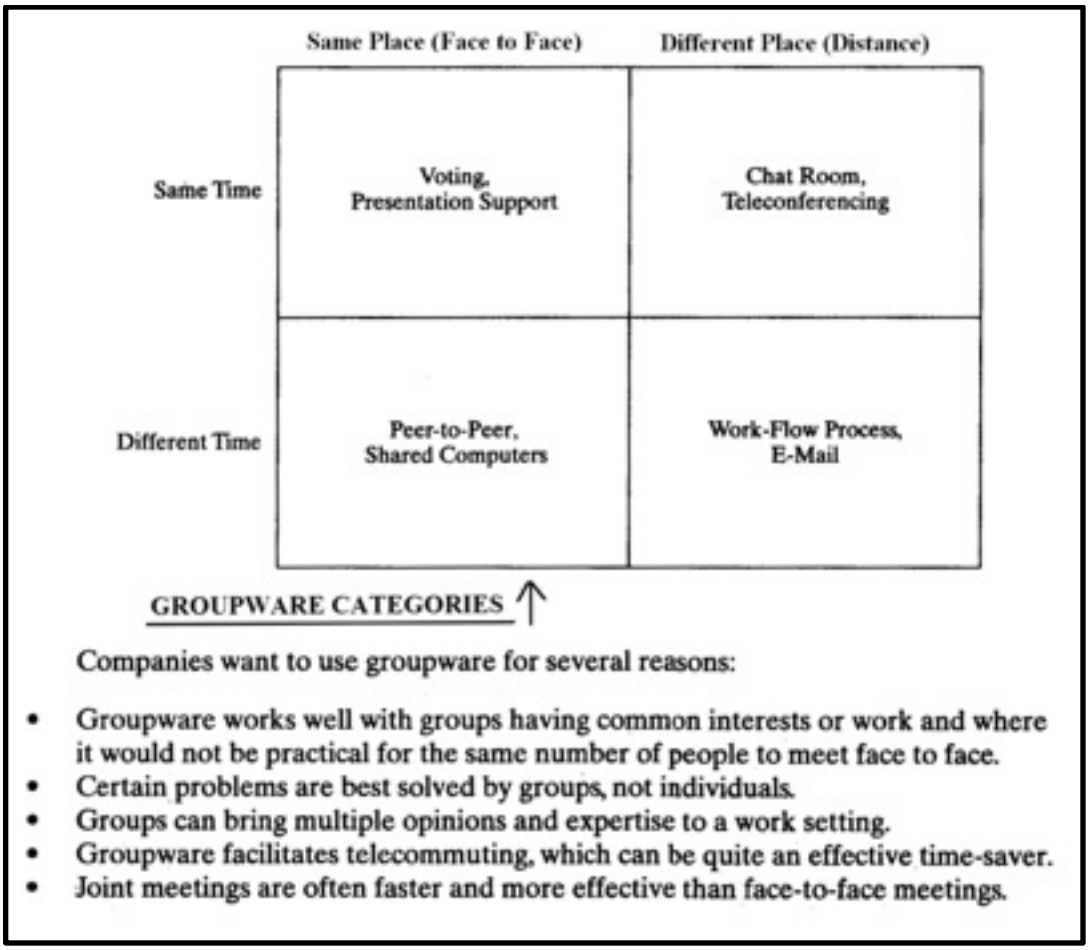
14.10.03 Extranets

If a company website links two or more trading partners, it is referred to as B2B (Business to Business) or extranet.



14.10.04 Groupware

Groupware is software that helps people to work together, especially for organizations that are geographically distributed and less likely to encounter face-to-face exchange among knowledge workers. Through this specific class of technology, people rely on groupware to communicate ideas, cooperate in problem solving, coordinate work-flow, or negotiate solutions.



Companies want to use groupware for several reasons:

- Groupware works well with groups having common interests or work and where it would not be practical for the same number of people to meet face to face.
- Certain problems are best solved by groups, not individuals.
- Groups can bring multiple opinions and expertise to a work setting.
- Groupware facilitates telecommuting, which can be quite an effective time-saver.
- Joint meetings are often faster and more effective than face-to-face meetings.

Groupware applications:

- Email with attachments, creating mailing groups.
- News groups and workflow systems.
- Chat rooms.
- Video communications.
- Knowledge sharing.
- Group calendaring and scheduling (project coordination).

14.10.05 E-Business

E-business brings the universal access of the internet to core business process of exchanging information between businesses, between people within the same business, and between a business and many clients.

From an interface perspective, e-business involves various knowledge exchanges:

- Business to business- internet and extranet- (B2B): E.g. Supply chain management (SCM).
  The objective of SCM is to have the right product in the right place, at the right time, at the right place, at right time and at right price.
  SCM = Supplier's supplier ➔ supplier ➔ Manufacturer ➔ Customer ➔ Customer's customer etc…
- Business to consumer: (B2C) – on internet: E.g. Merchant's web stores.
- Consumer to consumer: (C2C) – on internet: E.g. Auction sites.

14.11.00 Learning from DATA - TOOLS

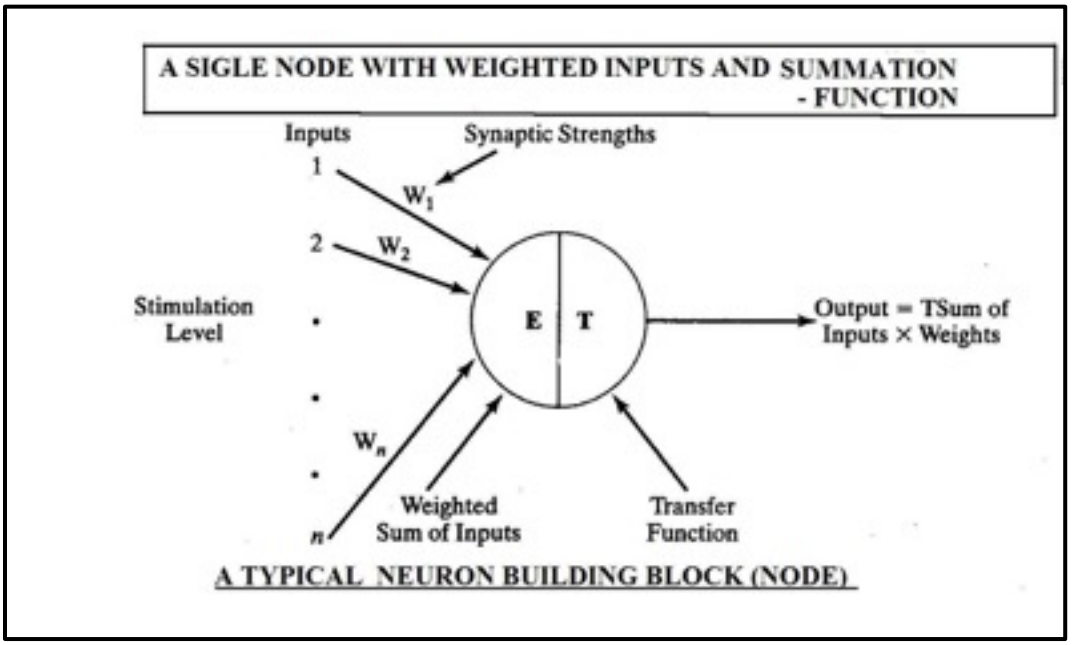
14.11.01 Introduction

The collaborative intelligence layer of KM infrastructure relies on several technologies, including artificial intelligence, expert systems, data warehousing, case-based reasoning (CBR), and neural networks.
The goal of learning concept is to improve the communication and quality of decision-making. Learning tools and procedures provide new knowledge about a product, or a service. In a knowledge automation environment, learning is the process of filtering ideas and transforming them into valid knowledge, having the force to guide decisions.

14.11.02 Neural Networks as a Learning Model

Neural network technology is modeled after human brains ie simulation of biological information processing via massive networks of processing elements called neurons. The neural networks are not digital or serial; they are analog and parallel. They learn by examples and evolve; and not guided by programmed rules.
The human brain comprises about a billion neurons. Each neuron interacts directly with 1000 -10,000 other neurons. A neuron fires or does not fire, depending on the strength of the input signals. Each neuron is viewed as a self-programming system that computes an output signal from an input signal. Each neuron has a transfer function that computes an output signal form input signal(s). The neuron fires only when the combined strength of inputs is above a threshold level. The rate of firing determines the magnitude of information. The brain accepts the inputs that lead to a process of learning. The neurons are electronically interconnected and form a massive network. Neural networks are best applied in situations having a need for pattern recognition. Financial institutions, for example, are using neural networks to simulate cash management, asset management etc. In the capital investment arena, neural networks are used to simulate the reaction of investors to changes in organizational concerns such as capital structure, dividend policy, and reported earnings.

A typical neuron building block or ***node*** is shown in the following figure.



14.11.03 Classification Trees

Let us consider a case of logic for sanctioning or rejecting a loan application from a customer.

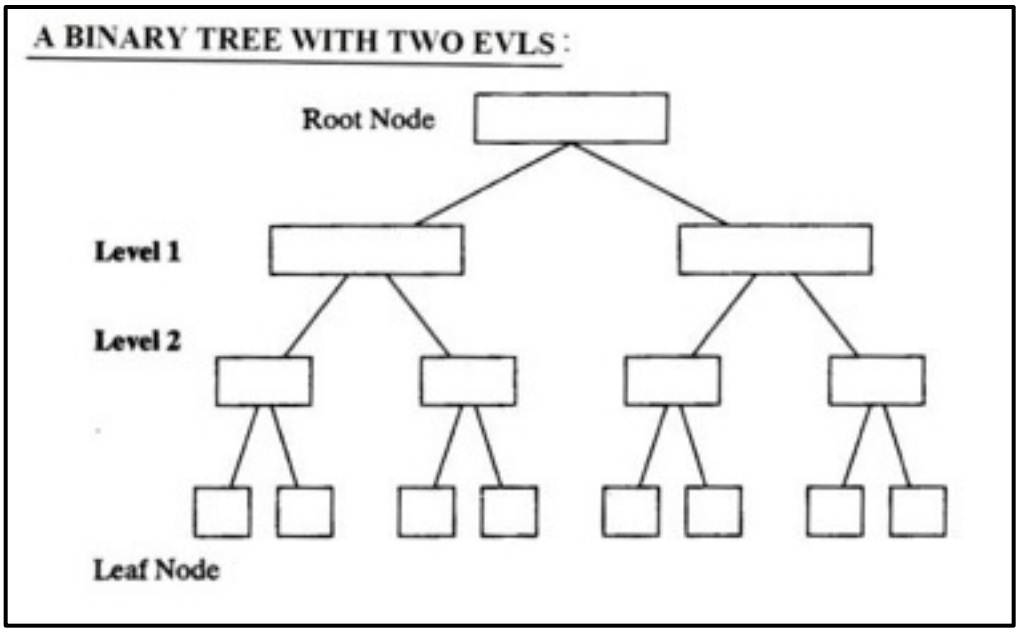
We can from past data / experience of defaulters, can build the logic as ***"If savings account average > $ X and assets owned by the applicant > $ Y, then grant loan; else reject the application"***.

In the historical data-base, the bank has the needed information about previous customers who honored the debts and those who did not. For the banker, it is important to find a reasonable argument to justify action.

By using classification tree algorithms technique, we could formulate the loan sanction criteria as stated above. In this case we consider savings account as the root-node

The concept of 'tree' is derived from graph theory.

A tree is a network of nodes connected by areas – also called branches – so that there are no loops in the networks. In general, there is a root node that is considered to be the starting node of the tree. The ending nodes of the tree are called leaf nodes. The root and leaf nodes are separated by a certain number of intermediate node organizations in layers some times called levels.
The following figure shows a tree with two intermediate levels.



14.12.00 Data mining- Knowing the Unknown

14.12.01 Introduction

Data can be source of undiscovered knowledge. We had discussed the process of extracting knowledge from data and information stored in databases, data warehouses, and other repositories in the previous chapter under MIS. The process is called data mining. Data mining plays an important roll in decision making process and is a key success factor in conducting business.

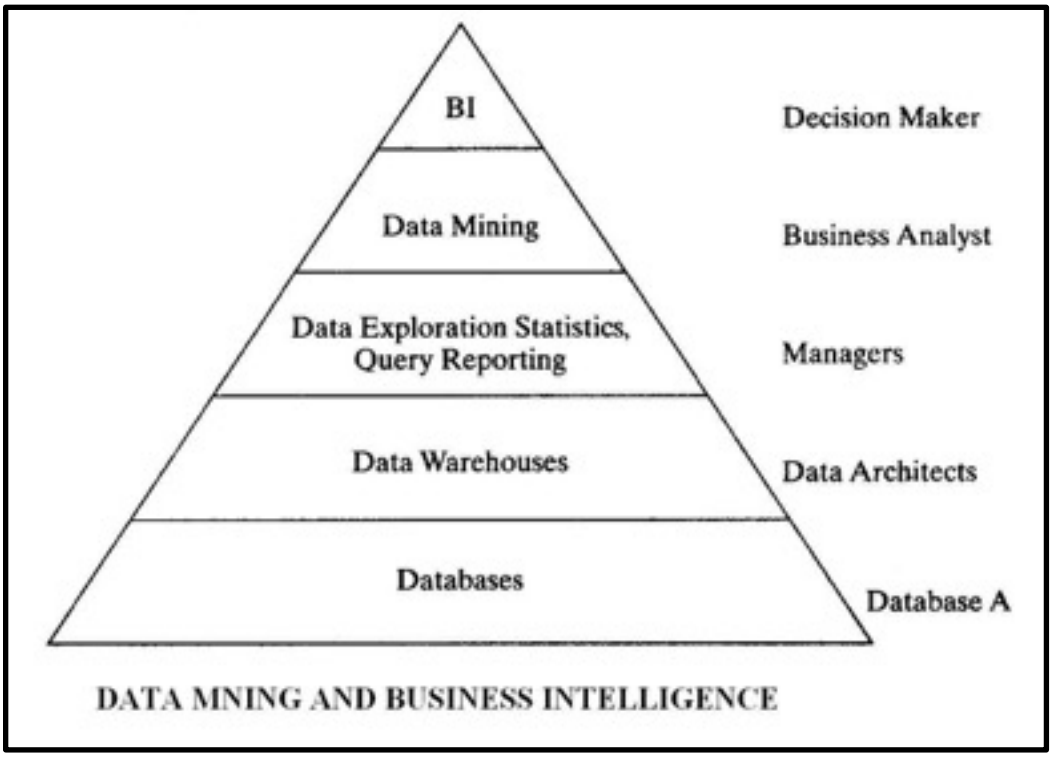
Definitions:

- The search for relationships and global patterns that exist in large databases but are hidden among the vast amount of data.
- A set of techniques used in automated approach to exhaustively explore and bring to surface, complex relationships in very large data sets.
- The process of finding previously unknown and potentially interesting patterns and relations in large databases.

14.12.02 Business Intelligence: (BI)

BI is a global term for all processes, techniques, and tools that support business decision making based on information technology. The approaches can range from a simple spreadsheet to an advanced decision support system (DSS).

Data mining is a component of BI. The following figure shows positioning of different BI technologies used at different levels of management and different purposes including tactical, operational, and strategic decisions.


BI
Decision Maker
Data Mining
Business Analyst
Data Exploration Statistics,
Query Reporting
Managers
Data Warehouses
Data Architects
Databases
Database A
DATA MNING AND BUSINESS INTELLIGENCE

14.13.00 Knowledge Management Tools and Knowledge Portals:

14.13.01 Introduction

Portals are considered to be virtual workplaces that:

- Promote knowledge sharing among different categories of end-users such as customers, partners and employees.
- Provide access to structured data stored in data warehouses, database systems, and transactional systems.
- Organize unstructured data such as electronic documents, paper documents, lessons, stories and the like.

Portals are web-based applications providing a single point access to online information.

14.13.02 Knowledge Portals

The main goal of a portal is to provide a single point of access to all information sources. Because of diverse information needs of various individuals, the portals have to deliver personalized interface.

As the situations are complex, the portals need to include the following functionalities.

1. Gathering and storing of data in multiple ways.
2. Categorization of information for easy access.
3. Distribution of structured information to users in the form electronic documents (Files, Pictures etc…)
4. Collaboration with the audience by suitable interface.
5. Publish information for a broad audience.
6. Personalization of information dissemination to increase productivity.
7. Search / Navigation for quick access to specific information.

14.14.00 Knowledge ownership - Ethical and legal issues

14.14.01 Code of Ethics

Code of ethics is a declaration of principles and beliefs that govern how the members of an organization are to behave.

14.14.02 Ethical Principles

- Justice.
- Equity.
- Honesty.
- Trustworthiness.
- Equality.
- Fairness.
- A subjective feeling of being innately right.

14.14.03 Some Important Terms to Know

- ❖ Copyright: Owners hip of an original work created by an author; a form of intellectual property protection that covers the feel, look, and content of print media like articles, textbooks, and software packages. Copyright Law gives the author or creator of a tangible product the right to exclude others from using the finished work.

- ❖ Trademark: Registration of a company's trade name so that others cannot use it; a word or a symbol that distinguishes a good from other goods in the market.

- ❖ Product Liability: A tort that makes a manufacturer liable if its product has a defective condition that makes it unusable or unreasonably dangerous to the user or consumer.

- ❖ Malpractice: Negligence or professional liability of a certified professional related to design defects in systems tailored specifically for professional use.

- ❖ Negligence: Omission to do something, which a reasonable person, guided by those considerations that ordinarily regulate human affairs, would do; lack of reasonable conduct and care.

- ❖ Warranty: A promise made by the seller that assures certain facts are truly representative of a product or service, subject to certain limitations.

14.15.00 Managing Knowledge Workers

14.15.01 Introduction

Knowledge worker is a person who transforms business and personal experience into knowledge through capturing, assessing, applying, sharing, and disseminating it with in the organization to solve specific problems or crate value.
He is the product of experience, values, processes, education, and the ability to be creative, innovative, and in tune with the culture of he organization. A sales person is a knowledge worker. Managers, lawyers, doctors, systems analysts, and accountants are knowledge workers.

14.15.02 Personality and Professional Attributes of a Knowledge Worker

- A knowledge worker incorporates several personality and professional attributes.
- Holds unique values and understands and adapts to the culture of the organization.
- Aligns personal and professional growth wit corporate vision and goals.
- Adopts an attitude of collaboration and sharing.
- Has innovative and creative capacity.
- Has clear understanding of the business, he is in.
- Is willing to learn, unlearn, and adapt to new ways of doing jobs.
- Has self-control.
- Is willing to tolerate uncertainties and grow with the company.
- Has risk-taking potential.

14.15.03 Business Roles in the Learning Organization

By learning organization, we mean an organization of people with ingrained commitment to improve their capacity, to create, and produce – who respond to uncertainty, to challenges in the market place, and to change in general.

Learning Organization is a group of people continually expanding their capacity to create what they want to create.
In brief, the rate of learning of an organization may become the most critical source of competitive advantage.

14.15.03.01 Management and Leadership

Traditional managers focus on the present and are action oriented; delegating, supervising and controlling. In contrast, smart managers focus on organizational learning to ensure operational excellence. They take the role of leadership and set direction. The focus is on future, developing strategies and sharing vision through effective communication with knowledge workers. Learning becomes the key focus for the organization's survival and growth. The leader's role in a learning organization is to facilitate the knowledge workers.

14.15.03.02 Work Management Tasks

Managers in a learning organization recognize and reward creative thinking, openness, and creativity. Work management tasks in a learning organization include the following:

- Searching out, creating, sharing, and using knowledge in everyday activities.
- Managing knowledge workers and cultivating their knowledge-oriented activities.
- Motivating knowledge workers.
- Managing collaboration among knowledge workers.
- Sharing information and integrating work among knowledge workers.
- Hiring and recruiting bright and knowledgeable workers.

14.15.04 Technology and Knowledge Worker

It plays a role in the learning organization in three key processes:

- Knowledge capture.
- Information distribution.
- Information interpretation.

In knowledge capture, a place for IT is in market research and competitive intelligence systems. Likewise, the use of e-mails, intranet can facilitate information distribution and interpretation.

14.15.05 Role of Ergonomics

With regular use of computers day after day, end-user performance and comfort are closely interrelated. No matter how sophisticated the electronic support, a knowledge worker can achieve full productivity with proper design of work environment. Ergonomics is a key issue here. Ergonomics involves comfort, safety, understanding, and ease of use.

The list of factors thataffect the ergonomics of knowledge workers fall into three major categories:

1. Environmental Issues: Lighting, Layout, Temperature etc…
2. Hardware Issues: Furniture, Comfortable seating, Design of workstations etc…
3. Knowledge worker-system interface: Documentation, User-training, Software etc…

Chapter 15
Internet and
Cloud Computing

15 Internet / Cloud Computing

We've all heard that a million monkeys banging on a million typewriters will eventually reproduce the entire works of Shakespeare. Now, thanks to the Internet, we know this is not
true.
... Robert Wilensky

Hooked on internet? Help is just a click away.

... Anonymous

Index

15.01.00 Introduction to Internet

What does **'www'** denote? It denotes **"world-wide-web".**

The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to link several billion devices worldwide. It is an international *network of networks* that consists of millions of private, public, academic, business, and government packet switched networks, linked by a broad array of electronic, wireless, and optical networking technologies. The Internet carries an extensive range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), the infrastructure to support email, and peer-to-peer networks for file sharing and telephony.

Packet switching is a digital networking communications method that groups all transmitted data – regardless of content, type, or structure – into suitably sized blocks, called *packets*.

15.02.00 Internet Governance

Internet governance is the development and application by Governments, the private sector and civil society, in their respective roles, of shared principles, norms, rules, decision-making procedures, and programs that shape the evolution and use of the Internet.

While there is no central Internet governing body of the World Wide Web, there are Internet regulation bodies that work behind the scenes to keep everything running smoothly. Here are the main Internet regulation entities:

- The World Wide Web Consortium (3WC): is the main international standards organization for the World Wide Web (abbreviated WWW or W3). The consortium is made up of member organizations which maintain full-time staff for the purpose of working together in the development of standards for the World Wide Web. The World Wide Web Consortium (W3C) has about 400 members.
- The Internet Society (ISOC): Provides leadership in addressing issues that confront the future of the Internet, and is the organization home for the groups responsible for Internet infrastructure standards. Assures the open development, evolution, and use of the Internet for the benefit of all people throughout the world. Currently ISOC has over 90 chapters in about as many countries.
- The Internet Architecture Board (IAB): Responsibilities include Internet standards and oversight.
- Internet Engineering Task Force (IETF): A large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. It is

open to any interested individual. IETF develops and promotes a wide range of Internet standards dealing in particular with standards of the Internet protocol suite. Their technical documents influence the way people design, use and manage the Internet.

- Inter-NIC: Provides public information regarding Internet domain name registration services.
- People for Internet Responsibility (PFIR): A group of people concerned about the present and future operations, development, management, and regulation of the Internet.
- The Internet Corporation for Assigned Names and Numbers (ICANN): is a technical coordination body for the Internet.

15.03.00 Words of Caution

Now, please let me initiate you to the cyber space, with a few statements of caution.

- The internet is a double-edged sword; you have got to know how to wield it.
- The internet is a wild horse; you need to know how to ride it.
- The internet is fraught with danger; you have to have your defenses in place.
- The internet could be vulgar; you must learn to keep away, unless you are a party to it.
- The internet is infested with predators on the prowl; you need to be slippery.
- The internet is flooded with garbage; you have to sift through it.
- The internet promises you a lot of free stuff; however, there is no such thing as a free lunch in this planet.
- The internet is infinite (well... almost...) ; you need to be focused; else, you will be marooned in cyberspace.
- The internet is addictive; you have to guard yourself against this addiction.

15.04.00 Development of a Website

Do you want to develop a website of your own? It is very simple and inexpensive indeed.

1. First, think of a name comprising any numeric /alphabetic characters and optionally an underscore _.

2. Select the type of the domain such as: xxx**.com**, xxx**.net**, xxx**.org**, xxx.**info**, xxx**.in** etc. depending on the application e.g. **.com** for **com**mercial application; **.org** for **org**anizational application; **.info** for **info**rmation application; **.in** for India based websites

etc. However, there is no particular or statutory restriction in choosing a domain name. Take whatever suits you.

3. Finalize the web address also known as URL (Unique resource locator) eg: **www.englishwordbank.com .**

4. Register your chosen domain name with any approved registrar; such as ***www.net4india.com*** etc. It may cost you as little as US$ 10 per year.

5. Develop web content yourself or through a consultant. Programming applications such as HTML (Hyper Text Markup Language), JAVA etc are extensively used in development of web content. You can display text, tabulations, images, videos, animations, color backgrounds etc in your website. The website may be static or interactive in nature. Sky's the limit for a website capability / web applications.

6. Select a web-service to host your website such as ***www.angelfire.com .*** You can also develop a free homepage - without even registering a domain name - using a template at this website even if you have no knowledge of software. It is all self explanatory. Try it out; you have nothing to lose except some sleep. You may provide the URL of the website where it is actually hosted to the domain name registrar in order to redirect the viewers who use the registered domain name as URL.

7. Launch your website.

8. Promote your website in the market.

9. Get on with your business or hobby in the world-wide-web.

Probably, you are already adept at surfing the web. I presume that you are familiar with email applications on the web in particular. A website may be static or interactive.

An example of static website displaying information is ***www.englishwordbank.com.***

Please visit a few interactive websites to understand the full power of the internet such as: Air India website viz. ***www.airindia.com***, Indian Railways website viz ***www.irctc.co.in***, a travel website viz. www.makemytrip.com, an education website such as ***www.math.com*** etc , an online sales website viz. ***www.flipkart.com*** etc

15.05.00 Cyber Space Terminology

You might have been often frustrated while probing the cyber world, especially when a strange response pops up on your screen. No one hears you scream in the cyber space! You are left to fend for yourself. You have to be right in every keystroke on the computer or else! Therefore, it pays to be a computer literate. In the previous chapter you have familiarized yourself with basic computer concepts. This chapter includes the basics of internet and related words, terms, phrases, slang, and abbreviations.

Most of the terms below have a more obvious “English Usage”, but they take on a more specific meaning when used in a technological context.

* **Ontology**: In metaphysics, ontology deals with questions of existence, while in computer science, ontology takes on a specialized meaning. It is used in the field of knowledge representation to describe concepts and relationship between concepts. Once some knowledge is represented using an ontology, it may be used to derive further knowledge.

* ***Revision:*** This might be something you do before an exam, but in a software context, this usually means software or database update. The more specific term ‘revision control’ is the management of changes to files, documents etc. over time.

* ***Packet:*** Generally speaking, a packet means a small package or bundle of something. This use has been extended to computer science where it typically means a message or a message fragment that may be transmitted over a computer network. Packets can be encrypted and decrypted, and oddly enough, they may also be sniffed.

* ***Wiki:*** A website that typically functions as a collaborative tool. Any user may add and edit content to this site. The origin of the word is from Hawaiian for wiki-wiki (quick). The term was coined by Ward Cunningham, the computer programmer who invented the wiki concept. e.g. www.wikipedia.com ; www.wikileaks.com .

* ***Protocol:*** You might normally encounter this work in diplomacy or politics where it generally means some kind of formal agreement between nations, but the more specific technical term means an agreed-upon format for transmitting data between two devices.

* ***Reflection:*** We know that humans are capable of reflection. The may reflect on their life, or they may reflect on the state of the world. Software is also capable of reflection (albeit, nothing weighty). A program can make certain decisions based on what its capabilities are. Reflection allows the development of a specific class of programs that rely on the information that reflection provides. Of course, a program doesn’t really perform reflection in the same sense that humans do.

* ***Stack:*** To understand stacks, think cafeteria plates. In the classic definition of stack, a “plate” can be pushed onto the stack or it may be popped off the stack. Extending this analogy, a stack is a data structure that supports pushing a value onto it, or popping the top value off it.

* ***Abstraction:*** To make a program easier to understand and implement, abstractions are an invaluable tool. An abstraction moves a program closer to the real-world situation it is trying to model, thus hiding all the complicated underlying details.

* ***Immutable:*** This may sound like a weighty term, but we shall deal with the down-to-earth meaning of the term in computer science. In object-oriented programming, an

immutable object cannot be changed (i.e. its state cannot be changed) once it has been created. Immutable objects often make a program easier to understand, and possess several other benefits as well.

* Template: A template is an archetype of the output with “holes” in it. These holes can be filled in with values. The values may be different each time, thereby resulting in different output. Templates may be used in such simple tasks as writing cover letters, or they may be used to generate complicated output in computer programs.

**** Paginate:*** In general, paginate simply means to number the pages of a book or manuscript in sequence. If we extend the concept of page to the internet, then pagination can be used to divide up the returned information into multiple pages (such as for search results in a search engine)

**** Resource:*** This is highly overused word but, in a software program, this typically refers to a component that is short supply such as a network connection or a database connection. It’s best not to hang onto resources (or even lose them) for too long, else you will run out of them very quickly.

**** Server:*** We aren’t referring to someone in a restaurant, but the analogy can be extended to computation. Typically, a server is a computer or computer program that provides services and manages access to a centralized resource. In general, a server processes requests and returns data.

**** Vaporware:*** Used to describe products announced well in advance of any actual release. In fact, the release may never happen at all. Wired magazine even has an “annual roundup of the tech industry’s biggest, brashest and most baffling unfulfilled promises”

**** Augmented Reality:*** A view of reality that is enhanced by computer-generated information. In other words, some generated information is superimposed on the real world.

**** Cache:*** In general, a cache may mean a location where items are stored. In computer terminology, a cache is typically a mechanism to allow for faster access to data. This usually means that the data is duplicated and stored in a separate storage that provides faster access than the original storage.

**** Facet:*** Generally, this means a prominent attribute or aspect of something. However, when extended to knowledge representation, facets can be used to represent objects using multiple classifications. For example, a product may be classified by its colour, cost and so on which allows the user to perform “faceted navigation.”

**** Cyberpunk:*** Cyberpunk (a portmanteau of cybernetics and punk) is a science fiction genre. Common themes of cyberpunk include a dystopian future, advanced technology,

cybernetics, and high-tech rebels. Movies such as Blade Runner and the Matrix trilogy are famous examples of this genre.

**** Ego-surfing:*** If you've ever looked up yourself on Google, then you would be guilty of ego-surfing.

**** Address:*** No, this is not a residential or office address, but the concept is the same in the virtual world. An address is a unique identifier for locating a piece of information. Generally, an address is simply a number, but it can also use a more complicated scheme such as used for an internet address.

**** Backtracking:*** You can backtrack on a statement you made earlier, but in computer science, this is related to search techniques. If going down one path results in no useful results, then the program can backtrack to a junction and then merrily proceed along other paths.

**** Avatar:*** In Hinduism, avatar means the manifestation of a deity (typically Vishnu) in human, super human, or animal form. The general concept still applies to the digital world where it means the representation of a user within a virtual environment.

**** Partition:*** No we aren't referring to the partition of India, but to the separation of a disk drive into multiple logical units. Partitioning a disk drive allows various operations to be performed separately or even to store different kinds of information on the various partitions.

**** Script:*** Not exactly a movie script, but the idea is the same. A script is a series of instructions executed by a program or scripting engine. Typically, a script might be used to implement some functionality outside of the main program, and in a different language from the main program.

**** Nibble:*** A nibble stands for four bits (or half-byte). This pun works because a small "bite" is a nibble.

* Conficker: A sophisticated computer worm targeting the Windows operating system that surfaced in 2008. The interesting thing about the name 'conficker' is that it is thought to be a portmanteau of the English word "configure" and the German word "ficker". Go figure!

**** Attachment:*** A direct counterpart of a real-world document attachment. In the digital world, this is usually a file that accompanies an email message (i.e. not literally included in the email message itself, but as a separate part of it). The receiver of an attachment needs to use an appropriate application to read the contents of the attachment.

**** Honeypot:*** This term is inspired by the phrase "like a bear to honey". The technical term is used to refer to a decoy program that fools a computer network intruder into

believing that it is the actual system, but is actually only a sandbox where the intruder's activities can be monitored.

**** Key:*** The term key is used extensively in computer science in various contexts. In the physical world, the word key is usually associated with "security", and this is no different in the digital world. A key is a string of bits used to encrypt and encrypt information being transmitted. Usually, this involves a public key (known to more than one person), and a private key (that is known to only one person).

**** Lurker:*** This word might evoke images of a shady person hanging out on some dimly lit street. The more specific term refers to a person who lurks around in an online discussion group - reading messages but not necessarily making any contribution to the online discussion.

**** Hog:*** The pig analogy can also be applied to a computer program. Such a program tends to take a long time to complete its task, and consume an inordinate amount of valuable resources in the process (such as memory, processor, and other system resources in short supply).

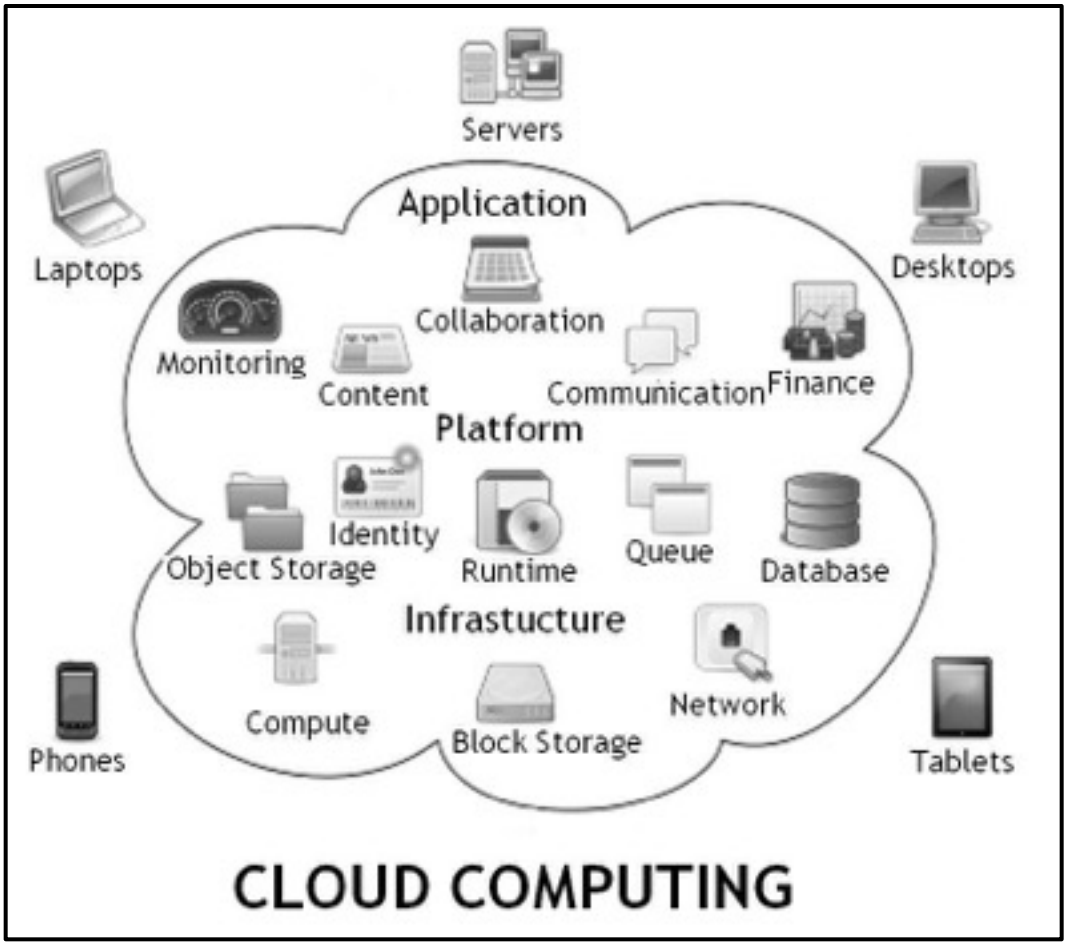
**** Spam:*** An unsolicited, often commercial, message transmitted through the Internet as a mass mailing to a large number of recipients.

15.06.00 Cloud Computing

A) Concept of cloud computing:

Cloud computing is the delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a utility (like the electricity grid) over a network (typically the Internet). Clouds can be classified as public, private or hybrid.

Cloud computing is a metaphor. For user, the network elements representing the provider are invisible, as if obscured by a cloud, which is why the term cloud computing has come into play.



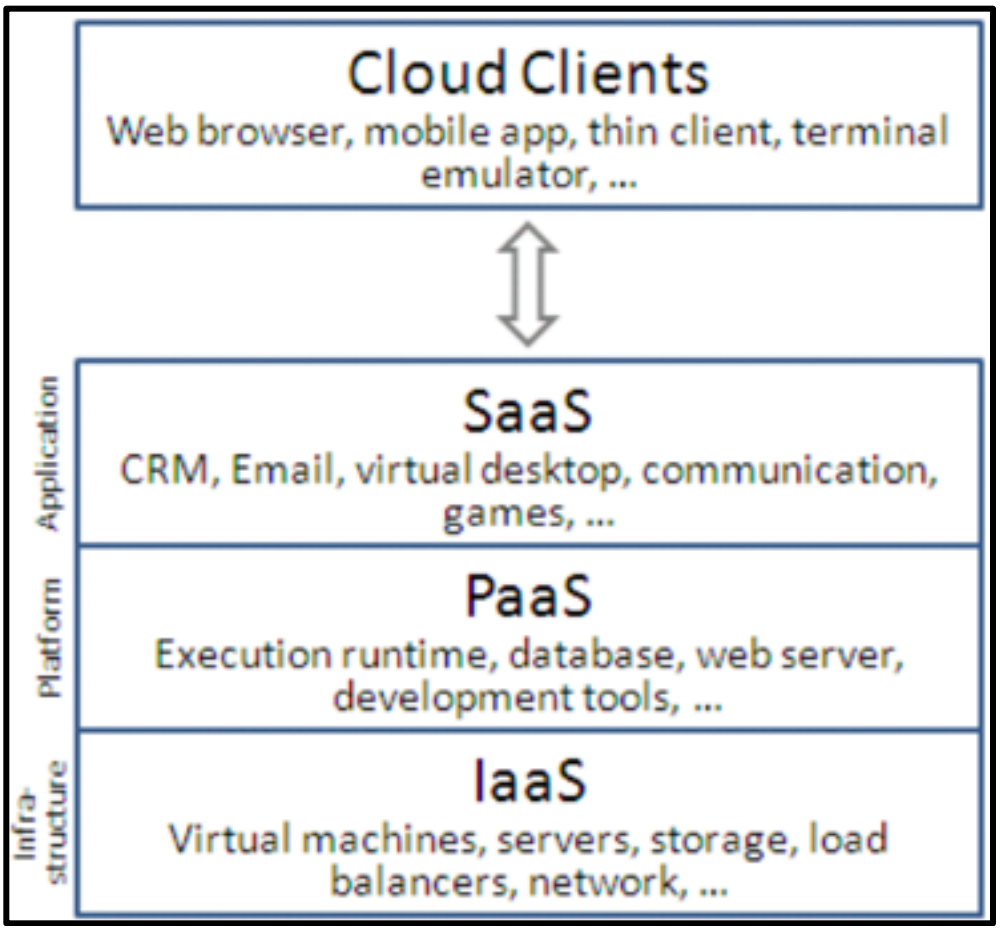
Cloud computing relies on sharing of resources to achieve economy of scale and fuller utilization of various resources at different locations. This is somewhat akin to a power grid. Cloud resources are generally not only shared by multiple users but also dynamically reallocated on demand. In other words, a company can subcontract its computer / software infrastructure requirement to a service-provider and concentrate on its core competence. It is the responsibility of the service-provider to gather resources controlled by different organizations. Companies can avoid upfront infrastructure costs, and get their projects up and running faster instead of getting bogged down with trials and tribulations of infrastructure development. The user only deals with and knows only the main cloud service provider and is oblivious of the locations of actual resources pooled by the provider. Cloud providers typically use a "pay as you go" model. Economy can be achieved only by cloud computing; going it alone would lead to high cost of operations.

Cloud computing is a kind of grid computing; it has evolved by addressing the quality of service and reliability problems. Cloud computing provides the tools and technologies to build data/compute intensive parallel applications with much more affordable prices compared to traditional parallel computing techniques.

B) Merits of cloud computing:

- Low cost for the user and economy of scale to the cloud provider.
- Easy maintenance of computer applications / software as they need not be installed on each user's computer and can be accessed from different locations.
- Device and location independence enables users to access systems using a web browser irrespective of their physical location and what device they use such as a P.C or a mobile phone.
- Can handle peak load requirements.
- Higher utilization and efficiency of the resources.
- Higher reliability of service.
- Centralization and control over vast resources by the cloud service provider results in rapid development of higher technology.
- Better monitoring of performance.
- Increased security-focused resources due to large scale centralization of data and expert supervision.

C) Service Models:



Cloud computing providers offer their services according to several fundamental models.

a) IaaS (Infrastructure as a service):

In the most basic cloud-service model, providers of IaaS offers computers - physical or virtual machines - and other resources (A hypervisor such as Xen, Oracle VirtualBox etc…)

A hypervisor or virtual machine monitor (VMM) is a piece of computer software, firmware or hardware that creates and runs virtual machines.

In computing, a virtual machine (VM) is an emulation of a particular computer system. Virtual machines operate based on the computer architecture and functions of a real or hypothetical computer and their implementations may involve specialized hardware, software, or a combination of both.

b) PaaS (Platform as Service):

In the PaaS model, cloud provides deliver a computing platform, typically including operating system, programming language execution environment, database and a web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity buying and managing the underlying hardware and software layers. Some PaaS offers: Microsoft Azure; Google App Engine.

c) SaaS (Software as Service):

In the business model using software as a service (SaaS), users are provided access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis. SaaS providers generally price applications using a subscription fee.

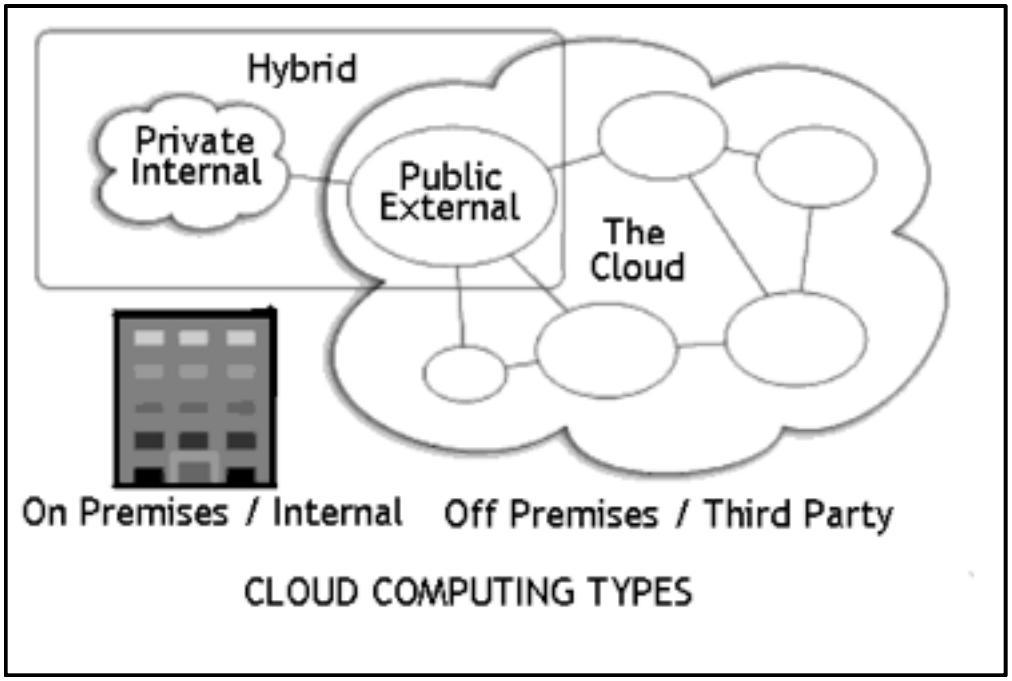
In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. Cloud users do not manage the cloud infrastructure and platform where the application runs.

This eliminates the need to install and run the application on the cloud user's own computers, which simplifies maintenance and support. SaaS allows a business the potential to reduce IT operational costs by outsourcing hardware and software maintenance and support to the cloud provider.

This enables the business to reallocate IT operations costs away from hardware/software spending and personnel expenses, towards meeting other goals.

In addition, with applications hosted centrally, updates can be released without the need for users to install new software. One drawback of SaaS is that the users' data are stored on the cloud provider's server.

D) Cloud Deployment Models:



a) Private Cloud: This is a cloud infrastructure operated solely for a single organization, whether managed internally or by a third party, and hosted either internally or externally.

b) Public Cloud: A cloud is called a 'public cloud' when the services are rendered over a network open to Public.

c) Hybrid Cloud: A hybrid cloud is a combination of two or more clouds - private, community, or public - that remain distinct entities, but are bound together, offering benefits of multiple deployment models.

The cloud is for everyone. The cloud is a democracy.

- The cloud saves your infrastructure cost.
- The cloud facilitates speedy implementation of your IT projects.
- The cloud provides expertise.
- The cloud provides security to your data-base.
- The cloud reduces your running cost.

Chapter 16
Business Economics

16 Business Economics

Business economics is for the benefit of 'haves' and not for 'have-nots'.

... Reddigari Seshadri Reddy

Chapter	Title
16	**Business Economics**
16.01.00	Introduction to Business Economics
16.02.00	Choice Behavior
16.03.00	Microeconomics
16.04.00	Macroeconomics
16.05.00	Business Economics
16.06.00	Scope of Business Economics
16.07.00	Significance of Business Economics

16.01.00 Introduction to Business Economics

16.01.01 Economics – Definition

- Used with a singular verb – The science that deals with the production, distribution, and consumption of goods and services, or the material welfare of humankind.
- Used with a plural verb – Financial element of something: e.g. the economics of running a business.

16.01.02 Business Economics - Definition: Business economics is a field in applied economics which uses economic theory and quantitative methods; and deals with economic issues and problems related to business organization, management, strategy, and expansion.

Issues and problems might include:

- How and why corporations emerge / expand /exit.
- The impact of entrepreneurs.
- Relationship and interaction between corporations.
- The role of Government in regulation.
- Relationship between the firms and labour.
- Capital Market.
- Product Market.
- Significance of organization structure.
- Business Environment.
- Financial issues and challenges.

Corporations make strategic decisions that can result in a profit or loss. Business economics studies how and why corporations make these decisions and how other economic factors can influence their choices.

Business Economics - also known as Managerial Economics - has developed itself into a sub-science within economics. Business economics is concerned with predominantly the economic problems of businesses. In this sense, some regard business economics as a form of micro economics. It is also sometimes referred to as the interface between business administration and economics.

16.02.00 Choice Behavior

Economics is the science that studies choice behavior. Some examples of decisions of this nature are cited below.

We, as individuals, make personal choices about many things and every day. e.g. Shall I invest in fixed deposit with a bank? Shall I buy an apartment or a plot? Shall I deposit my money in a foreign savings account? Shall I buy a cheap or expensive pair of jeans? Shall I buy a new car? Shall I change my job? etc…

Businesses also make the same types of decisions on a continual basis. Should we lower the price due to heavy competition? Should we merge with company X? Should we employ temporary labour or subcontract some of the jobs? Should we introduce a new product? Should we change the organization structure? Should we buy CNC machines to replace conventional machines? Etc...

Politicians, organizations and governing bodies also make choices because they can only spend their money once. They ask themselves if they can bring in more money via taxes or whether they should borrow for this purpose. Should they invest in education or the military? Or should they simply pay off the national debt? etc...

In essence, any business involves decision-making. Decision making means the process of selecting one out of two or more alternative courses of action. The question of choice arises because the basic resources such as capital, land, labour and management are limited and can be employed in alternative uses. The decision-making function thus becomes one of making choice and taking decisions that will provide the most efficient means of attaining a desired end, say, profit maximization.

Different aspects of business need attention of the concerned manager.

It would be in the interest of the business to reach an optimal decision; the one that promotes the goal of the business firm. A scientific formulation of the business problem and finding its optimal solution requires that the business firm is equipped with a rational methodology and appropriate tools.

Business economic meets these needs of the business firm.

Business economics serves as a bridge between economic theory and decision-making in the context of business.

Business economics (or managerial economics) is “the integration of economic theory with business practice for the purpose of facilitating decision-making and forward planning by management.”

We may, therefore, define business economics as that discipline which deals with the application of economic theory and methodology to business management. Business

economics thus lies on the borderline between economics and business management and serves as a bridge between the two disciplines

Economists search for explanations which provide an answer to such questions as the following.

- How does the price of a product affect the behaviors of people/families/ consumers? (Micro-economics).
- What is the effect of a stagnating housing market on the construction sector? (Meso-economics).
- What is the influence of a new performance measurement system on the profits of an organization? (Business Economics).

16.03.00 Microeconomics

Microeconomics (from Greek prefix *mikro-* meaning "small" and economics) is a branch of economics that studies the behavior of individuals and small impacting organizations in making decisions on the allocation of limited resources. Typically, it applies to markets where goods or services are bought and sold. Microeconomics examines how these decisions and behaviors affect the supply and demand for goods and services, which determines prices, and how prices, in turn, determine the quantity supplied and quantity demanded of goods and services.

16.04.00 Macroeconomics

Macroeconomics (from the Greek prefix *makro-* meaning "large" and economics) is a branch of economics dealing with the performance, structure, behavior, and decision-making of an economy as a whole, rather than individual markets. This includes national, regional, and global economies.

Macroeconomists study aggregated indicators such as GDP, unemployment rates, and price indices to understand how the whole economy functions. Macroeconomists develop models that explain the relationship between such factors as national income, output, consumption, unemployment, inflation, savings, investment, international trade and international finance.

16.05.00 Business Economics

Business economics also known as Managerial economics is the "application of the economic concepts and economic analysis to the problems of formulating rational managerial decisions". It is a branch of economics that applies microeconomic analysis to decision methods of businesses or other management units. As such, it bridges economic theory and economics in practice. It draws heavily from quantitative techniques such as business statistics (probability theory, regression analysis, correlation, sampling theory

etc. and operations research (transportation model, simplex technique, simulation, queuing theory etc). If there is a unifying theme that runs through most of managerial economics, it is the attempt to optimize business decisions given the firm's objectives and given constraints imposed by scarcity, for example through the use of operations research, mathematical programming, game theory etc for strategic decisions, and other computational methods.

Please recall that many of these quantitative methods / techniques have been enumerated in the earlier chapters titled:

A) Production and Operations Management.

B) Business Statistics.

C) Operations Research.

Almost any business decision can be analyzed with managerial economics techniques, but it is most commonly applied to:

Risk analysis - various models are used to quantify risk and asymmetric information and to employ them in decision rules to manage.

Production analysis - microeconomic techniques are used to analyze production efficiency, optimum factor allocation, costs, and economies of scale and to estimate the firm's cost function.

Pricing analysis - microeconomic techniques are used to analyze various pricing decisions including transfer pricing, joint product pricing, price discrimination, price elasticity estimates, and choosing the optimum pricing method.

Capital budgeting - Investment theory is used to examine a firm's capital purchasing decisions.

16.06.00 Scope of Business Economics

Some of the specific areas of managerial decision making are:

1. Production Parameters.
2. Demand Analysis and Forecast.
3. Product Cost Analysis.
4. Product Pricing.
5. Profit Management.
6. Capital Investment.
7. Working Capital Management.

8. Choice of product and technology.

16. 06.01 Production Parameters

Let us elaborate on the nature of decisions involved in production management.

- **What to produce?** - A firm will produce according to its perception of the customer demand. It can either produce consumer goods like food, clothing etc. (which are for consumption purpose) or it can produce capital goods like machinery etc. (which are for investment purposes).
- **How to produce?** - Goods can be produced by certain techniques. Firms have the option of producing goods by labour-intensive technique and capital intensive technique. Labour-intensive technique is the one in which manual labour is used to produce goods. Capital intensive technique is the one in which machinery like forklift, assembly belts etc. are used to produce goods.
- **How much to produce?** - A firm has to decide its production capacity, keeping in view the demand pattern.
- **For whom to produce?** - A firm has to decide its target population (i.e. to whom they will serve products and/or services). For instance, it will not be viable to produce luxury products for middle income or low income group. Therefore, a firm needs to match its produce according to the target population it is serving.

16.06.02 Demand Analysis and Forecasting

Business firm is an economic organization which transforms productive resources into goods to be sold in the market. A major part of business decision making depends on accurate estimates of demand. A demand forecast can serve as a guide to management for maintaining and strengthening market position and enlarging profits. Demand analysis and forecasting provide the essential basis for business planning and occupies a strategic place in managerial economics.

16.06.03 Product Cost and Production Analysis

Study of economic costs, combined with the data drawn from the firm's accounting records, can yield significant cost estimates which are useful for management decisions. An element of cost uncertainty exists because all the factors determining costs are not controllable. Discovering economic costs and the ability to measure them are the necessary steps for more effective profit planning, cost control and sound pricing practices.

Production analysis is narrower in scope than cost analysis. Production analysis frequently proceeds in physical terms while cost analysis proceeds in monetary terms. The main topics covered under cost and production analysis are: Cost concepts and

classification, Cost-output Relationships, Economy of scale, Production function and Cost control.

16.06.04 Pricing Decisions, Policies and Practices

Pricing is an important area of business economics. In fact, price is the genesis of a firm's revenue and as such its success largely depends on how correctly the pricing decisions are taken. The important aspects dealt with under pricing include: Price Determination in Various Market Forms, Pricing Method, Differential Pricing, and Price Forecasting.

16.06.05 Profit Management

Business firms are generally organized for purpose of making profits and in the long run profits earned are taken as an important measure of the firm's success. If knowledge about the future were perfect, profit analysis would have been a very easy task. However, in a world of uncertainty, expectations are not always realized so that profit planning and measurement constitute a difficult area of business economics. The important aspects covered under this area are : Nature and measurement of profit, profit policies, and technique of profit planning like break-even analysis etc…

16.06.06 Capital Investment

Among the various types business problems, the most complex and troublesome for the business manager are those relating to a firm's capital investments. Relatively large sums are involved and the problems are so complex that their solution requires considerable time and thought. Often the decision involving capital management are taken by the top management. Briefly capital management implies planning and control of capital expenditure. The main topics dealt with are: cost of capital, rate of return, and selection of projects.

16.06.07 Working Capital Management

Working capital comprises certain cost elements such as, inventory in stores, work-in-process, suppliers' credit, receivables etc. Various quantitative techniques are adapted to control working capital / inventory. Inventory should be such that the cost of holding inventory needs to be optimized with minimal production hold-ups on account of shortage of material. Some of the techniques are: ABC Analysis, Economic Order Quantity (EOQ) Technique etc

16.06.08 Choice of a New Product and Technology

Before introducing a new product, management has to make it reasonably certain of demand forecast. A scientific market survey needs to be conducted to assess long term

demand pattern. As regards selection of technology, one has to consider the cost of investment and return on investment; and try to adapt the state-of-the-art technology to avoid product obsolescence. To introduce a new product, we need to select a plant location, make a project implementation schedule, and work out a plant layout. A few techniques such as PERT (Project Evaluation and Review Technique), plant location / plant layout techniques are available for decision making in this area.

16.07.00 Significance of Business Economics

Business economics is concerned with those aspects of traditional economics which are relevant for business decision making in real life. These are adapted or modified with a view to enable the manager take better decisions. Thus, business economics accomplishes the objective of building a suitable tool kit from traditional economics.

It also incorporates useful ideas from other disciplines such as psychology, sociology, etc. if they are found relevant to decision making. In fact, business economics takes the help of other disciplines having a bearing on the business decisions in relation various explicit and implicit constraints subject to which resource allocation is to be optimized.

Business economics helps in reaching a variety of business decisions in a complicated and uncertain environment. Certain examples are:

- What products and services should be produced?
- What input and production technique should be used?
- How much output should be produced and at what prices it should be sold?
- What are the best sizes and locations of new plants?
- When should equipment be replaced?
- How should the available capital be allocated?

Conclusion:

Business economics makes a manager a more competent model builder.

Where the operations are conducted though known focus functional areas, such as finance, marketing, personnel and production, business economics serves as an integrating agent by coordinating the activities in these different areas.

Business economics takes cognizance of the interaction between the firm and society, and accomplishes the key role of an agent in achieving the social and economic welfare goals. It has come to be realized that a business, apart from its obligations to shareholders, has certain social obligations. Business economics focuses attention on these social obligations as constraints subject to which business decisions are taken. It serves as an

instrument in furthering the economic welfare of the society through socially oriented business decisions.

The usefulness of business economics lies in borrowing and adopting the techniques and methodology from economic theory, incorporating relevant ideas from other disciplines to take better business decisions, serving as a catalytic agent in the process of decision making by different functional departments at the firm's level, and finally accomplishing a social purpose by orienting business decisions towards social obligations.

In all the earlier chapters we had come across various aspects and techniques adopted pertaining to business economics. Most importantly, the application of OR techniques in business operations is self evident.

Optimization is the key success factor in business economics.

Chapter 17
Managerial Finance and Accounting

17 Finance and Accounts / Managerial Finance and Accounting

A good financial plan is a road map that shows us exactly how the choices we make today will affect our future.

... Alexa Von Tobel

17.01.00 Overview of Accounts and Finance

'Finance and Accounts' is too vast a subject to be condensed here. The subject is too involved and beyond the scope of this book. We shall, however discuss this subject in generic and qualitative terms rather than in a detailed technical or statutory terms with emphasis on 'managerial Finance & accounting'. This knowledge may suffice in entrepreneurial endeavours.

What is the difference between accounting and finance? Some overlap between these two functions is to be expected. Here is the comparison.

17. 01.01 Accounting

Accounting is the preparation of accounting records. This includes measuring, preparation, analyzing, and the interpretation of financial statements. Accounting is often referred to as the language of business, mostly because the financial documents derived from the accounting preparation are widely used among managers, investors, tax authorities, executives, and many others to see how the company is performing.

Bookkeeping is the method used to record all the financial transactions, essentially the day to day accounting operations. Luca Pacioli is often referred to as the "father of accounting" because he was the first to publish a book regarding the double entry method of bookkeeping. Debits and credits are bookkeeping terms.

There are many governing bodies and organizations concerning this function. The International Accounting Standards Board (IASB) governs the general globe. Many countries often adhere to their own standards as well. In the United States, the Generally Accepted Accounting Principles (GAAP) guides the accounting field and its profession. Some characteristics of GAAP are Relevance, Timeliness, Reliability, Comparability, and Consistency. Accounting can be further broken down into sub-categories like Tax, Corporate, Audit, Management, and even Financial Accounting.

In Management accounting or managerial accounting, managers use the provisions of accounting information in order to better inform themselves before they decide matters within their organizations, which allows them to better manage and perform control functions.

17.01.02 Finance

Finance covers an array of subjects, but the three main categories would be:

(1) The study of money and capital markets.

(2) Management and control of assets and investments, which focuses on the decisions of individual and financial and other institutions as they choose securities for their investments portfolios, and

(3) Managerial finance (business finance) which involves the actual financial management of the firm, as well as profiling and managing project risks, return on investment, working capital management etc…

Managerial finance is probably the most important function to all types of businesses, deal with financial services or manufacturers. Managerial finance also involves analyzing the performance of the firm in order to forecast its future performance. It involves making decisions regarding working capital issues such as level of inventory, cash holding, credit levels, etc

17.02.00 Managerial Accounting

17.02.01 Definition

According to the Institute of Management Accountants (IMA): Management (or managerial) accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy.

17.02.02 Scope of Managerial Accounting

The American Institute of Certified Public Accountants (AICPA) states that management accounting as practice extends to the following three areas:

- Strategic management—advancing the role of the management accountant as a strategic partner in the organization.
- Performance management—developing the practice of business decision-making and managing the performance of the organization.
- Risk management—contributing to frameworks and practices for identifying, measuring, managing and reporting risks to the achievement of the objectives of the organization.

The Institute of Certified Management Accountants (ICMA) states *"A management accountant applies his or her professional knowledge and skill in the preparation and presentation of financial and other decision oriented information in such a way as to assist management in the formulation of policies and in the planning and control of the operation of the undertaking"*.

They are much more interested in forward looking and taking decisions that will affect the future of the organization, than in the historical recording and compliance aspects of the profession. Management (Managerial) accounting knowledge and experience can therefore be obtained from varied fields and functions within an organization, such as

information management, efficiency auditing, marketing, valuation, pricing, logistics, etc.

17.02.03 Tasks / Services of Management Accountants

The primary tasks / services performed by management accountants:

- Annual budgeting.
- Business metrics development.
- Capital budgeting.
- Client profitability analysis.
- Cost allocation.
- Cost analysis.
- Cost–benefit analysis.
- Cost-volume-profit analysis.
- Financial forecasting.
- Internal financial presentation and communication.
- IT cost transparency.
- Life cycle cost analysis.
- Make or buy analysis.
- Price modeling.
- Product profitability.
- Rate and volume analysis.
- Sales forecasting.
- Strategic management advice.
- Strategic planning.

17.03.00 Differences Between Financial Accounting and Management Accounting

Management accounting information differs from financial accounting information in several ways:

- While shareholders, creditors, and public regulators use publicly reported financial accounting information, only managers within the organization use the normally confidential management accounting information.

- While financial accounting information is historical, management accounting information is primarily forward-looking.
- While financial accounting information is case-based, management accounting information is model-based with a degree of abstraction in order to support generic decision making.
- While financial accounting information is computed by reference to general financial accounting standards, management accounting information is computed by reference to the needs of managers, often using management information systems.

17.04.00 Managerial Finance

Managerial finance is the branch of finance that concerns itself with the managerial significance of finance techniques. It is focused on assessment rather than technique.

The difference between a managerial and a technical approach can be seen in the questions one might ask of annual reports. The concern of a technical approach is primarily measurement. It asks: is money being assigned to the right categories? Were generally accepted accounting principles (GAAP) followed?

The purpose of a managerial approach, however, is to understand what the figures mean.

- Someone using such an approach might compare the returns to other businesses in their industry and ask: are we performing better or worse than our peers? If we are performing worse, what is the source of the problem? Do we have the same profit margins? If not, why? Do we have the same expenses? Are we paying more for something than our peers?
- They may look at changes in asset balances or red flags that indicate problems with bill collection or bad debt.
- They will analyze working capital to anticipate future cash flow problems.

Managerial finance is an interdisciplinary approach that borrows from both ‘managerial accounting’ and ‘corporate finance’.

Sound financial management creates value and organizational agility through the allocation of scarce resources amongst competing business opportunities. It is an aid to the implementation and monitoring of business strategies and helps achieve business objectives.

17.05.00 Corporate Finance

Corporate finance is the area of finance dealing with the sources of funding and the capital structure of corporations and the actions that managers take to increase the value

of the firm to the shareholders, as well as the tools and analysis used to allocate financial resources. The primary goal of corporate finance is to maximize or increase shareholder value.

Investment analysis (or capital budgeting) is concerned with the setting of criteria about which value-adding projects should receive investment funding, and whether to finance that investment with equity or debt capital. Working capital management is the management of the company's monetary funds that deal with the short-term operating balance of current assets and current liabilities; the focus here is on managing cash, inventories, and short-term borrowing and lending (such as the terms on credit extended to customers).

The terms corporate finance and corporate financier are also associated with investment banking. The typical role of an investment bank is to evaluate the company's financial needs and raise the appropriate type of capital that best fits those needs.

Financial management overlaps with the financial function of the Accounting profession. However, financial accounting is the reporting of historical financial information, while financial management is concerned with the allocation of capital resources to increase a firm's value to the shareholders.

The goal of this branch of finance is to develop skills for making corporate investment and financing decisions. Topics include discounted cash flow and other valuation techniques; risk and return; capital asset pricing model; corporate capital structure and financial policy; capital budgeting; mergers and acquisitions; and investment and financing decisions in the international context, including exchange rate/interest rate risk analysis. Detailed knowledge of this subject is beyond the scope of this book. It suffices, at this juncture, just to know the scope of this function and a host of possibilities in this area.

Role of corporate finance:

- Capital budgeting / Return on investment.
- Capital structure: Debt / Equity.
- Dividend policy.
- Investment and financial decisions.
- Investment and project analysis.
- Maximizing shareholder value.
- Mergers and acquisitions.
- Policy on remuneration to employees.

- Valuation.
- Working capital management.

17.06.00 Finance Lingo

We come across many terms concerning finance in news papers, conversations, and TV programs. It pays to increase your word power in this field. Let us list some commonly used terms of finance.

Certain financial terms often mean different things to different organizations depending on their own particular accounting policies. Financial terms will have slightly different interpretations in different countries. So as a general rule for all non-financial business people, if in doubt, ask for an explanation from the person or organization responsible for producing the figures and using the terms - you may be the only one to ask, but you certainly will not be the only one wondering what it all means.

Acid Test: A stern measure of a company's ability to pay its short term debts, in that stock is excluded from asset value. (Liquid assets / Current liabilities); this is also referred to as the *"Quick Ratio"*.

Asset: Something you own; *Liability*: Something you owe.

Asset Turnover: Measure of operational efficiency - shows how much revenue is produced per $ of assets available to the business. It is the ratio of *'sales revenue'* to '*total assets less current liabilities'*.

Bad Credit: A qualification of an individual's credit history that indicates that a borrower carries a higher credit risk. A low credit score indicates bad credit, while a high credit score is an indicator of good credit. Creditors who have lent money to an individual with bad credit face a higher risk of that individual missing payments or defaulting.

Bad Debt: A debt that is not collectible and therefore worthless to the creditor.

Bankrupt: (adjective) A person or organization declared in law, unable to pay outstanding debts; e.g. "the company was declared bankrupt" and "his father went bankrupt and the family had to sell their home"; Can also mean "completely lacking in a particular quality or value"; e.g. "their cause is morally bankrupt".

Bankruptcy: (noun) The state of being bankrupt. Bankruptcy is a legal status of a person or other entity that cannot repay the debts it owes to creditors.

Bankruptcy Law: A procedure by which an indebted person or company sacrifices most or all of his remaining assets in exchange for being relieved from the obligation to pay remaining debts.

Balance Sheet: a statement of the assets, liabilities, and capital of a business or other organization at a particular point in time, detailing the balance of income and expenditure over the preceding period.

Bond: A bond is a financial instrument whereby you lend money to a city, a company, a government, or any other entity that issued it. In return the issuer pays interest.

Book Value: A company's book value is its worth in terms of the amount realizable on sale of all its assets and all liabilities are discharged.

BSE: Bombay Stock Exchange.

Budget: In a financial planning context the word 'budget' (as a noun) means an amount of money that is planned to spend on a particularly activity or resource, usually over a trading year, although budgets apply to shorter and longer periods.

Bull Market: A rising stock market.

Bear Market: A falling stock market.

Call Money: Money loaned by a bank that must be repaid on demand. Unlike a term loan, which has a set maturity and payment schedule, call money does not have to follow a fixed schedule. Brokerages use call money as a short-term source of funding to cover margin accounts or the purchase of securities. The funds can be obtained quickly.

Capital Gain: The profit on the sale of capital assets such as bonds, real estate, stocks etc

Capital Loss: Same as above in the reverse.

Cash flow: The movement of cash in and out of a business from day-to-day direct trading and other non-trading or indirect effects, such as capital expenditure, tax and dividend payments.

Cash flow Statement: The cash flow statement provides a third perspective alongside the Profit and Loss account and Balance Sheet. The Cash flow statement shows the movement and availability of cash through and to the business over a given period, certainly for a trading year, and often also monthly and cumulatively. The availability of cash in a company that is necessary to meet payments to suppliers, staff and other creditors is essential for any business to survive, and so the reliable forecasting and reporting of cash movement and availability is crucial.

Collateral: Something pledged as security for repayment of a loan, to be forfeited in the event of default.

Commodity: Wheat, corn, gold, silver, yarn, minerals etc contracts for which are traded in risky markets.

Cost of Sales: is commonly arrived at via the formula: opening stock + stock purchases - closing stock. Cost of sales is the value, at cost, of the goods or services sold during the period in question, usually the financial year, as shown in a Profit and Loss Account (P&L).

Debenture: A type of debt instrument used by a large company to borrow money, but not secured by any physical assets or a collateral; backed only by reputation of the company.

Debt equity ratio: is a measure of the relationship (ratio) between the funds provided by creditors and the capital contributed by shareholders.

Depreciation: A reduction in the value of an asset due to wear and tear with passage of time.

Dividend: The amount of distribution of profit - remaining after investments - among the shareholders of a company.

Dow Jones Industrial Average: An index based on the stock prices of thirty big industrial companies in USA. It is a traditional indicator of stock values and state of economy.

Equity: Difference between assets and liabilities. It also refers to shareholding in a company.

Fixed Assets: Assets held for use by the business rather than for sale or conversion into cash, eg, fixtures and fittings, equipment, buildings.

Fixed Cost: It is a cost which does not vary with changing sales or production volumes. E.g. building lease costs, permanent staff wages, rates, depreciation of capital items.

Gross Profit: Sales less cost of goods or services sold. Also referred to as gross profit margin, or gross profit, and often abbreviated to simply 'margin'. See also 'net profit'.

Net Profit: Net profit normally refers to profit after deduction of all operating expenses, notably after deduction of fixed costs or fixed overheads. This contrasts with the term 'gross profit' which normally refers to the difference between sales and direct cost of product or service sold (also referred to as gross margin or gross profit margin) and certainly before the deduction of operating costs or overheads. Net profit normally refers to the profit figure before deduction of corporation tax, in which case the term is often extended to 'net profit before tax' or PBT.

ICD: Inter corporate deposit. Money deposited by one corporation in another at agreed terms.

IPO: Initial public offer (IPO) or stock market launch is a type of public offering where shares of stock in a company are sold to general public.

Kickback: The payment of something of value to an individual with the goal of persuading or influencing his or her decision or performance in a certain situation.

Letter of Credit: These mechanisms are used by exporters and importers, and usually provided by the importing company's bank to the exporter to safeguard the contractual expectations and particularly financial exposure of the exporter of the goods or services. (Also called 'export letter of credit, and 'import letter of credit'.)

Liquidity: The availability of liquid assets (easily encashable) to an individual, or a company.

Liquidation: In law, liquidation is the process by which a company or part thereof is terminated - usually when bankrupt - and the assets are sold to generate funds to pay the creditors.

Liquidity Ratio: Indicates the company's ability to pay its short term debts, by measuring the relationship between current assets (i.e. those which can be turned into cash) against the short-term debt value. (current assets/current liabilities) This is also referred to as the Current Ratio.

Margin: Buying stock on margin is buying stock in part with money borrowed from the stock broker. If the price of stock falls below a certain point and you can not pay the money, the stocks may be sold at a loss to cover your position.

Microfinance: is a general term used to describe financial services to low income individuals or those not having access to typical banking services.

Money Market: One of the sections of a financial market where securities and financial instruments with short-term maturities are traded is called the money market. Financial assets like treasury bills, certificates of deposits, commercial paper and bankers' acceptance are some of the short-term debt securities traded in the money market.

Moribund: No longer active or effective; State of being near death; In Finance, the term is used to describe unrecoverable outstandings.

Mortgage: When you obtain a mortgage to buy a house, you are persuading the bank to buy a house for you and let you live in it by assuring payment to the bank in instalments including interest at agreed terms.

Mutual Fund: A mutual fund is an investment pool in which a large number of investors put their money together, with the hope of earning some amount based on the fund’s investment pattern.

Net Assets: Total assets (fixed and current) less current liabilities and long-term liabilities that have not been capitalized (e.g. short-term loans).

Overhead: An accounting term that refers to all ongoing business expenses not including or related to direct labor, direct materials or third-party expenses that are billed directly to customers. Overhead must be paid for on an ongoing basis, regardless of whether a company is doing a high or low volume of business.

Price / Earning Ratio: A stock's P/E ratio is the ratio of its price and the value of the company's earnings in the past year divided by the number of shares outstanding.

Prime Rate: The interest rate that banks charge their biggest and the best loan customers. Everyone else pays more.

Profit and loss account: An account in the books of an organization to which incomes and gains are credited and expenses and losses debited, so as to show the net profit or loss over a given period.

Proxy: Shareholders who can not attend a company's annual meeting can still vote by sending a proxy (an absentee ballot).

Quick Ratio: This is the relationship between current assets readily convertible into cash and current liabilities. This is a sterner test of liquidity.

Repo Rate: Repo rate is the rate at which the central bank of a country (RBI in case of India) lends money to commercial banks in the event of any shortfall of funds.

Reverse Repo Rate: is the rate at which the central bank of a country (Reserve Bank of India in case of India) borrows money from commercial banks within the country. It is a monetary policy instrument which can be used to control the money supply in the country.

Reserves: The accumulated and retained difference between profits and losses year on year since the company's formation.

Restricted Funds: These are funds used by an organization that are restricted or earmarked by a donor for a specific purpose, which can be extremely specific or quite broad, eg., endowment or pensions investment.

Revaluation of Assets: In finance, a "revaluation of fixed assets" is a technique adapted to accurately describe the true value of the capital goods owned by the company.

Security and Exchange Commission (or Security and Exchange Board): The Government agency that oversees the trading of stocks, bonds, and other securities.

Share Capital: The balance sheet nominal value paid into the company by shareholders at the time(s) shares were issued.

Shareholders' Funds: A measure of the shareholders' total interest in the company represented by the total share capital plus reserves.

Stock Exchange: A market in which shares / securities are bought and sold; e.g BSE (Bombay stock Exchange)

Stock Split: A company is said to split an existing stock when it issues two or more smaller shares to shareholders, in lieu of one existing stock. For instance, you may get 10 one dollar (face value) shares in lieu of one existing 10 dollar share. The idea is to drive down a share value to make it attractive to investors as also to infuse flexibility in trading quantities.

Tax Shelter: Any investment that permits the investor to protect income from taxation.

Variable Cost: A cost which varies with sales or operational volumes, e.g. materials, fuel, commission payments.

Venture Capital: Money provided by investors to startup firms and small businesses with perceived long-term growth potential. This is a very important source of funding for startups that do not have access to capital markets. It typically entails high risk for the investor, but it has the potential for above-average returns.

Warrant: An option to buy certain amount of stocks at a certain price within a certain period of time.

Warranty: A type of guarantee that a manufacturer or similar party makes regarding the condition of its product. It also refers to the terms and situations in which repairs or exchanges will be made in the event that the product does not function as originally described or intended.

Working Capital: Current assets less current liabilities, representing the required investment, continually circulating, to finance stock, debtors, and work in progress.

Write off: is a reduction of the recognized value of something. In accounting, this is a recognition of reduced or Zero value of an asset. E.g. Bad debts were written off. Obsolete inventory is written off.

Yield: The annual income generated by an investment expressed as a percentage of its cost.

17.07.00 Profit and Loss Account

"Profit and Loss Account" is one of the financial statements of a company and shows the company's revenues (proceeds from sale of products and services) and expenses (comprising cost of material, organization and administration expenses, interest, depreciation etc.) during a financial year. It shows the financial performance of a company during a particular period. The profit or loss is the bottom line.

I know a dental surgeon-turned-entrepreneur in USA. He started his own multi-specialty dental clinic in USA. . He has achieved close to a million dollar turnover within a span of

two years after start. The trend is on the upswing. He has kindly provided the “profit and loss account” and “balance sheet” information for inclusion in this text book. Let us call this enterprise “ABC Dental” for reasons of confidentiality

The “profit and loss account of “ABC Dental” is reproduced here, which is self-explanatory.

ABC Dental
Profit and Loss Account (Value in US$)

	TOTAL
Practice Receipts	948,450.34
Total Income	**948,450.34**
	948,450.34
Administrative Services	
Accounting & Legal	7,099.25
Advertising	12,115.52
Bank Fees	4,358.60
Dues and Subscriptions	1,227.25
Entertainment & Meals	2,127.16
Insurance	7,364.90
Interest Expense	8,181.48
Malpractice Insurance	3,180.00
Office Expenses	2,202.49
Office Supplies & Expense	9,065.99
Promotional/Patient Gift Cards	713.78
Renewal, Professional Service Corp	100.00
Total Administrative Services	**57,736.42**
Facilities Expense	
Decor	1,696.16
Janitorial	360.00
Purchase Equipment and Technology	406.99
Rent	74,452.32
Rental Property Taxes	5,050.00
Repairs & Maintenance	2,405.46
Utilities	18,748.20
Total Facilities Expense	**103,119.13**
Leased Equipment	7,568.13
Payroll Expenses	392.38
Company Contributions	
Retirement	5,058.50
Total Company Contributions	**5,058.50**
Total Payroll Expenses	**5,450.88**

	TOTAL
Staff Compensations	
Admin Staff Salary & Benefits	
Salary	267,186.43
Taxes	21,166.36
Uniforms	256.51
Total Admin Staff Salary & Benefits	**288,609.30**
Clinical Staff Salary & Benefit	
Continuing Education	450.00
Uniforms	327.29
Total Clinical Staff Salary & Benefit	**777.29**
Total Staff Compensations	**289,386.59**
Variable Expenses	
Drugs & Dental Supplies	66,895.22
Lab expenses, Ortho	1,888.61
Laboratory Expense	47,418.49
Supplies & Materials, Ortho	530.59
Total Variable Expenses	**116,732.91**
Total Expenses	**579,994.06**
	368,456.28
Interest Income	65.47
Total Other Income	**65.47**
Contract Labor	169,870.92
Principals Salary & Benefits	
Automobile Expense	6,733.68
Professional Disability Insurance	2,236.08
Travel	57.90
Total Principals Salary & Benefits	**9,027.66**
Total Other Expenses	**178,898.58**
	-178,833.11
	$189,623.17

17.08.00 Balance Sheet

A balance sheet is a summary of the financial balances of a sole proprietorship, a business partnership, a corporation or other business organization in which assets, liabilities and ownership equity are listed as of a specific date, such as the end of its financial year. The balance sheet of "ABC Dental" is reproduced here.

ABC Dental
Balance Sheet (Value in US$)

	TOTAL
Current Assets	
Bank Accounts	
Business Premium Money Market	102,076.68
PNC Checking	39,966.25
PNC Line of Credit	-10,000.00
Total Bank Accounts	**132,042.93**
Total Current Assets	**132,042.93**
Fixed Assets	
Accumulated Depreciation	-95,768.07
Automobile	0.00
Furniture, Fixtures & Equipment	251,013.71
Total Fixed Assets	**155,245.64**
Other Assets	
Accumulated Amortization of Other Assets	-8,982.10
Security Deposits	6,204.36
Start Up Costs	48,993.25
Total Other Assets	**46,215.51**
TOTAL ASSETS	**$333,504.08**
Liabilities	
Current Liabilities	
Credit Cards	
Travel Rewards Visa Business 7617	4,000.88
Wells Fargo LOC	12,821.81
Total Credit Cards	**16,822.69**
Other Current Liabilities	
Direct Deposit Payable	0.00
Due to Shareholder	3,109.93
Payroll Liabilities	
Federal Taxes (941/944)	5,779.27
Federal Unemployment (940)	276.48
IL Income Tax	934.83
IL Unemployment Tax	17.86

	TOTAL
Vanguard	0.00
Wage Garnishment Order, Progressive Financial Services, Inc	32.97
Total Payroll Liabilities	**7,041.41**
SEP IRA Liability	0.00
Total Other Current Liabilities	**10,151.34**
Total Current Liabilities	**26,974.03**
Long-Term Liabilities	
Loan Payable - BMW	0.00
Loan Payable - Patterson	26,428.66
Loan Payable - PNC	143,762.30
Loan Payable - Wells Fargo	58,501.77
Loan Payable Patterson 3	8,211.39
Loan Payable-Patterson 2	813.09
Total Long-Term Liabilities	**239,717.21**
Total Liabilities	**266,691.24**
Equity	
Capital Stock	1,000.00
Opening Bal Equity	-8,957.88
Retained Earnings	-94,352.45
Shareholder Distributions	-20,500.00
Net Income	189,623.17
Total Equity	**66,812.84**
TOTAL LIABILITIES AND EQUITY	**$333,504.08**

Chapter 18
Management Styles

18 Management Styles

Quote: If you work for an autocratic management, switch off your brain; If you work for a participative management, take to acting; If you work for a coaching management, act dumb; If you are with a laissez faire management, stop working; If you work for a democratic management, do what pleases you; If you work for a paternalistic company, play on emotions; If you work for a 'management by walking around' (MBWA) company, eat well; If you work for a political company, huddle with the right people; If you work for a bureaucratic company, just serve your time; and finally work for a consultancy firm if you do not wish to take any responsibility.

... Reddigari Seshadri Reddy

Index

18.01.00 Definition

Management styles are characteristic ways of making decisions and relating to subordinates. Management style is the manner in which an organization manages its employees and their work activities and varies depending upon factors such as the characteristics of employees, the work activities engaged in, the culture of the organization, and the prevailing circumstances internal or external. The style of leadership is generally dependent upon the prevailing circumstance; therefore leaders should exercise a range of management styles and should deploy them as appropriate. Depending on business circumstances, a manager might need to employ more than one management style to achieve a high degree of effectiveness in their role.

Management styles can be categorized into several contrasting styles. A variety of management style types exist, such as: autocratic, paternalistic, democratic, participatory, consultative, coaching, MBWA (Management by walking around), laissez-faire, etc, and a particular style might be more suitable for a certain type of business or employee group than another.

18.02.00 Theory X, Y, and Z

18.02.01 Theory X and Theory Y

Whether you use Douglas McGregor's Theory X or Theory Y as a management style depends on how you generally view people. If you adhere to Theory X, you assume that people don't like work, they must be coerced and controlled to work, and the average person prefers to be directed because she or he doesn't want responsibility and places job security above ambition. Under this theory, you manage by using rewards such as money, perquisites, titles etc; and punishments such as warning, suspension, reduction in emoluments, termination for non-performance.

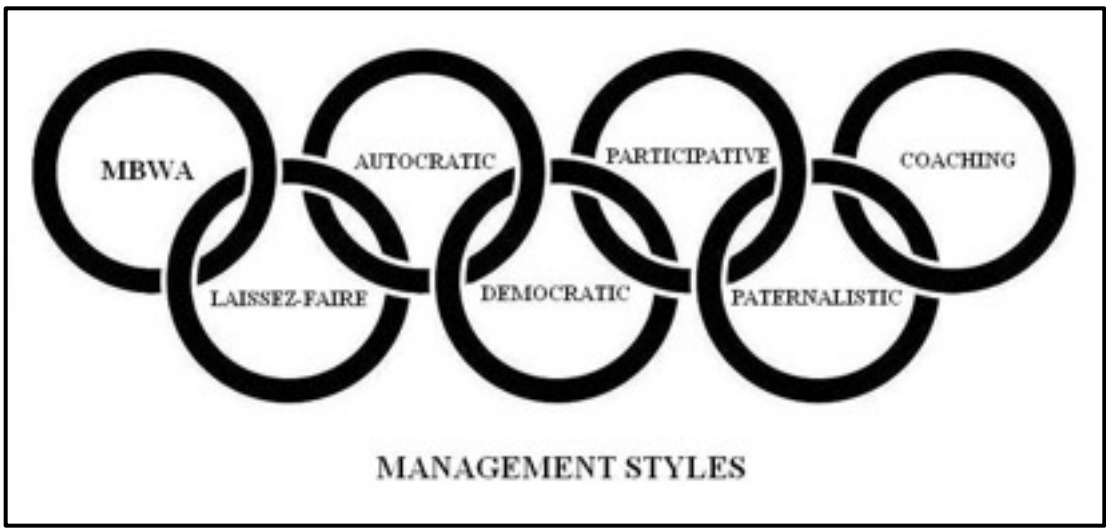
On the other hand, if you believe people might like work, will exercise self-direction and self-control, see satisfaction as obtainable from work, seek responsibility, are creative at solving problems, and believe that everyone has intellectual potential, then you will seek to help employees achieve their potential by getting satisfaction from their work. This is Theory Y. Helping employees reach their potential and achieve job satisfaction also advances organizational goals because employee potential and job satisfaction are tied to goal achievement.

18.02.02Theory Z

If you admire Japanese business, then you may like Theory Z, which combines Japanese and U.S. management elements. Specific features of Theory Z include support of long-term employment, less specialized career paths for employees, informal control, group decision-making and a concern for the individual above work issues. This management

approach is designed to satisfy both lower-order needs such as basic physical and psychological needs and higher-order needs such as self- fulfillment. You help satisfy lower-level needs by adequate remuneration and concern for the welfare of the employees and help satisfy higher-level needs by encouraging them to take responsibility for their work and invite them to participate in decision making process.

18.03.00 Styles of Man agent



18.03.01 Management by Walking Around (MBWA)

You manage by walking around. The idea is that you are on the ground listening to your employees and gathering information so you can take care of problems as they emerge rather than wait for them to fester into a serious malady. However, you've got to be careful not to micromanage or interfere in day-to-day operations. You have got to be a coach / guide and get involved in problem solving and conflict resolution. Employees should be able to see your positive contribution from MBWA.

Disadvantages to a MBWA style of management:

- There may not be enough or even entire lack of support from employees for management. The employees may be reticent in giving honest feedback to the '*MBWA Manager'*.
- Another disadvantage can materialize when the interactions during rounds are perceived or executed as micro management style.
- Another disadvantage or pitfall of MBWA is the manager taking ownership of too many issues that surface during the talks. The manager should only intervene when the resolution of the issue is more advantageous to the organization.

18.03.02 Laissez Faire Management Style

Laissez-faire management take a back seat role in the company providing guidance only when needed, employees are allowed to let their own ideas and creativity thrive in their respective areas

of operations. In this leadership management style, the team is given the freedom to complete the tasks in any manner they deem fit. It is a hands off approach at the apex management level in terms of direction, but the managers answer questions and provide guidance as needed. This is a good way to help develop individual contributors into leaders which is only going to serve to make your team stronger in the long run.

However, this may lead to conflicting situations if a few of the managers assume the role of a leader and dictate terms to other managers.

Dictionary meaning of 'Laissez Faire': A policy or attitudes of letting things take their own course, without interfering. Synonyms: noninterventionist, non-interfering.

18.03.03 Autocratic Management Style

An autocratic manager makes decisions without the consultation, serving as a dictator in communicating orders. The autocratic manager likes to be in total control of situations. This style of management leads to work getting done on time because there are less people involved in the decision making process. The problem with this type of management style is that the employees are going to eventually lose motivation working in such an environment due to lack of involvement in any decision making process. For situations or events where an 'on the spot decision' needs to be made, this type of leadership can serve a purpose, but trying to have an autocratic style of management in place for long periods of time is going to be problematic. This style of leadership is more suited for a prison setting or in the military and not so much for business management. The authoritative leader mobilizes the team toward a common vision and focuses on end goals, leaving the means up to each individual. The authoritative style works best when the team needs a new vision because circumstances have changed, or when explicit guidance is not required. Authoritative leaders inspire an entrepreneurial spirit and vibrant enthusiasm for the mission.

This style is not advisable when the leader is working with a team of experts who know more than him or her. It is also possible for autocratic management to thrive if the leader is technically, administratively and managerially competent.

18.03.04 Democratic Management Style

Democratic leaders decentralize authority. It is characterized by consultation with the subordinates and their participation in the formulation of plans and policies. He encourages participation in decision-making. He leads the subordinates mainly through persuasion and example rather than fear and force. McGregor labels this style as Theory Y. The employees feel that management is interested in them as well as in their ideas and suggestions. They will, therefore, place their suggestions for improvement. A democratic manager is willing to share authority with his staff by delegating it to get the job done. He relies on the competency of his team to get the job done as per plan. Employees like this type of management style in business because they feel involved and part of the process. Their job performance is likely to be better than in an autocratic setting. The democratic style is most effective when the leader needs the team to buy into or have ownership of a decision, plan, or goal, or if he needs fresh ideas from qualified teammates. It is not the best choice in an emergency situation, when time is of the essence.

Advantages for democratic leadership are as follows:

- Higher motivation and improved morale.
- Increased co-operation with the management.
- Improved job performance through participation.
- Reduction of grievances.
- Reduction of absenteeism and employee turnover.

A democratic leader may also be autocratic in emergency situations. A pure democratic style of management is not practical under many circumstances. He may be autocratic, consultative, participatory, coaching type, or paternalistic depending on the nature of circumstances.

18.03.05 Participative Management Style

Also sometime known as consultative management style, this decision making style in management revolves around getting lots of feedback from the employees before coming to a conclusion and making a decision. If you make sure that you share important information with employees and let the employees participate in the decision-making in matters that directly affect them, then you are using a participative management style. In order for participative management to work, employees must have the knowledge and ability to effectively participate and the company's culture must support the approach. Participative management is a good choice in organizations that are not concerned with a strict hierarchy and employ educated and skilled workers. This process can take a bit longer as there are more voices to be heard, but getting a consensus on major decisions can lead to buy-in from those who might otherwise have been opposed to the implementation of such changes. If you are going to make company or departmental policy changes, this type of style can make the team feel involved and more apt to go with the flow of whatever changes are coming down. This style also works well for brainstorming sessions as you work on new product ideas.

The flipside of this style of management and leadership is that employees may feel that you don’t value their opinion if the final decision is not in accordance with the suggestions made by them.

18.03.06 Paternalistic Management Style

Under this management style the leader assumes that his function is paternal. The relationship between the leader and his group is the same as the relationship between the head of the family and the members of the family. The leader guides and protects his subordinates as members of his family. As the head of the family, he provides his subordinates with good working conditions and benefits. It is presumed that the employees would work harder out of gratitude.

This type of leadership style is generally prevalent in small / proprietary firms. This is not possible in large and professional organizations.

18.03.07 Coaching Type Management Style

In this mode, the manager focuses on development of his team members rather than immediate tasks in order to develop consistently high performers. The coaching style works best when the leader wants to help teammates build lasting personal strengths that make them more successful overall. It is least effective when teammates are defiant and unwilling to change or learn, or if the leader lacks proficiency.

This one-on-one style focuses on developing individuals, showing them how to improve their performance, and helping to connect their goals to the goals of the organization. Coaching works best "with employees who show initiative and want more professional development." But it can rebound if it is perceived as 'micromanaging' an employee, and undermines his ability or her self-confidence.

It is to be noted that no particular style of management is ideal. A specific management style could evolve as the circumstances change.

Chapter 19
Metrics / Performance Review

19 Metrics / Performance Review

In business, words are words; explanations are explanations; promises are promises; but performance is reality.

... Harold S. Geneen

Index

19.01.00 Definition of Metrics

Metrics are a set of measurements that quantify results. Performance metrics quantify the units of performance. Project metrics tell you whether the project is meeting its goals. Business metrics define the business' progress in measurable terms.

19.02.00 Introduction to Metrics

A **performance metric** is that which determines an organization's behavior and performance. Performance metrics measure an organization's activities and performance. It should support a range of stakeholder needs from customers, shareholders to employees. While traditionally many metrics pertain to quantity / finance, inwardly focusing on the performance of the organization, metrics may also focus on the performance against customer requirements and value. In project management, performance metrics are used to assess the health of the project and consist of the measuring of seven criteria: safety, time, cost, resources, scope, quality, and actions.

Developing performance metrics usually follows a process of:

1. Establishing critical processes / customer requirements.

2. Identifying specific, quantifiable outputs of work.

3. Establishing targets against which results can be assessed.

The metrics should be applicable to high value performance indices. There is not much use of measuring low value indices. If the metrics concern low value indices and ignore high value indices, the phenomenon is called measurement inversion.

To correct for the measurement inversion other methods, like applied information economics, introduce the "value of information analysis" step in the process so that metrics focus on high-value measures. Organizations where this has been applied find that they define completely different metrics than they otherwise would have and, often, fewer metrics. For projects, the effort to collect a metric has to be weighed against its value as projects are temporary endeavors performed with finite resources.

There are a variety of ways in which organizations may react to results. This may be to trigger specific activity relating to performance (i.e., an improvement plan) or to use the data merely for statistical information. Often closely tied in with outputs, performance metrics should usually encourage improvement, effectiveness and appropriate levels of control.

Performance metrics are often linked in with corporate strategy and are often derived in order to measure performance against a critical success factors.

19.03.00 Value Based Performance Metrics

Generally, most organizations are attuned to the need for performance metrics. Undoubtedly, they are a key mechanism for analyzing the effectiveness of a business. However, what constitutes a metric may vary from one organization to another.

Traditional metrics have their origin in manufacturing and marketing / sales environments and these have typically been focused on 'historical' financial indicators. E.g. Sales Turnover, Profit indicators, performance against budget etc. All of these view a snapshot picture and none focus on the customer's requirements or business strategy. These types of metrics often try to assemble meaningful information from the myriad of transactional data that has been assimilated – however the slant is one of performance of the company – e.g. its profit, its turnover – there are often no links towards performance against customer objectives or requirements and organizational strategy. These types of traditional metrics do little to indicate whether a customer was left satisfied or not or how an organization is faring against it's critical success factors.

So what of the value based metrics! By focusing on four attributes, financial, customer, business process, learning and growth the balanced scorecard went someway into developing metrics that were strategically focused and captured some semblance of the benefits the organization was providing to the customer – most importantly these measures were not purely financial. However these still do not answer the question of value add.

The key question for organizations is whether "management understands how companies create value". There has to be a level of understanding of what the value chain means to the business before metrics can be developed – there is not a "one-size-fits-all" solution – performance metrics are not a cookbook that can be followed. Creative strategic thinking is required in order to develop an effective performance metric system as no two organizations are alike.

The balanced scorecard helped organizations management information evolve primarily from financial analysis to something more holistic but was still not primarily focused on the needs of the customer.

However where a business fully understands how and where it derives value, value based programs can focus not only on the performance of the originating business but on the performance towards satisfying the customer – targeting benefits provided by the service or process to the end customer with metrics tuned accordingly.

Many value based metrics utilize the QCD (Quality Cost and Delivery) model. Common metrics may include process cycle efficiency, lead time, delivery performance etc. Defects or errors incurred are measured as an indicator into how customer requirements were met. This is further amplified by measuring customer satisfaction results. Rather

than the traditional measure of inventory valuations, inventory turnover, batch sizes and safety stock are analyzed.

Metrics have evolved into output focused tools that provide information on the performance of a business against the specified needs of the customer. Performance metrics study the process broken down into it's constituent steps analyzing defects, cost and productivity indicators.

Example of traditional and value based performance metrics.

TRADITIONAL METRICS	VALUE-BASED METRICS
Sales turnover	Lead time
Staff turnover	Adherence to schedule
Actual vs. Budget (Production / Sales) Quantity / Value	Number of defects / errors
Machine utilization	Debt-Equity ratio
Machine efficiency	Customer satisfaction
% Material cost of sales	Productivity
Absenteeism	Inventory turnover

Deploying a comprehensive performance metric system within a business is time consuming and complex. It requires top-level support and commitment to act on the results. There is a clear difference between traditional measures and those that look at the value chain. Most businesses adopt a hybrid of the two. With the advent of computers, it has now become easier to obtain timely performance metrics.

Measuring customer satisfaction metrics is the most critical of all. With the satisfied customer, other performance indices are sure to improve.

19.04.00 Tools and Techniques for Measurement

Various tools for measurements are enumerated in the earlier chapter titled ‘TQM’ / sub-chapter titled “Tools for Measurement”.

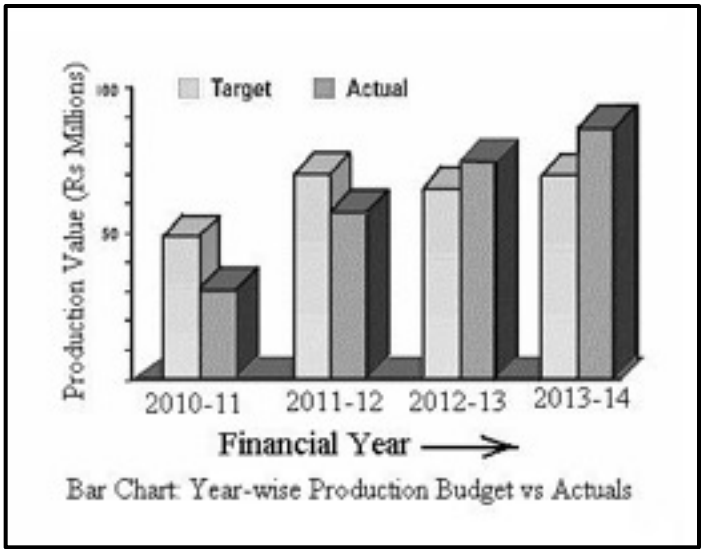
Some of the techniques are:

- Check Sheet.
- Scatter Diagram.
- Histogram.
- Bar Chart.
- Control Chart.
- Time Line.
- Flow Chart.
- Pie-Chart.

19.05.00 Examples of Metrics / Performance Review

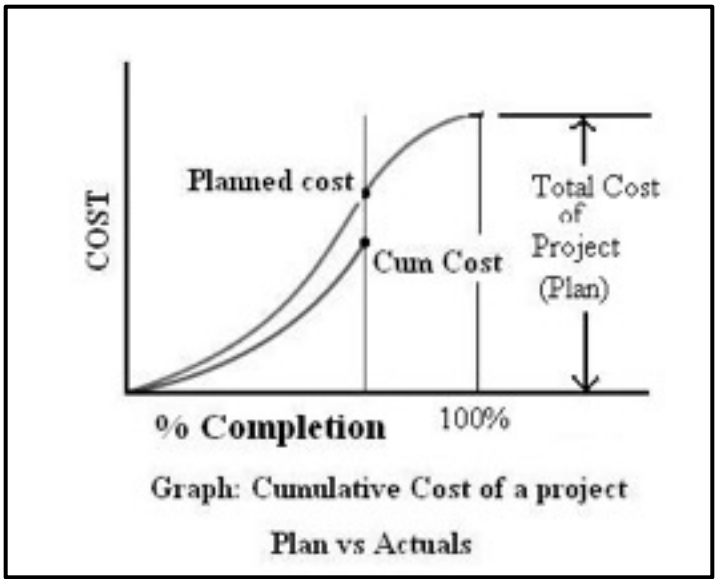
Some performance review charts – Budget vs. Actuals are illustrated as follows.

19.05.01 Review of Year-wise Production: Budget vs. Actuals



Bar Chart: Year-wise Production Budget vs Actuals

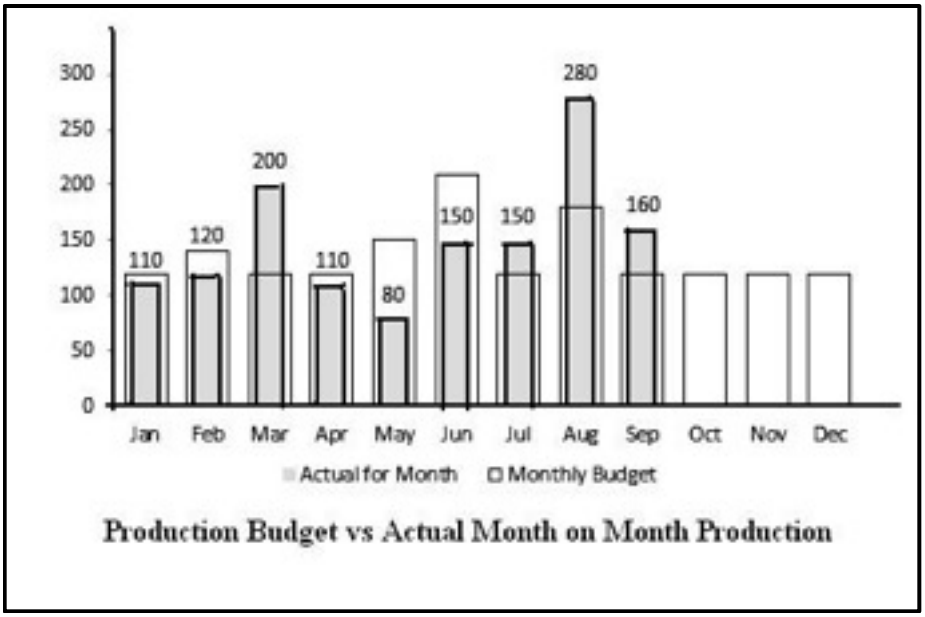
19.05.02 Review of Cumulative Cost of a Project:



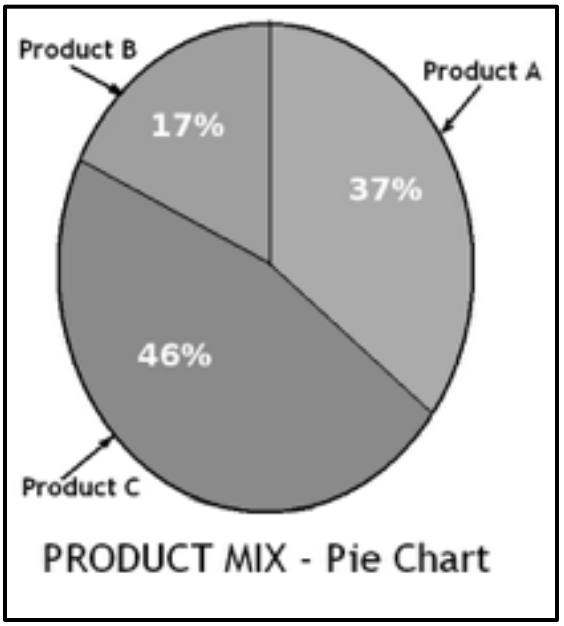
Graph: Cumulative Cost of a project

Plan vs Actuals

19.05.03 Review of Month-wise Production: Budget vs. Actuals



19.05.04 Review of Product Mix:



Chapter 20
Business Ethics

20 Business Ethics

The first step in evolution of ethics is a sense of solidarity with other human beings. ... Albert Schweitzer

Index

20.01.00 Definition of Ethics

Ethics is the branch of knowledge that deals with moral principles that govern a person's or group's behavior. Applied ethics is a field of ethics that deals with ethical questions in many fields such as medical, technical, legal and business.

20.02.00 Overview of Business Ethics

Business ethics - also known as corporate ethics - is a form of applied ethics or professional ethics that examines ethical principles and moral or ethical problems that arise in a business environment. It applies to all aspects of business conduct and is relevant to the conduct of individuals and business organizations as a whole.

Business ethics can be both a normative (imply "ought-to-be" types of statements and assertions) and a descriptive discipline. As a corporate practice the field is primarily normative. In academia descriptive approaches are also taken attempting to understand business behavior. The range and quantity of business ethical issues reflects the degree to which business -with a profit-maximizing behavior- is perceived to be at odds with non-economic social values.

Business ethics reflects the philosophy of business, whose aim is to determine the fundamental purpose of a company. It is usually, an act of maximizing profits in order to maximize shareholder returns. Peter Drucker - author business consultant- observed, "There is neither a separate ethics of business nor is one needed", implying that standards of personal ethics cover all business situations. Another view of business is that it must exhibit corporate social responsibility (CSR): an umbrella term indicating that an ethical business must act as a responsible citizen of the communities in which it operates even at the cost of profits or other goals. If business has no ethical obligations, other institutions could make the same claim which would be counterproductive and inimical to the corporation.

Ethical issues include the rights and duties between a company and its employees, suppliers, customers and neighbors, its fiduciary responsibility to its shareholders. Issues concerning relations between different companies include hostile takeovers, industrial espionage, unholy alliances /coteries, and head-hunting. Related issues include corporate governance; corporate social entrepreneurship; political contributions; legal issues such as the ethical debate over introducing a crime of corporate manslaughter*;* and the marketing of corporations' ethics policies. Corporate manslaughter is a crime. It enables a corporation to be punished and censured for culpable conduct that leads to a person's death. This extends beyond any compensation that might be awarded in civil litigation or any criminal prosecution of an individual including an employee or contractor

The three major areas of public concern regarding business ethics are executive pay, corporate tax avoidance, nepotism, and corruption.

20.03.00 Historical Perspective of Business Ethics

Historically, interest in business ethics accelerated dramatically during the 1990s, both within major corporations and within academia. Firms started highlighting their ethical stature in the late 1980s, possibly trying to distance themselves from the business scandals of the day. Thereafter, the idea of business ethics caught the attention of academics, media and business firms. Today, most major corporate websites lay emphasis on commitment to promoting non-economic social values under a variety of headings such as ethics codes and social responsibility charters. In some cases, corporations have redefined their core values in the light of business ethical considerations.

Adam Smith said, "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices. Governments use laws and regulations to control business behavior; so as to be beneficial to public. Ethics implicitly regulates areas and details of behavior that lie beyond governmental control. The emergence of large corporations with limited relationships and sensitivity to the communities in which they operate accelerated the development of formal ethics regimes. Ethics is a double edged weapon; If you do you are damned and if you don't you are damned; one way or another. But it is safer to be ethical.

20.04.00 Ethical Issues in Business

20.04.01 Fundamental Issues of Business Ethics

The most fundamental ethical issues that businesses must consider are integrity, credibility and trust. A clear understanding of integrity includes the idea of conducting your business affairs with honesty and a commitment to customer satisfaction. When customers perceive that a company is exhibiting a resolute commitment to ethical business practices, a high level of trust can develop between the business and the people. A relationship of trust between a company and the customers is the key to success in business.

20.04.02 Diversity issues of Business Ethics

The world is a diverse place with multicultural and multiracial communities, who should be treated with utmost respect. A company can learn a great deal from this diversity. An ethical response to diversity begins with recruiting a diverse workforce, enforces equal opportunity in training and career progression when every employee is able to enjoy a respectful workplace environment that values their contributions. Realizing the full

potential of all the employees and maximizing their contribution is essential for success in business.

20.04.03 Decision Making Issues of Business Ethics

The following framework for ethical decision-making is a useful method for exploring ethical dilemmas and identifying ethical courses of action.

Recognize an ethical issue, collect relevant facts, evaluate alternative actions, take a decision, test possible outcomes and take a final decision. The ethical decision making should protect the interest of employees, contractors, customers, and general public. It must be ensured that business operations are fair and just resulting in common good.

20.04.04 Compliance with Laws Concerning Business Ethics

Businesses are expected to fully comply with environmental laws, safety regulations, fiscal and monetary reporting statutes and all applicable civil rights laws. No one may ask any employee to break the law, or go against company values, policies and procedures. A company shall define a policy of ethical business conduct. All the directors, managers, and other employees shall conduct business in accordance with the policy of business conduct.

A business cannot claim to be ethical, if it ignores unethical practices by its own establishments or its suppliers, contractors, distributors, sales agents, associate companies etc. such as:

- Use of child labour and forced labour.
- Production in sweatshops.
- Violation of the basic rights of workers.
- Ignoring health, safety and environmental standards.
- Using outdated equipment etc…

20.05 Pressure for Business to Act Ethically

Businesses and industries increasingly find themselves facing *external pressure t*o improve their ethical track record. An interesting feature of the rise of consumer activism online has been increased scrutiny of business activities. Pressure groups such as consumer forums exert pressure on Businesses to comply with acceptable ethical standards.

Direct consumer action is another way in which business ethics can be challenged. Consumers may take action against:

Businesses they consider to be unethical in some way (e.g. return policy, bad quality)

Business acting irresponsibly (e.g. inadequate service)

20.06.00 Advantages of Ethical Behavior

- Higher revenues – demand from positive consumer support.
- Improved brand and business awareness and recognition.
- Better employee motivation and recruitment.
- New sources of finance – e.g. from ethical investors.

20. 07.00 Ethical Principles

1. Honesty: ***Be honest in all communications and actions.*** Ethical executives are worthy of trust and honesty. They are not only truthful, they are candid and forthright. Ethical executives do not deliberately mislead or deceive others by misrepresentations, overstatements, partial truths, selective omissions, or any other means and when trust requires that they supply relevant and correct information.

2. Integrity: ***Maintain Personal Integrity.*** Ethical executives earn the trust of others through personal integrity. Integrity refers to a wholeness of character demonstrated by consistency between thoughts, words and actions. They live by ethical principles despite great pressure to do otherwise. Ethical executives are principled, honorable, upright and scrupulous. They fight for their beliefs and do not sacrifice principle for expediency.

3. Credibility / Promise-Keeping: ***Keep promises and fulfill commitments*****.** Ethical executives can be trusted because they make every reasonable effort to fulfill the letter and spirit of their promises and commitments.

4. Loyalty: ***Be loyal within the framework of other ethical principles*****.** Ethical executives justify trust by being loyal to their organization and the people they work with. Ethical executives place a high value on protecting and advancing the lawful and legitimate interests of their companies and their colleagues. They do not, however, put their loyalty above other ethical principles.

5. Fairness: ***Strive to be fair and just in all dealings***. Ethical executives are fundamentally committed to fairness. They do not exercise power arbitrarily nor do they use indecent means to gain any advantage over another's difficulties.

6. Caring: ***Demonstrate compassion and a genuine concern for the well-being of others***. Ethical executives are caring, compassionate, benevolent and kind. They understand the concept of stakeholders and they always consider the business, financial and emotional consequences of their actions on all stakeholders. Ethical executives seek to accomplish their business objectives in a manner that causes the least harm and the greatest positive good.

7. Respect for others: ***Treat everyone with respect.*** Ethical executives demonstrate respect for the human dignity, autonomy, privacy, rights, and interests of all those who have a stake in their decisions; they are courteous and treat all people with equal respect and dignity regardless of sex, race, religion, or national origin.

8. Law Abiding: ***Obey the law.*** Ethical executives abide by laws, rules and regulations relating to their business activities.

9. Commitment to Excellence: ***Pursue excellence all the time in all things***. Ethical executives pursue excellence in performing their duties, are well-informed and prepared, and constantly endeavor to increase their proficiency in all areas of responsibility.

10. Leadership: ***Exemplify honor and ethic****s.* Ethical executives are conscious of the responsibilities and opportunities of their position of leadership and seek to be positive ethical role models by their own conduct. They lead by setting an example and take responsibility for any failure.

11. Reputation and Morale: *Build and protect and build the company's good reputation and the morale of its employees.* Ethical executives understand the importance of their own and their company's reputation as well as the importance of the pride and good morale of employees. They avoid words or actions that that might undermine respect and they take steps to correct or prevent inappropriate conduct of others.

12. Accountability: ***Be accountable.*** Ethical executives acknowledge and accept personal accountability for the ethical quality of their decisions and omissions to themselves, their colleagues, their companies, and their communities.

20.08 Unethical Practices in Various Functional Areas of Management

A) Finance:

- Unduly aggressive financial targets.
- Pressure to reduce tax liabilities.
- Aggressive accounting practices to keep stock prices high.
- Insider trading.
- Hostile takeovers.
- Fraudulent financial statements.
- Motivated / Deliberate under/over-invoicing.
- Manipulation of costing in order to mislead customers, inflate/deflate inventory value, cross subsidizing between products etc…
- Making early payments to favored parties.
- Nit picking on petty expenses.
- Manipulating profit / loss statement and balance sheet with a view to avoid tax, influence stock prices etc…

B) Personnel / HRD:

- Recruitment of kith and kin regardless of their merits.
- Recruitment of under or over qualified persons.
- Paying unfair wages / Paying below the statutory minimum wage level
- Training and promoting only pet / favorite employees.
- Tampering with the personnel records (e.g. Leave records, Performance reports etc…)
- Divide and Rule approach.
- Unsafe working conditions.
- Long working hours.
- Lack of concern for welfare of the employees.
- Flouting labour laws.

C) Manufacturing Operations: Design / Production / Purchasing / Quality Control:

- Substandard product specification.
- Using defective material.
- Deviating from standards.
- Inadequate packaging.
- Lack of concern for safety of workmen.
- Priority for speed at the cost of quality.
- Using substandard equipment for production and testing
- Causing pollution.
- Procurement of substandard material for personal gains
- Keeping excessive inventories.
- Squeezing suppliers on prices and deliveries.
- Encouraging sweatshops.

D) Sales and Marketing / service:

- Supply of substandard products.
- Delay in supply of goods to customers.
- Increasing prices and then offering discounts.
- Making derogatory remarks against competitors.
- Overcharging for spares and service.
- Refusing service under false pretexts.
- Delay in providing after-sales service.
- Refusal to provide after-sales service.
- Not accepting responsibility for defects in a product.
- Exaggerating product features / merits in an advertisement.
- Providing excessive credit facilities to sales agents / distributors.
- Fictitious billing to inflate sales figures, under pressure.

Chapter 21
DO’s and DON’Ts of Sound Management

21 Dos and Don’ts of Sound Management

An ideal manager is not a person who can do the work better than his men; he is a person who can get his men to do the work better than he can.

... Frederick W. Smith

Chapter	Title
21	**Do’s and Don’ts of Sound Management**
21.01.00	Do’s of Sound Management
21.02.00	Don’ts of Sound Management
21.03.00	Ideal manager

21.00.00 Things the Ideal Managers Do And Don't Do

Excellent managers succeed by virtue of what they do or don’t do. Their styles and personalities may differ widely. Their styles could be as unique as their personalities, while elements of the personal style may vary. However, there are some absolutes that one can surmise about their management substance. Accordingly, here are of the things that excellent managers do or don’t do

21.01.00 Do’s of Sound Management

- The best managers have the big picture of their operations in mind; and they know their company’s business operations and objectives very well. This enables them to align their departmental activities with the overall objectives of the company.
- They have a strategic action plan to implement various measures such as cost reduction, quality improvement, productivity etc and stay focused.
- They are consistent in their behavior, even though they are tough. His team members can predict his behavior and know what to expect and there is no uncertainty. Problems arise when a manager is erratic in his behavior and actions. Workers do not like if their manager is lenient and upbeat one day and tough another day.
- They do not interfere in the day-to-day work assigned to their workers / staff. They treat their employees’ time as valuable as their own.
- The best managers earn respect by being prompt with their employees as they are with their own superiors.
- They are punctual and expect punctuality from their employees.
- They are not afraid to question when thing are going wrong. They are not afraid of asking uncomfortable questions to their own management. However, they are very respectful in their behavior towards their superiors. They express their independent and honest opinions in a pleasant manner. They are not cantankerous.
- They are trustworthy. They are true to their words and earn respect of the team workers.

21.02.00 Don’ts of Sound Management

The ideal managers do not get intoxicated with power or abuse their powers. They do not take advantage of their powers. The best managers realize that positional power is a privilege, and wield it judiciously.

- The best managers do not play favorites. Some people are just more naturally likable. Some always have a positive attitude, while others equally talented may not have the same charisma. But any natural tendencies toward favoritism should be resisted; it's not only unfair – it's a quick way to lose, or at least damage, the respect of your team.
- They do not take impulsive or irrational decisions. Hasty or emotional decisions are rarely optimal or even fair. Decisions taken in anger can seriously go wrong and detrimental to the organization.
- They do not ignore conflict situations. They resolve the conflicts amicably, diplomatically, and effectively. This is an important feature of good management.
- Good managers do not feel threatened by the abilities of their employees. They are secure, and want to build a team of talented people whom they continue to develop. Since management is all about accomplishing things through others, the better people you have, higher will be the quality work.
- They do not make false promises. They maintain a high degree of credibility in their talks and deeds.

21.03.00 Ideal Manager

The qualities of an ideal manager are enumerated as follows:

- **Leadership:** The ideal manager shows outstanding skills in guiding and motivating team members towards attainment of the organization's goals and the right decisions at the right point of time. He leads the team from the front. He leads by setting an example. He takes responsibility for his actions.
- **Planning and delegation:** The ideal manager Possesses foresight and skills to understand the relevant capabilities of team members. He plans tasks and delegates to the right people to get tasks done within deadlines.
- **Domain expertise:** He demonstrates complete knowledge of his field and confident about that knowledge, with the common sense to make quick productive decisions, and ability to think outside the box.
- **Sets clear objectives:** He is result oriented and sets clear objectives to his team members. Employees should always know what is expected of them. One way is to set achievable targets and frequently monitor progress.
- **Positive recognition:** He immediately recognizes team members, publicly and / or privately, when they complete a job successfully or show initiative. Most employees are not motivated by money alone. Good managers know that employees want regular recognition that their job is being done well.

- **Active listener:** He shows traits such as listening with feedback, optimistic attitude, motivating ability, and a concern for people. Listening to what is said as well as what is not said is of the utmost importance. All interruptions should be avoided.
- **Shows empathy:** This is the ability to understand and share the feeling of another person. Empathy requires that you suspend judgment of another's actions or reactions, while you try to understand them, and treat them with sensitivity, respect, and kindness.
- **Always honest:** Everything that a manager does is seen by his employees. If a manager says one thing and does something else, employees see it. Managers must be straightforward in all words and actions. That also means recognizing weaknesses, and admitting mistakes.
- **Sense of humor:** The ideal manager keeps his team members in good humor. People of all ages and cultures respond positively to humor. One of the most frequently cited attractions in great personal relationships is a sense of humor.
- **Keeping cool.** A great manager is an effective communicator and a composed individual, with a proven tolerance for ambiguity. He never loses his cool, and is able to correct the team members without emotional body language or statements.
- **Communication skill:** He possesses excellent communication skills.

How to build better Bosses

In the following chapter, you will read about the Google plan code-named "Project Oxygen". The objective of the mission was to advise as to "How to Build Better Bosses".

Chapter 22
Epilogue:
Realm of Business World

22 Epilogue - Realm of Business World

Nowadays the rage for possession has got to such a pitch that there is nothing in nature, sacred or profane, out of which profit can not be squeezed.

... Desiderius Erasmus

Note: Desiderius Erasmus was a Dutch Renaissance Humanist (1466-1536). Squeezing anything and everything for profit is the malady prevailing since time immemorial, as is evident from recorded History of Humans. In the present context, we have to keep in mind that profit making is in the nature of things and can not be eliminated; we can only hope to keep the affliction under control.

Corporation is an ingenious device for obtaining profit without individual responsibility.

... Ambrose Bierce

While humans could be either saints or wrong doers, businesses could not be otherwise. Of Course, business is conducted by human species; and consequently businesses are human in nature.

... Reddigari Seshadri Reddy

Chapter	**Title**
22	**Epilogue – Realm of Business World**
22.00.00	Introduction
22.01.00	Foxconn Technology Group
22.02.00	Apple Inc.
22.03.00	Wal-Mart Stores Inc.
22.04.00	Mondragon Corporation
22.05.00	Amazon Corporation
22.06.00	Maruthi-Suzuki Ltd
22.07.00	Google

22.00.00 Introduction

We have so far studied the principles of management, various business activities / techniques, business ethics, and styles of management.

Is *"ideal management"* an oxymoron? Well, almost…

Do businesses and ethics go hand in hand? Not necessarily!

Now let us see the real world situations in the realm of business. While humans could be saints or wrong doers, businesses could not be otherwise. Of Course, business is conducted by human species; and businesses are human in nature.

Here are a few case studies pertaining to the conduct of businesses in the real world.

1. Foxconn Technology Group.
2. Apple Inc.
3. Wal-Mart Stores Inc.
4. Mondragon Corporation.
5. Amazon Corporation.
6. Maruthi-Suzuki Ltd.
7. Google

22.01.00 Foxconn Technology Group

Source: SACOM (**S**tudents and **S**cholars **A**gainst **C**orporate **M**isbehavior Report.

Hon Hai Precision Industry Co., Ltd., trading as **Foxconn Technology Group**, is a Taiwanese multinational electronics contract manufacturing company headquartered in Tu Cheng, New Taipei, Taiwan. It is the world's largest electronics contractor manufacturer, and the third-largest information technology company by revenue.

Foxconn is primarily an original equipment manufacturer and its clients include major American, European, and Japanese electronics and information technology companies. Significant products that the company manufactures include the BlackBerry, iPad, iPhone, Kindle, Playstation 4, Xbox One, and Wii U. It is the largest private employer in China. Foxconn has factories in Asia, Europe, Mexico and South America that together assemble around 40 percent of all consumer electronics products sold. Foxconn has 13 factories in nine Chinese cities - more than in any other country.

Foxconn has been involved in several controversies relating to how it manages employees in China. There has been a history of suicides at its factories blamed on working conditions. Civil society and media zoomed in on Foxconn recently not because

of its prodigious workforce or its profits. It was because the sad plight of the workers at Foxconn factories, many of whom perished from suicides.

Workforce at Foxconn:

- 1,000,000: Number of workers Foxconn employs in China.
- 100,000: Number of production lines it runs.
- 300,000: Number of people working exclusively on the iPhone.
- 24 hours (12 Hr shift x2), 7 days a week: Foxconn's iPhone factory runtime.

Profit maximization is the ultimate corporate principle, under which workers' dignity and well-being are of no concern. Foxconn is not the only one to be blamed, but it is the most typical factory run by a management methodology that boosts productivity through the degradation of workers into dehumanized machines.

Low wages / Unpaid work assemblies:

Over a quarter of Foxconn's work force lives in company barracks and many workers earn less than $20 a day. Workers at many factories have to compulsorily attend assemblies /meetings before and after work shift, which may last for an hour. The management evaluates the production target of the previous day, reminds workers of the tasks they need to pay special attention to, and discipline workers, etc. According to some interviewees in Shenzhen, they are warned not to talk to strangers, especially journalists. Before starting to work, management would ask the workers, "how are you?" Workers must shout, "Good! Very good! Very, very good!" No matter workers like it or not, they can only follow the instructions from the management.

Long working hours / Frequent change of work shifts:

The factories work 6 days a week; extended to 7 days at times. There are day and night shift workers at Foxconn. Day shift is from 8:00 Hrs to 20.00 Hrs, and night shift from 20:00 Hrs to 8:00 Hrs, the next morning; 12 Hr shift working! Due to low wages workers are forced to work overtime to make both ends meet and consequently some workers toil 16 Hours a day. The assignment of work shift is not regular. Workers are assigned change in shift working far too often; the day and night shifts are sometimes changed 2 to 3 times a month. The change of shift is unbearable and leads to deterioration of mental and physical health of workers. Besides being illegal this is exploitation, to say the least.

Absolute obedience:

"Outside the laboratory, there is no high-technology, only execution of discipline"; A famous quote from Terry Gou. This implies absolute obedience is a rule in Foxconn. The culture of absolute obedience is imposed on workers starting from recruitment. Some applicants recall that they were badly treated in the recruitment centers. The instructors

were arrogant and rude. A worker said, “We come to look for jobs, but the attitude of the instructors make us feel as if we come to beg for their mercy.” All workers have to be highly focused on their work. They are not allowed to talk, doze off, giggle, stretch their bodies or move around. These would lead to rapprochement from the frontline management. Foxconn practices military style management in a civilian environment. Is it possible to do so without state sponsoring? Hard to believe!

Inhumane punishment:

Managers yell at workers for minor mistakes or for being slow in production. Many of them just try to get used to reproaches from the management. Apart from being scolded, some other forms of punishment are used. Workers, who make a mistake or violate any factory rule, would receive demerits. Moreover, the details of their cases are be posted on the notice board; humiliating indeed. Workers believe that demerits may lead to deduction of production bonus.

Harassment from security guards:

Workers are afraid of security guards; many of them having encountered harassment from the security force. Based on the 1,736-questionnaire survey result, 28% of respondents reported having been insulted by management and security guards. Some of the workers are beaten up by security guards. An instance of a security guard hitting a worker with an electrical baton was reported.

Health and Safety:

The Law on the Prevention and Treatment of Occupational Diseases of China provides that “the employing work unit must adopt effective protective facilities against occupational diseases, and provide protective articles to the laborers for personal use against occupational diseases.” Notwithstanding the provisions of law, workers in Foxconn’s production facilities suffer from the threat of occupational diseases. Personal protective equipment such as surgical masks, goggles, gloves, safety shoes etc are not provided to guard against hazardous working conditions. And health examination is denied.

Health and safety problems have negative impact on the bonuses and career paths of frontline workers and middle management. Some managerial staff try to cover up the cases for their own sake. Workers are asked to take sick leave instead of medical leave despite the fact that there are work-related injuries with insurance implications.

Student Workers:

Some interviewees highlighted to the media, that the proportion of student workers was as high as one-third. For some time, Foxconn ceased to recruit new workers in Shenzhen. Instead, a high number of vacancies were filled by tens of thousands of student interns. It

is believed that Foxconn alone cannot mobilize such a high number of students, without active help from provincial governments.

Trade Unions in China:

The ACFTU (All-China Federation of Trade Unions) is the largest union in the world, with over 280 million members; it's also one of the weakest in representing their members, existing primarily to serve the CCP (Chinese Communist Party) convey its messages and policies to the workers, and spread the "mass line." In fact, all other trade unions unaffiliated with the ACFTU are illegal. At the factory of workplace level, most trade unions are basically controlled directly or indirectly by management and they don't really represent workers' interests.

And, yet, China permits no independent trade unions or free collective bargaining. Complaint and mediation procedures are weak. Profits at any cost!

How does Foxconn Management style compare with the Management Science?

Is it a state-sponsored exploitation?

22.02.00 Apple Inc.

Apple Inc. is an American multinational corporation headquartered in Cupertino, California, that designs, develops, and sells consumer electronics, computer software, online services, and personal computers. Its best-known hardware products are the Mac line of computers, the iPod media player, the iPhone smartphone, and the iPad tablet computer. Its online services include iCloud, iTunes Store, and App Store. Its consumer software includes the OS X and iOS operating systems, the iTunes media browser, the Safari web browser, and the iLife and iWork creativity and productivity suites.

Apple was founded by Steve Jobs, Steve Wozniak, and Ronald Wayne on April 1, 1976, to develop and sell personal computers. It was incorporated as Apple Computer, Inc. on January 3, 1977, and was renamed as Apple Inc. on January 9, 2007.

Apple is the world's second largest information technology company by revenue after Samsung Electronics and the world's third-largest mobile phone maker after Samsung and Nokia. *Fortune* magazine named Apple the most admired company in the world. Apple is the technology leader in their field and is amongst “Best Global Brands”.

However, the company has received criticism for its contractors' labor practices, as well as for its own environmental and business practices.

Company Details:

- No of retail stores = 425
- Market Capitalization = US $ 446 Billion

- No of Permanent Employees = 72,800
- No of Temporary Employees = 3,300
- Annual Revenue = US $ 170 Billion

Apple and American Economy:

Apple has been phenomenally successful, making products people love and directly creating about 50,000 American jobs; but criticized for not locating its manufacturing operations in America, even as Americans complain to Apple about the working conditions of those doing the manufacture abroad mainly at Foxconn Technology Group factories in China with life in dormitories, 12-hour shifts 6 days a week, and low pay. It isn't enough for Apple to have changed the world with its innovative consumer electronics. The physical production of Apple's products accounts for over a million of manufacturing jobs globally. America, which finds itself several million jobs short of where it would like to be, and particularly short of the semi-skilled manufacturing positions that once powered growth in the middle class, seems to want some of those back. Is that an unreasonable desire? Not at all! But you can't have the cake and eat it too. Are the Americans willing to accept lower wages? Can they live in dormitories located next to a factory? Can they mobilize thousands of workers at short notice to meet any peak demand? Can they handle the associated problems of massive pollution? Can they manufacture the products at acceptable prices? Apparently, there are no answers to these questions at the moment. Time will tell!

Success with mobile devices:

Apple achieved widespread success during the period 2007-2012 with its iPhone, iPod Touch and iPad products, which introduced innovations in mobile phones, portable music players and personal computers respectively. In addition, the implementation of a store for the purchase of software applications represented a new business model. Touch screens had been invented and seen in mobile devices before, but Apple was the first to achieve mass market adoption of such a user interface that included particular pre-programmed touch gestures.

Technology Leadership and Brand loyalty

Apple's brand loyalty is considered unusual for any product; almost amounting to brand fanaticism. People have an incredibly personal relationship with Apple's products. This is achieved by excellent product innovation and quality.

Criticism of Apple Inc:

- Although they have been predominantly successful, their production methods, which involve huge amounts of hard labour have come under heavy criticism.

Apple Inc. has received much criticism for the use of sweatshop labor, environmental destruction, and unethical business practices as a result of the method they undertake to produce electronics.

- Foxconn Technology group is one of their major suppliers, who are notorious for their unethical business practices. The facility has 300,000 employees, many working six days a week, often spending up to 12 hours a day at the plant. Over a quarter of Foxconn work force lives in company barracks and many workers earn less than $20 a day. The operations of Foxconn have been enumerated earlier in this chapter. Apple Inc. is a party to this violation. Of course, they have their own reasoning. They can not supply their products at current prices if manufactured in USA.
- There has been criticism of Apple's portable devices, whether iOS-based (i.e., iPhone, iPod Touch, iPad), or other non-iOS-based (i.e., iPod Classic, iPod Nano, iPod Shuffle), being locked into iTunes and creating an iTunes Store monopoly for these devices. Because of this, Steve Jobs was ordered to attend a court hearing regarding antitrust violations specifically with iPods and iTunes.
- Apple has been criticized for post-launch price reductions, most notably after the price of the iPhone was cut by $200 just two months after its release. This quick drop in price resulted in many complaints to Apple. Apple worked to rectify complaints by offering $100 store credit to early iPhone customers who had bought their iPhones from Apple or AT&T.

Conclusion:

Overall, Apple Inc. has been successful in developing a range of magical products, but the means of these achievements are open to much debate and criticism.

22.03.00 Wal-Mart Stores Inc.

Wal-Mart Stores, Inc. branded as **Walmart** is an American multinational retail corporation that runs chains of large discount department stores and warehouse stores. Headquartered in Bentonville, Arkansas, the company was founded by Sam Walton in 1962 and incorporated on October 31, 1969. It has over 11,000 stores in 27 countries, under a total 55 different names. The company operates under the Walmart name in the US and Puerto Rico. It operates in Mexico as Walmart de México y Centroamérica, in the United Kingdom as Asda, in Japan as Seiyu, and in India as Best Price. It has wholly owned operations in Argentina, Brazil, and Canada.

The company is the world's largest public corporation, according to the Fortune Global 500 list in 2014, the biggest private employer in the world with over two million employees, and the largest retailer in the world. Walmart is a family-owned business, as the company is controlled by the Walton family, who own over 50 percent of Walmart through their holding company, Walton Enterprises.

Sam's Club, of Walmart group, is a chain of warehouse clubs which sell groceries and general merchandise, often in large quantities. Sam's Club stores are "membership" stores and most customers buy annual memberships.

To the uninitiated, Walmart is a success story! Is it? Successful only in profiteering? Let us see what is this Walmart business is all about.

Walmart is the largest employer in the United States, employing almost five times as many people as IBM, the second largest employer in the U.S. With close to 2.2 million employees worldwide, Walmart has faced a torrent of lawsuits and issues with regards to its workforce. These issues involve low wages, poor working conditions, inadequate health care, as well as issues involving the company's strong anti-union policies. In November 2013 the National Labor Relations Board (NLRB) announced that it had found that Wal-Mart had pressured employees not to engage in strikes and had illegally disciplined workers who had engaged in strikes.

Criticism:

Wal-Mart has been subject to criticism from numerous groups and individuals. Among these are labor unions, community groups, religious organizations, environmental groups, and even Wal-Mart's own customers and employees. They have protested against the company's policies and business practices, including charges of racial and gender discrimination. Other areas of criticism include the corporation's foreign product sourcing, treatment of product suppliers, employee compensation and working conditions, environmental practices, the use of public subsidies etc. Yet, Wal-Mart denies doing anything wrong and maintains that low prices are the result of efficiency. It is strange to note that the Founder Sam Walton held the belief that the company’s contribution to society was the fact that it operated efficiently, thereby lowering the cost of living for its customers, and therefore in that sense was a “powerful force for good”. For whose good really?

Critics point to Wal-Mart's high turnover rate as evidence of an unhappy workforce, although other factors may be involved. Approximately 50% of its employees leave within the first year.

Unfair Labour Practices:

There have been many strikes at Wal-Mart resulting in acts of reprisal by management against some striking employees. Over the past few years, in response to these reprisals, dozens of Unfair Labor Practice (ULP) charges have been filed by "OUR Walmart" (*Organization United for Respect at Walmart*) on behalf of "OUR Walmart" members who have experienced retaliation for their activities with the organization. These ULPs fall into three general categories:

1) Terminations: workers have been terminated by Wal-Mart in retaliation for their participation in "OUR Walmart"

2) Threats: workers have been threatened with loss of job or store closings in retaliation for their activities with "OUR Walmart"

3) Reduction in hours: retaliatory reduction of hours for workers who have been involved with "OUR Walmart"

Cheap Goods:

No doubt, Walmart supplies cheap goods albeit by means of exploitation of employees, suppliers, and contractors. However, there is a flipside to Wal-Mart's contribution. The secret is, Wal-Mart is exploiting China more than its own employees. The Chinese workforces involved in manufacturing goods for Walmart are the real victims. They are grossly underpaid workers with wages below subsistence level, which is why the goods get cheaper. It is anybody's guess as to the extent of pollution caused in China due to excessive manufacturing activities there for Walmart, Apple and the like. Walmart employees are getting away lightly as compared to the workers producing goods for Walmart; this said in a lighter vein. It is true that Wal-Mart's employees are grossly underpaid and are an unhappy lot. Wal-Mart is thriving on account of the Chinese policy of making cheap goods for them at cheaper prices.

Wal-Mart in India:

In India, small businesses beat Wal-Mart at their own game. They also import cheap Chinese goods - at prices barely above material cost - and sell them at every street corner in India. The transport cost is not much as China and India are neighbors. Why would anyone drive to Wal-Mart to buy cheap goods when every item is available just a stone-throw away! To make matters worse, India also manufactures a lot of cheap, cheaper, and cheapest goods - as competitive as Chinese goods - and sell them alongside Chinese stuff. Indians are busy with computer software development and other white collar activities and have no time or inclination to compete with China in the manufacturing sector. They already have a massive task of infrastructure development such as roads, buildings, irrigation projects, and the like. Wal-Mart is unlikely succeed in India. If at all, there is any slim chance, Indian political system will abort it on the tracks. China has

become the world's manufacturing center; bordering on being the backyard of the world polluting the elements of nature; their rivers (water), earth, and air. The fourth element, the fire is not yet polluted!

Policy of reducing staff strength and lowering wages:

Despite Wal-Mart executives' insistence on cost cutting, the members of 'OUR Walmart' demand for improved staffing is not inconsistent with a desire for profitable business. Contrary to popular managerial belief, which holds that payroll at low-cost retailers should be kept as grossly low as possible, recent research shows that spending more on staffing, in terms of wages, hours and training, can help rather than hurt a retailer's bottom line. In a study of four low-cost retailers viz. Costco, Quiktrip, etc Professor Zeynep Ton of MIT's Sloan School of Management found that these chains, which invest substantially more in training and payroll than their peers, also have substantially higher asset and labor productivity than similar companies with leaner payrolls.

Deteriorating customer service:

As per some national surveys, consumers generally do not like shopping at Wal-Mart, and the issues cited by customers who dislike their experience in Wal-Mart stores appear to be directly related to staffing problems. The quality of goods sold at Walmart is mostly substandard. The only reason for the large customer base is *'low price of goods',* for the time being.

Health and safety risks:

Many Wal-Mart associates believe the low staffing levels contribute to safety risks at the company, and clearly Wal-Mart management has struggled with safety violations in its stores, at times resulting in an unsafe working environment for employees and an unsafe shopping environment for customers.

Wage and hour violations:

While Wal-Mart executives proudly boast of the company's relentless pursuit of labor expense reductions, the company's history of systematic wage and hour law violations in the United States has been extensively documented. In its most recent Form 10-K filed with the Securities and Exchange Commission, Wal-Mart disclosed that it remains a defendant in numerous" wage and hour class actions, and has continued to appeal.

Gender, race, disability and religion:

Wal-Mart continues to face formidable challenges in court related to gender discrimination in pay and promotions. Wal-Mart's reputation has also taken a hit for other recent discrimination and harassment lawsuits. Between June 2006 and August 2012, Wal-Mart has settled at least 9 EEOC (Equal Employment Opportunities Commission)

cases for $13.4 million related to disability discrimination, gender discrimination, racial discrimination, religious discrimination and sexual harassment.

Violations in Wal-Mart's supply chain / Wal-Mart's suppliers of goods:

Public scandals and legal violations continue to occur at Wal-Mart contractors and subcontractors throughout the company's supply chain, both in supplier factories and in warehouses that store and move goods sold at Wal-Mart. According to a recent report by the National Employment Law Project, in the Inland Empire, labor violations in the warehousing industry are widespread, including lack of overtime pay, piece rate pay schemes that only lead to compensation for select portions of work performed, illegal and falsified pay records, and hazardous workplace conditions.

Recent reports by whistleblowers and outside observers reveal that many Wal-Mart suppliers of goods around the world also continue to violate local laws and Wal-Mart's Standards for Suppliers. Workers' rights organizations from around the world continue to uncover new labor violations in Wal-Mart's supply chain, suggesting systemic, widespread failures in Wal-Mart's prevention and handling of these issues.

Scott Nova, corporate social responsibility expert and Executive Director of the Worker Rights Consortium, calls Wal-Mart "the leading corporate contributor to the persistence and pervasiveness of abusive and exploitative labor conditions in global export manufacturing.

22.04.00 Mondragon Corporation

The MONDRAGON Corporation is a corporation and federation of worker cooperatives based in the Basque region of Spain. It was founded in the town of Mondragon in 1956 by graduates of a local technical college. Its first product was paraffin heaters. It is the tenth-largest Spanish company in terms of asset turnover and the leading business group in the Basque Country. At the end of 2013, it employed 74,061 people in 257 companies and organizations in four areas of activity: finance, industry, retail and knowledge. Mondragon cooperatives operate in accordance with Statement on the Co-operative Identity maintained by the International Cooperative Alliance.

Mondragon is worker owned, it's not worker managed, although the management does come from the workforce often.

Mondragon Mission:

"MONDRAGON Corporación Cooperativa" or "MONDRAGON Cooperative Corporation" is a business-based socioeconomic initiative with deep roots in the Basque Country, created for and by people and inspired by the Basic Principles of our Co-operative Experience. It is firmly committed to the environment, competitive improvement and customer satisfaction in order to generate wealth in society through business development and the creation of preferably co-operative, employment, which:

- Is based on a firm commitment to solidarity and uses democratic methods for organization and management.
- Fosters participation and the involvement of people in the management, profits and ownership of their companies, developing a shared project which unites social, business and personal progress.
- Fosters training and innovation through the development of human and technological skills.

Business culture:

Mondragon co-operatives are united by a humanist concept of business, a philosophy of participation and solidarity, and a shared business culture. The culture is rooted in a shared mission and a number of principles, corporate values and business policies.

This framework of business culture has been structured based on a common culture derived from the 10 Basic Co-operative Principles, in which Mondragon is rooted: Open Admission, Democratic Organization, the Sovereignty of Labour, Instrumental and Subordinate Nature of Capital, Participatory Management, Payment Solidarity, Inter-cooperation, Social Transformation, Universality and Education.

This philosophy is complemented by four corporate values: *Co-operation*, acting as owners and protagonists; *Participation*, which takes shape as a commitment to management; *Social Responsibility*, by means of the distribution of wealth based on solidarity; and *Innovation*, focusing on constant renewal in all areas.

Areas of Activity:

1. Finance: Banking Business of Laboral Kutxa.

2. Industries: Capital goods, Bicycles, Exercise Equipment, Construction Equipment etc…

3. Retail Business: Eroski.

4. Knowledge: University of Mondragon.

At Mondragon, there are agreed-upon wage ratios between executive work and field or factory work which earns a minimum wage. These ratios range from 3:1 to 9:1 in

different cooperatives and average 5:1. That is, the general manager of an average Mondragon cooperative earns no more than 5 times as much as the theoretical minimum wage paid in his/her cooperative. In reality, this ratio is smaller because there are few Mondragon worker-owners that earn minimum wages, because most jobs are somewhat specialized and are classified at higher wage levels. The wage ratio of a cooperative is decided periodically by its worker-owners through a democratic vote.

Wage regulation:

Scholars such as Richard D. Wolff, American professor of economics, have hailed the Mondragon set of enterprises, including the good wages it provides for employees, the empowerment of ordinary workers in decision making, and the measure of equality for female workers, as a major success and have cited it as a working model of an alternative to the capitalist mode of production.

Actually, one of the successes of Mondragon is its ability to create a sense of identity among the workers within the company, encouraging an environment of solidarity and collegiality among them, a feeling that also extended to non-worker-owners.

22.05.00 Amazon Corporation

Source of information: Book titled "Mindless - Why Smarter Machines are Making Dumber Humans" by Simon Head

Amazon is now a leading global online-seller not only of books but also of music and movie DVDs, video games, gift cards, cell phones, and magazine subscriptions etc. Login at www.amazon.com, choose a product of your choice, and place order; and in a very short time the item will be at your doorstep.

Within the corporate world, Amazon now ranks with Apple as among the United States' most esteemed businesses. It is hard to resist the temptation to compare Amazon with Walmart. Like Walmart, Amazon combines state-of-the-art CBSs (Computer Business Systems) with human resource practices reminiscent of the nineteenth and early twentieth centuries.

Amazon exceeds Walmart in the use of monitoring technologies to track the minute-by-minute movements and performance of employees and in settings that go beyond the assembly line to include their movement between loading and unloading docks, between packing and unpacking stations, and to and from the shelves at gigantic warehouses

where goods ordered by Amazon's online customers are sent by manufacturers and wholesalers, there to be shelved, packaged, and sent out again to the Amazon customers.

Please recall the contents of the earlier chapter in this book titled "Brief History of management" where in we had discussed about Taylorism and Scientific management. Amazon easily beats Taylor in Taylorism, hands down; albeit using CBSs (Computer Business Systems) which Taylor had no access to. You may call this "21st century Taylorism" in the garb of scientific management. Amazon's shop-floor processes are an extreme variant of Taylorism that Frederick Winslow Taylor himself would hang his head in shame, or turn in his grave. With this twenty-first-century Taylorism, management experts, *scientific managers,* take the basic workplace tasks at Amazon, such as the movement, shelving, and packaging of goods, and break down these tasks into their subtasks, usually measured in seconds; then rely on time and motion studies to find the fastest way to perform each subtask; and then work out ***"the best process"*** that employees must adapt. The entire process is dehumanized and deskilled.

Yes, Amazon is truly a global organization, and this globalism provides insights into how Amazon responds to workplaces beyond the United States that can follow different rules.

The propaganda machine claims that "Amazon cares about the customer" and "everything at Amazon is driven by and for the customer". At Amazon, there is this pseudo cult of the customer as an object of 'trust' and 'care'.

Amazon's embellishment of this customer cult with the politically correct language of "*care*" and "*trust*" comes with a strong dose of deception because Amazon's customers are principally valued by the corporation as mainstays of the bottom line, and not as the prime movers of the business. There is still more humbug in this game because Amazon treats a second significant grouping of persons with whom it has dealings - its employees - with the very opposite of *'care'* and *'trust'*. They are expected to be devotees of this *"pseudo customer cult"*, no matter what. The harsher side of Amazon is coming to light in recent years. It has been in Germany that this humbug has been exposed and the true role of the "cult of the customer" has become clear. In US and UK, Amazon management is hegemonistic as there is no independent employee voice to contest management's demands for increased output unmatched by increases in real wages. But in Germany Amazon has to deal with work councils (*Betriebsrat*); a powerful union, the United Services Union (Ver.Di), with 2.2 million members; and high officials of the federal and state governments more closely aligned with labor than their counterparts in the United States and the United Kingdom. When confronted by the unions in Germany to negotiate on wages and working conditions, especially for temporary workers who are badly exploited at Amazon management refused on the grounds that employees should be

"thinking about their customers and not about their own selfish interests". This is not a very convincing argument, of course.

Amazon keeps pushing up employee productivity relentlessly while keeping hourly wages at or near poverty levels. The rationale is setting up targets based on elemental time standards established by so called scientific management. Amazon achieves this with a regime of workplace pressure, in which targets for the unpacking, movement, and repackaging of goods are relentlessly increased to levels where employees have to struggle to meet their targets and where older and less dexterous employees would begin to fail and get marginalized. These marginal employees who acquire too many demerits are then fired.

Amazon's system of employee monitoring is of the most oppressive kind with the aid of state-of-the-art surveillance technology. Amazon tags its employees with personal sat-nav (satellite navigation) computers that tell them the route they must travel to shelve consignments of goods, but also set target times for their warehouse journeys and then measure whether targets are met. As a result of this undue pressure, some Amazon employees are in constant motion across the floors of its enormous centers and others work like robots on assembly lines (belt conveyors) packing goods for shipping. Machines measured whether the packers were meeting their targets for output per hour and whether the finished packages met their targets. Apart from digital controls, the supervisors keep an eagle's eyes to ensure that the workers do not pause even catch their breath. Workers would be reprimanded even if they talk to one another, or slow down. The supervisors monitor how often a packer goes to the bathroom and whether or not he has gone to the nearest bathroom. If not, ask why not?

Other examples include providing UK employees with cheap, ill-fitting boots that gave them blisters; relying on employment agencies to hire temporary workers whom Amazon can pay less, avoid paying them benefits, and fire them at will.

In another shocking case at Allentown- Pennsylvania center at USA, during the summer of 2011, revealed the lengths Amazon was prepared to go to keep costs down and output high. How ruthless can Amazon be! Ambulances stationed on hot days at the Amazon center to take employees suffering from heat stroke to the hospital. Despite the summer weather, there was no air-conditioning in the depot, and Amazon refused to let fresh air circulate by opening loading doors at either end of the depot for fear of theft. Inside the plant there was no slackening of the pace, even as temperatures rose beyond $100^{\mathbf{o}}$ F.

Amazon's business model, the workplace practices that raise employee productivity to very high levels also keep employees off balance and thus ill placed to secure wage increases that match their increased output. The "cult of the customer" preached by Amazon is a scented smoke screen thrown up to hide this fact.

Should these apparent benefits to customers be achieved at the altar of a system that treats employees as untrustworthy human robots and relies on intimidation to push them to the limit, while denying them the rewards of their own increased efficiency? Pause and ponder!

22.06.00 Japanese Style of Management / Maruthi Suzuki Ltd

Transfer of Corporate Japan overseas: USA:

Because of the success of Japanese companies, many countries tried to adapt a Japanese system of human resource management. They hoped to increase productivity, quality, worker satisfaction etc; but it was not to be. There was an immediate increase in the number of American firms using Japanese style because of its initial appealing nature and its proven success in Japan; however, because of great cultural differences, this style did not succeed in the long run. Although a few companies in America have been successful, many companies are having difficulties transferring the Japanese style. American cultural barriers stand in the way of implementing Japanese system.

Some features of Japanese System:

- Employees are expected to meet peak demand by way of long working hours, overtime at short notice.
- Team members help each other to get out of any problem. There is a sense of *'familism'***;** They rotate jobs to make workforce flexible in order to carry out multiple tasks.
- Seniority and job security are also important aspects of the Japanese system. Workers in Japan know that their elders will have the better positions. If they perform well, their chance for seniority will come along later.

- Japanese workers have a high degree of loyalty towards their company.
- Japanese workers feel the peer pressure more than that of management.
- Participative management.
- Tradition of continuous improvement known as "***Kaizen***".

Japanese cultural traits, such as homogeneity, familism, and loyalty are conducive to successful implementation of such a system. Cultural conditions and expectations in America prevent its long-term success.

Let us see the American way in relation to the Japanese style.

- Employees do not like to work long hours or work overtime at short notice because of their prior commitments, especially concerning family members.
- There is more individualism in American psyche.
- They tend to feel resentment towards inefficient workers.
- College graduates and talented young persons do not like the idea of seniority for promotions.
- Americans look for better opportunities and tend to change jobs often.

America is a multicultural society and its cultural features are at variance with Japanese culture of homogeneity, loyalty towards company, familism at work etc. There is no one way of doing things here. This aspect is not conducive to the Japanese way of working.

However, certain features of Japanese system such as "participative management", "Kaizen" etc have contributed to increase in productivity and employee satisfaction in America.

Transfer of Corporate Japan Overseas: Suzuki in India:

Maruti Suzuki India Limited - formerly known as Maruthi Udyog - is an automobile manufacturer in India. It is a subsidiary of Japanese automobile and motorcycle manufacturer Suzuki. Maruti Suzuki manufactures and sells a complete range of cars from the entry level Alto, to the hatchback Ritz, Celerio, A-Star, Swift, Wagon R, Zen and sedans DZire etc.

The company's headquarters are at No 1, Nelson Mandela Road, New Delhi.In February 2012, the company sold its ten millionth vehicle in India.

In 1982, a license & Joint Venture Agreement is signed between Maruti Udyog Ltd. and Suzuki of Japan. Since its founding in 1983, Maruti Udyog Ltd experienced problems with its labour force. The Indian labour it hired readily accepted Japanese work culture and the modern manufacturing process. In 1997, there was a change in ownership, and

Maruti became predominantly government controlled. Relationship between the Government of India, and Suzuki Motor Corporation over the joint venture was a point of heated debate in the Indian media until Suzuki Motor Corporation gained the controlling stake.

However, the company had been plagued by labour problems and unrest. There were demands for increase in wages, which the company could not afford. Workers complained of harsh working conditions and hiring of temporary workers at low wages. There were many instances of violence in the factories. Notwithstanding these problems, the company continues to be a profitable venture and is well known for its excellent service network.

Implementation of Japanese system at Suzuki:

Initially, Suzuki brought in the following changes at the Indian subsidiary:

- An open-office policy of housing 50 employees in one office including managers, all sitting in the open. There were no separate cabins for managers. This was meant to promote close-knit working among the staff and between the staff and managers.
- A common uniform for all employees irrespective of their ranking.
- Common canteen and menu for all employees.
- Stress on cleanliness, maintenance, and quality.
- Implementation of *'Kaizen'*, a system of continuous improvement.
- Conduct shop floor meetings to discuss problems and schedule of work.
- Report for duty 10 minutes in advance of start of a shift for exercising and changing dress and a strict policy on punctuality.
- Report at the workstation within a minute after the siren goes off.
- Engage in continuous improvement process (Kaizen)

Gradually the cultural differences began to show up, hindering implementation of the Japanese work culture at Suzuki works, in India. Following cultural differences were at play:

- Maintaining punctuality was problematic. In Japan, employees have their own vehicles for commuting and public transport system is also good; whereas Indians have to depend on inefficient public transport system.
- Due to the prevailing culture at the workers' previous employment, unauthorized absenteeism was rampant. Old habits die hard!

- Stopping work for a few minutes to take rest is an old habit for the Indian workers.
- Lack of team work.
- Lack of quality consciousness.
- Managers are status conscious and do not wish to sit in the open; they want cabins.
- Managers wish to have special arrangements for food.
- Workers resented the idea of reporting for duty 10 minutes in advance; that too without proportionate remuneration.

As in America, the cultural differences challenged the concepts of Japanese system at work in India too. As a result, a hybrid system evolved, albeit with limited benefits. However, the Japanese method contributed toward significant improvement in product quality.

Suzuki management solved some of these problems as follows:

- Take fresh engineering graduates and workmen without previous experience so as to mold them to their way of working.
- Training of staff by experienced Japanese supervisors who had good hand-on experience.
- Superior Suzuki technology eliminated some human element in working.

22.07.00 Google - Matrix, the movie

If it is not in Google, it does not exist.

… Jimmy Wales

There is nothing, nothing, nothing that Google can not tell you. Google knows all that there is to know. The only problem is that of assimilating the information provided by Google, by the lesser mortals.

… Reddigari Seshadri Reddy

I can not imagine a life without Google. Why?

Have you seen the movie, Matrix (Trilogy); a dream world and an illusion at its best? It is a computer program to subdue human population. Google is presently “the MATRIX” in its nascent stage. I am sure it will soon evolve into a MATRIX and even surpass it at present rate of technological development. I was an ignorant and clueless lad earlier. Thanks to Google, I have the answers to every question. I will be soon be nostalgic about being a clueless kid.

I feel I am trapped in a matrix when I look for information at google search engine. At the same time I feel secure at the thought of having any information just a click away, thanks to Google. Other sources of information such as Wikipedia are a distant second, at best. Wikipedia is one-dimensional while Google is 3D animation of sorts. I get a video for every subject on earth in Google's youtube.com ranging "from how to make an omelet"➔ "how to repair a dishwasher" ➔ "how to build a house" ➔ "how to conduct heart surgery" and so on. Amazing, isn't it?

Google is sure to throw up whatever information one may need or not need. I grab my laptop, whenever I feel the urge to gather some information, which I may not even be in need of. Mostly, I fabricate a need for some information, just because Google beckons me.

Gone are the days when I used to call up my friends or visit a library for gathering information. Google has totally isolated me from the social circle. I do not feel the need to talk to anybody. Google tells me everything I need to know; which movie should I go to, which restaurant I should choose, what to buy and where, location of any place on this planet, exchange rate 10 years back, share price movement since inception of any company etc. This said in a lighter vein.

I am not undermining the usefulness of Google. It is truly an amazing tool.

Origin and Operations:

Stated Mission: Google's mission is to organize the world's information and make it universally accessible and useful.

Google is an American multinational corporation specializing in Internet-related services and products. These include online advertising technologies, search, cloud computing, and software. Most of its profits are derived from AdWords. Google AdWords is an online advertising service that places advertising copy at the top, bottom, or beside, the list of search results Google displays for a particular search query. The choice and placement of the ads is based in part on a proprietary determination of the relevance of the search query to the advertising copy. AdWords has evolved into Google's main source of revenue.

Google was founded in the year 1998 by Larry Page and Sergey Brin while they were Ph.D. students at Stanford University. Google's headquarters in Mountain View, California, is referred to as "the Googleplex", a play on words on the number googolplex and the headquarters itself being a *complex* of buildings. It may of interest to note that Google started its operations in a humble garage of a friend in Menlo Park, California. The name Google, originated from a misspelling of the word "googol", the number one

followed by one hundred zeros, which was picked to signify that the search engine was intended to provide large quantities of information.

A **googol** is the large number 10^{100}; that is, the digit 1 followed by 100 zeroes:

Google is a company that started its operations in a lowly garage with a misspelled name (googol was misspelled as Google) with just one employee. Interesting!

Highlights:

The corporation has been estimated to run more than one million servers in data centers around the world.

Google process over one billion search requests each day

Number of employees = 47,756

Corporate culture:

On *Fortune* magazine's list of best companies to work for, Google ranked first in 2007, 2008 and 2012. Google was also nominated in 2010 to be the world's most attractive employer to graduating students in the ***Universum*** Communications talent attraction index. Google's corporate philosophy includes principles such as "you can make money without doing evil".

As a motivation technique, Google uses a policy often called Innovation Time Off, where Google engineers are encouraged to spend 20% of their work time on projects that interest them. Some of Google's newer services, such as Gmail, Google News, Orkut, and AdSense originated from these independent endeavors. Many new product launches originated from the Innovation Time Off.

Philanthropy:

In 2004, Google formed the not-for-profit philanthropic Google.org, with a start-up fund of $1 billion. The mission of the organization is to create awareness about climate change, global public health, and global poverty.

In 2011, Google donated 1 million Euros to International Mathematical Olympiad to support the next five annual International Mathematical Olympiads.

Tax avoidance:

Google uses various tax avoidance strategies. Out of the five largest American technology companies it pays the lowest taxes to the countries of origin of its revenues. The company accomplishes this partly by licensing technology through subsidiaries. Following criticism in UK on this issue, Chairman Eric Schmidt said, "It's called capitalism. We are proudly capitalistic".

Criticism of Google:

Criticism of Google includes alleged misuse and manipulation of search results, its use of others' intellectual property, concerns that its compilation of data may violate people's privacy, censorship of search results and content, and the energy consumption of its servers as well as concerns over traditional business issues such as antitrust, monopoly, and restraint of trade.

Google's stated mission is *"to organize the world's information and make it universally accessible and useful"*. This mission and the means used to accomplish it have raised concerns among the company's critics. Much of the criticism pertains to issues that have not yet been addressed by cyber laws.

Likely misuse of search results by users:

With the Google interface the user gets the impression that the search results imply a kind of totality.

Page rank manipulation:

Numerous companies and individuals have voiced concerns regarding the fairness of Google's Page rank and search results after their websites disappeared from Google's first-page results. It is conjectured that Google favored its own services in search results. Complainants have been unable to provide evidence in courts.

Biased rankings for Google Shopping:

Google announced that they will no longer be maintaining a strict separation between search results and advertising. Google Shopping will be replaced with a nearly identical interface, according to the announcement, but only paid advertisers will be listed instead of the neutral aggregate listings shown previously. To counter this change in Google Shopping, Microsoft, who operates the competing search engine Bing, launched a public information campaign titled Scroogled to drive away Google users.

Copy rights issues:

Google Books previously known as Google Book Search and Google Print is a service from Google Inc. that searches the full list of books and magazines that Google has scanned. Results from Google Books show up in both Google Web Search and the dedicated Google Books site (books.google.com). Up to three results from the Google Books index may be displayed, if relevant, above other search results in Google Web Search.

A click on a result from Google Books opens an interface in which the user may view pages from the book, if out of copyright or if the copyright owner has given permission. Books in the public domain are available in "full view" and free for download. For in-

print books where permission has been granted, the number of viewable pages is limited to a "preview"

Google's ambitious plans to scan millions of books and make them readable through its search engine have been criticized for copyright infringement. The Association for Learned and Professional Society Publishers and the Association of American University Presses both issued statements strongly opposing Google Books, stating that "Google claims a sweeping right to appropriate the property of others for its own commercial use".

Google Map Maker:

is a service launched by Google in 2008 designed to expand their Google Maps service. Google Map Maker allows user contributed data to be put into the Google Maps service, similar to OpenStreetMap. It includes concepts such as organizing mapping parties and mapping for humanitarian efforts. It has been criticized for taking work done for free by the general public and claiming commercial ownership of it.

Environmental issue:

By Google's own admission, the company continuously uses enough electricity to power 200,000 homes; which is about 300 million watts or about a quarter of the output of a nuclear power plant. Total carbon emissions may far exceed a million metric tons, mostly due to fossil fuels that provide electricity for the data centers and over a million servers. Google is making an attempt to reduce pollution by funding some clean energy initiatives. Google is also working with other members of the IT community to improve efficiency on a broader scale. In 2007 Google co-founded the "Climate Savers Computing Initiative", a group which champions more efficient computing and dedicated to cutting computer energy costs. But like any other business, Google is doing what it must to conduct their operations and can not be singled out for criticism on this issue. Microsoft is also reported to rival Google in causing pollution. There seems to be no easy answer.

In this milieu of debate over climate control issue , some *'vested interests'* claim that CO2-based climate alarm is *humbug*. I would like to believe this, even as evidence is overwhelmingly building up to the contrary. I wish the evidence is a conjecture. Let us give this a benefit of doubt. Am I just just fantasizing!

Project Oxygen:

Management at the Googleplex (Google Headquarters) embarked on a plan code-named ***"Project Oxygen"***, in early 2009. Their mission was to devise something far more important to the future of Google Inc. than its next search algorithm. They wanted to build better bosses. Were they trying to reinvent the wheel or trying to challenge the

conventional wisdom? In Project Oxygen, the statisticians gathered more than 10,000 observations about managers across more than 100 variables. The research team analyzed performance review reports, conducted interviews / surveys, collected voluminous data, correlated the words and phrases in the feedback, and by the year-end came out with a report listing what can be termed " Eight Habits of Highly Effective Google Managers". Hold your breath; in anticipation of what might be revelations by the mighty data-mining Google.

The list read like this:

- "Have a clear vision and strategy for the team."
- "Help your employees with career development."
- "Don't be a sissy: Be productive and results-oriented."
- "Possess technical expertise."

The list goes on… At first glance, the findings sound too obvious. Why did it take so long for the Giant Google to realize the obvious? Why did Google reinvent the wheel. Maybe, they wanted some unique kind of wheel; Google Wheel? However, it turned out to be more interesting, when the list was to be prioritized. Google found that technical expertise ranked dead last among Google's big eight traits.. What employees valued most were even-keeled bosses who made time for one-on-one meetings, who helped people puzzle through problems by asking questions, not dictating answers, and who took an interest in employees' lives and careers.

Knowing the capabilities of "*Google Search Engine*", we'd always believed that to be a manager, particularly on the engineering side, you need to be as deep or deeper a technical expert than the people who work for you. It turns out that it is important but absolutely the least important thing. Much more important thing is just making that connection and being accessible. Most companies are better at exhorting you to be a great manager, rather than telling you how to be a great manager. These findings are convincing to Google employees as they are based on their own company's data.

These results were extensively discussed in various training programs and performance reviews. It was found that there was a significant improvement in the performance of the Managers, subsequently. The whole exercise was to make the Google managers aware of what works, and what does not.

Google Code of Conduct:

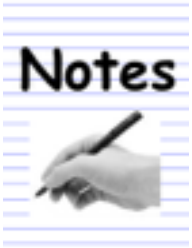
"Don't be evil." Googlers generally apply those words to show how we serve our users. But "Don't be evil" is much more than that. Yes, it's about providing our users unbiased access to information, focusing on their needs and giving them the best products and

services that we can. But it's also about doing the right thing more generally – following the law, acting honorably and treating each other with respect.

The Google Code of Conduct is one of the ways we put "Don't be evil" into practice. It's built around the recognition that everything we do in connection with our work at Google will be, and should be, measured against the highest possible standards of ethical business conduct. We set the bar that high for practical as well as aspirational reasons. commitment to the highest standards helps us hire great people, build great products, and attract loyal users. Trust and mutual respect among employees and users are the foundation of our success, and they are something we need to earn every day.

Bibliography

1. B.Mahdevan, Operations Management; Pearson education.
2. Dale H.Besterfield / Carol Besterfield-Michna / Glen H.Besterfield / Mary Besterfield-Sacre, Total Quality Management: Prentice Hall – an imprint of Pearson Education.
3. Dale H.Besterfield, Carole Besterfield-Michna, Glen H.Besterfield, and Mary Besterfield-Sacre., Total Quality Management: Pearson Prentice Hall Dipak Kumar Bhattacharyya., Production and Operations Management: Excel Books.
4. Hamdy A.Taha, Operations Research: Prentice Hall – an imprint of PEARSON.
5. Harold Koontz/Heinz Weihrich; Essentials of Management: Tata McGraw Hill Education Pvt Ltd.
6. Investopedia - Investment Education.
7. J.K.Sharma, Business Statistics: Pearson Education.
8. James R.Evans and James W.Dean, JR.,Total Quality: Management, Organization and Strategy: South-Western College Publishing, a division of Thomson Learning Inc.
9. John M.Kelly., Total Quality Management: Alexander Hamilton Institute Inc / Infotech Standards India Pvt Ltd.
10. Oxford English Dictionary.
11. Philip Kotler / Kevin Lane Keller, A Framework for Marketing Management: Pearson Education.
12. Poornima M.Charantimath., Total Quality Management: Pearson Education (Singapore) Pte ltd.
13. Prem Kumar Gupta / D.S.Hira, Operations Research, S.Chand & Company Ltd.
14. R.B.Khanna., Production and Operations Management: Prentice-Hall of India Pvt Ltd.
15. Rajesh ray, Supply Chain Management for Retailing.
16. Richards Bronson / G.Naadimuthu, SCHAUM'S Outlines: Tata McGraw-Hill Publishing Company Ltd.
17. Roget's Thesaurus.
18. S.N.Chary., Production and Operations Management: Tata McGraw-Hill Publishing Company Ltd.
19. Seshadri Reddy and Harish Reddy, Blame it on me: Frog Books, an imprint of Leadstart Publishing Pvt Ltd.
20. Seshadri Reddy and Harish Reddy, Word Bank: Anika Publications.
21. Sunil Chopra / Peter Meindl / D.V.Kalra, Supply Chain Management: Pearson Education (Singapore) Pte Ltd.
22. Wikipedia - The free encyclopedia.
23. Word Power - from Reader's Digest.
24. Word Smart: Princeton Review.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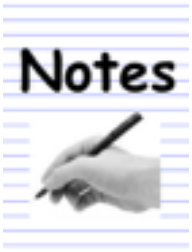
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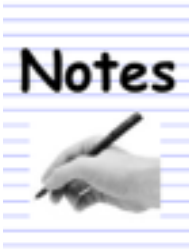
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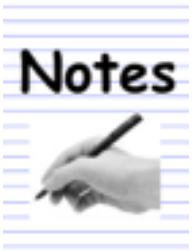
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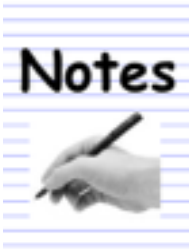
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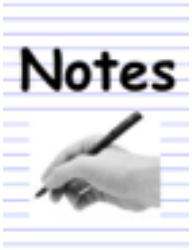
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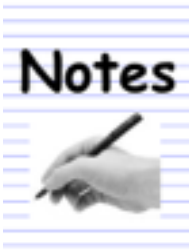
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INDEX: Management Capsule

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