**INDUSTRIAL ENGINEERING MANAGEMENT**

**(BA-1710)**

**B. Tech. (CE; EC, IT & EE)**

**Industrial Management**

**VI/VII Semester**

**Contact Hours : 4 hrs./week**

**No. of questions to be set : 10 (2 from each unit)**

**No. of questions to be answered: 5 ( 1 from each unit**

**UNIT I**

Philosophy and Development of Management thought. Concept and definition of management, Functions and Roles of Management, Social Responsibilities of Management.

Pioneers in Management, Taylor’s Scientific Management, Contribution of Henry Fayol, Gilberth and Mayo.

Schools of Management Thought: Human Behaviour, Social System, Systems approach, management process school.

Control Charts for SQC: Statistical Quality Control (SQC). Control charts or variables such as X, R charts and control charts for attributes such as p-chart, c-chart.   
Construction & use of the control charts. Process capability.

Reliability : Introduction to reliability, bath-tub curve. Life expectancy. Reliability based   
design. Series & Parallel System. Defect Diagnosis and prevention : Basic causes of failure, curve/control of failure. MTBF. Maintainability, Condition monitoring and dignostic techniques.   
Value Engineering : Elements of value analysis Techniques

**UNIT II**

Quantitative Techniques in Managerial Decisions: Concept of budget and budgetary control. Time-event network analysis; ABC Analysis, Break-even Analysis; Decision Tables; Concept of productivity, measuring productivity, Use information technology

Production Management

Types of production; Types of Planning, Manufacturing Planning; Production planning, Scheduling; Work study & Method Study; Systems of wage payments, bonus, Automation. Organization of production, planning and control department.

**Materials Management**

Practice of purchasing and materials management, quality, quality standards and inspection, sources of supply; pricing principles and practices. Inventory Mangement, EOQ model; Value Analysis and Value Engineering.

**References:**

a) H. Koontz and H. Weihrich, “Management”, McGraw Hill, 1989.

b) Dobler W.D. “Purchasing & Materials Management”, TMHC, New Delhi, 1984.

**DAY-1**

**What is management**

It is very difficult to give a precise definition to the term management. It is essentially the common elephant which is explored by several blind men and explained according to individual confined experiences. Management essentially has been evolutionary in growth. Different thinkers laid stress on different aspects. Since it is a field which has borrowed heavily from other disciplines hence the tendency has been to view and interpret it from very different angles. The economist looks upon it as a resource like land, capital and labour. The bureaucrats interpret it as a system of authority to achieve business goals. The sociologists considers managers as a part of the class of elite in the society. The psychologist defines it as way to understand and motivate people. For mathematician and scientist it is the quantitative technique to increase productivity and decrease costs.

**Management** refers to the process of coordinating and integrating work activities so that they’re completed efficiently and effectively with and through other people.

1. The *process* refers to the ongoing functions or primary activities engaged in by managers.

2. Coordinating others’ work activities is what distinguishes a manager’s job from a nonmanagerial one.

3. **Efficiency** is getting the most output from the least amount of inputs, the goal of which is to minimize resource costs.

1. **Effectiveness** is completing activities so that organizational goals are attained; often described as “doing the right things.”

Some important definition which came up during its process of evolution are as follows:

**F.W. Taylor**: Management is the art of knowing what you want to do and then seeing it is done in the best and cheapest way.

**Henry Fayol**: To manage is to forecast and to plan, to organize, to command, to coordinate and to control.

**Ralph Davis**: Management is the function of executive leadership anywhere.

**George Terry**: Management is a distinct process consisting of planning, organizing, actuating and controlling performed to determine and accomplish the predetermined objectives by the use of people and resources.

**Lawrence Appleby**: Management is the development of people and not just that of the organization.

**Dalton Macfarland**: Management is the process by which managers create, direct, maintain and operate purposive organizations through systematic, coordinated, cooperative human effort.

**Stanely Vance**: Management is simply the process of decision making and control over the action of humanbeings for the express purpose of attaining predetermined goals.

**Peter Drucker**: Management is work, and as such it has its own skills, its own tools, its own techniques its own principles and its own ethics. It is the organ, the life giving, acting, dynamic organ of the institution it manages.

**Jhon Mee**: Management may be defined as the art of securing maximum results with a minimum of effort so as to secure maximum prosperity and happiness for both employer and employee and give the public best possible service.

**NATURE/CHARACTERISTICS OF MANAGEMENT**

**1)** **Management is a process**: It is a process of planning, organizing, coordinating and controlling. These functions are performed continuously and simultaneously and not necessarily in any serial order.

It is possible to acquire knowledge for handling the different functions of this process through experience and without any theoretical training. However it becomes a more effective and efficient with the help of training and formal knowledge.

**2) It is a social process:** It takes place only through people. It is this pervasiveness of human element that gives management its special character as a **social process**.

**3) It involves group effort:** Management came into existence when a group (animal?) decided to join individual strength and abilities to attain a common and predetermined objective. However, now it has attained a new dimension and even the individual efforts have been recognized to possess management principles. Self-actualization, in fact, was recognized as the ultimate level by Maslow while propounding his theory of motivation.

**4) It aims at achieving pre-determined objectives:** All organization - be they political, social or commercial purpose - are essentially groups of individuals formed for common objectives.

**5) It is a distinct entity:** It is a distinct work. It involves “getting things done through others” rather than “doing” itself.

**6) It is a multi-disciplinary subject:** It draws upon many other disciplines such as physics, mechanics, anthropology, sociology, psychology and other social sciences.

**7) Co-ordination is its essence:** The whole idea of co-ordination is to adjust, reconcile and synchronize individual efforts so that group effort becomes more effective and help achieve the common objective.

**8) It is a system of authority:** Management is a rule-making and rule enforcing body, and within itself it is bound together by a web of relationship between superiors and subordinates.

**9) It is all pervasive:** Unlike the common perception, management is not limited just to business organization, but exists at all levels be it the government of a nation, scientific research, religious organizations or even sports.

**10) It is an essential human activity:** It has always been a part of human society ever since the dawn of civilization.The life today has become so complex that entire world will collapse without it.

**11) It is a profession:** It is backed by a systematic body of knowledge. A number of its principles need proper learning and formal education. But it fails (unlike medical and legal) to qualify the test of professionalism relating to restricted entry.

**DAY-2**

**Is Management Art or Science?**

The debate has been long and intense. Generally it is said that Management is an art, though not so perfect as music or painting. At the same time it is considered a discipline of science though not as exact as physical Science

Art is an expression of our feelings, emotions, ideas and values and a release of our fear, anxieties and tensions. It provides an opportunity to stretch ourselves beyond the physical confines of our universe. Management shares all these attributes with arts.

Science refers to a systematized body of knowledge acquired by mankind through observation, experimentation and intelligent speculation, which is capable of verification. Through this process some general principles related to a phenomena can be evolved. This is true for Management also.

However it is obvious that management is a discipline of arts. Music too is based on principles of sound, yet by no stretch of imagination can it be termed a discipline of science. The same is true for painting.

**WHAT DO MANAGERS DO?**

No two managers’ jobs are alike. But management writers and researchers have developed some specific categorization schemes to describe what managers do. We’re going to look at five categorization schemes: functions and processes, roles, skills, managing systems, and situational analysis.

A. Management Functions and Processes. Henri Fayol, a French industrialist from the early part of the 1900s, proposed that managers perform five management functions: POCCC (plan, organize, command, coordinate, control). These functions still provide the basis around which popular management textbooks are organized, but the functions have been condensed to four.

a. **Planning** involves the process of defining goals, establishing strategies for achieving those goals, and developing plans to integrate and coordinate activities.

b. **Organizing** is the process of determining what tasks are to be done, who is to do them, how the tasks are to be grouped, who reports to whom, and where decisions are to be made.

c. **Staffing** is the process of determination who will do the tasks identified during organizing.

c. **Leading** includes motivating subordinates, influencing individuals or teams as they work, selecting the most effective communication channel, or dealing in any way with employee behavior issues.

d. **Controlling** is monitoring activities to ensure that they are being accomplished, comparing performance with previously set goals, and correcting any significant deviations.

2. The reality of managing isn’t quite as simplistic as these descriptions imply. It’s more realistic to describe managers’ functions from the point of view of a process.

3. The **management process** is the set of ongoing decisions and work activities in which managers engage as they plan, organize, lead, and control.

**DAY-3**

**Social responsibilities of Management**

Social responsibilities of management is not a fashionable term as is generally believed. Nor has it been coined to make management more acceptable or legitimate. It is certainly a way of life.

**Areas of Social obligation**: The chief areas are as follows:

1. To efficiently utilize and conserve the national resources in general and the resources of concern in particular. Any relaxation in this respect may correctly be deemed as ‘social sin’. It is the obligation of management to support and vindicate society’s concern for rational utilization of its resources, and survival of its business institutions.
2. There are four important groups in society, whose interest it is the aim of management to promote.

(a) Owner of the business: e.g. Shareholders.. Under the present Companies act, the shareholders possess four very important rights in addition to the fundamental right of speaking and voting at company meetings:

(i) The right to pass the annual accounts

(ii) To declare dividend

(iii) To elect the directors of the company

(iv) To appoint the auditors of the company and fix their renumeration.

In India in the absence of any integrating organiztion the shareholders’, particularly the poor ones, rights are paper feasts - ineffective and illusory. For the growth of healthy and responsible business sector, it is essential that management makes earnest efforts to develop shareholders’ opinion and they should be made to take effective and active interest in the working of the company.

(b) The customer who has to be satisfied about the quality and price of the product. It is the fundamental right of the consumers to have greater and cheaper goods and it is the responsibility of the management to do so.

(c) The employees who depends upon the organization for livelihood. Employees are firt human beings and only then workers. Hence it is the responsibility of management that their basic needs and dignity are not compromised.

(d) Society at large of which it must promote the general good. It is essential for example, that Government should have sufficient funds. As major contributors of taxes, it is the responsibility of management to provide funds to the exchequer.

1. To observe the rules of competitive game strictly.
2. To observe the law of the land as laid down by the government.
3. To support the socio-economic developmental policies of the government.
4. Problems of pollution, environmental degradation, technological unemployment, squalor, congestion, housing and crime in urban areas in which business firm are located, population explosion & family planning, depletion and degeneration of natural and other resources, community health etc. all fall within the orbit of social responsibility of management
5. The general values and philosophy of the country or society should also be respected. In Indian context, apart from distinctive cultural values, it includes democratic participative endeavour, fundamental spirit of freedom, tolerance, fair-play, secularism, emancipation of weaker and minority sections and groups, technological dynamism, equitable opportunities for development of all regions, social justice and non-violence. (DEFSET)

**The following factors in the Indian socio-economic environment have lent added significance to the social responsibilities of business:**

1. The pledge of government to remove poverty and bring about a socialistic pattern of society in which private interest are subordinated to the national interest.
2. The pledge of the people of India to fulfill economic programme easily.
3. Development of professional management to fulfill the national socio-economic objectives.
4. Aspirations of working class.
5. Pressures from lending Institutions like bank and insurance companies.

The need for developing the knowledge expertise in the country.

Management Roles. In the late 1960s, Henry Mintzberg conducted a precise study of managers at work. He concluded that managers perform 10 different, but highly interrelated roles.

1. Management roles refer to specific categories of managerial behavior.

a. **Interpersonal roles** included figurehead, leadership, and liaison activities.

b. **Informational roles** included monitoring, disseminating, and spokesperson activities.

c. **Decisional roles** included those of entrepreneur, disturbance handler, resource allocator, and negotiator.

2. Follow‑up studies of Mintzberg’s role categories in different types of organizations and at different managerial levels within organizations have generally supported the notion that managers perform similar roles.

Management Skills. Managers need certain skills to perform the varied duties and activities associated with being a manager.

1. Robert L. Katz found through his research in the early 1970s that managers need three essential skills or competencies.

a. **Technical skills** are skills that include knowledge of and proficiency in a certain specialized field.

b. **Human skills** include the ability to work well with other people both individually and in a group.

c. **Conceptual skills** include the ability to think and to conceptualize about abstract and complex situations, to see the organization as a whole, and to understand the relationships among the various subunits, and to visualize how the organization fits into its broader environment.

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**DAY-4**

**PIONEERS IN MANAGEMENT**

The development of management thought has been evolutionary in nature. Though the systematic study of management started only in the second half of the nineteenth century, but management in some form or the other has existed ever since the dawn of civilization. Evidence of the use of principles of management is to be found in the administration of Mohenjodaro and Harappa in 2000 B.C., the Buddha order and the sangha in 530 B.C., the organization of public life in ancient Greece, the organization of Roman Catholic Church and the organization of military forces.

Some important contributors in the field of management are:

**Robert Owen**: Time-efficiency study, an important tool useful even today, was his major contribution. He was a textile mill manager in Scotland during 1800 to 1828. He made remarkable observations regarding the factors which influenced the productivity of the personnel. He said a machine in a state of good repair more than paid for itself by increased productivity and longer life. He applied it to the ‘vital machines’ - the men in the organization.

**F.W. TAYLOR**: The scientific Management era is profoundly associated with F.W.Taylor, so much so that he is called the “Father of Scintific Management”. Taylor was the first one to recognize the need of a scientific approach to the task of managing an enterprise. He was an Industrial Engineer. He studied the causes of low efficiency carefully and concluded that management did not really manage. He decided to work out a system whereby the interests of the management and workers became the same. His scientific approach comprised of (a) Observation, (b) measurement, (c) experimentation and (d) Inference. He further condenesed the knowledge and experience by classifying, tabulating and reducing to rules, laws and formulae. He summed up his approach in these words:

1. Science, not rule of thumb.
2. Harmony and not discord.
3. Co-operation and not individualism.
4. Maximum output in place of restricted output.
5. Development of each man to his greatest efficiency and prosperity.
6. Equitable division of work and responsibility between management and labour.
7. To find one best method of working.
8. Carefully determine a fair day’s work for a fair day’s wage.

Techniques recommended for the achievement of these principles and objectives are:

1. Functional control instead of line control to prevent the necessity of all round executive which is of rare occurrence. Division of work into thinking and doing for separation of mental work from manual work.
2. Determination of task - on the basis of method study, routing, motion study, time study, fatigue study and rate setting.
3. Planning of Industrial operations - what work shall be done, how the work shall be done, where the work shall be done and when the work shall be done.
4. Proper selection, placement and training of workers by a centralized personnel department.
5. Improvement in the methods of work viz:

(a) Standardization of tools and equipments

(b) Regulation of speeds of machine.

(c) Improvement of work environment

1. Introduction of cost analysis to find out inefficiency and wastage and to distinguish between profitable and unprofitable activities.
2. Mental revolution to bring about harmony between labour and management.
3. Creation of healthy and cheerful atmosphere within the factory to remove dullness and monotony of factory life.
4. Supply of proper materials and uptodate machineries.

**Limitations of Taylor’s approach:**

Taylor’s approach had mixed reaction during his lifetime.

1. It was not appreciated by workers and their unions for obvious reasons. It prescribed one best way’ of doing jobs and workers were compelled to follow it.
2. The approach gave advantage to physically strong workers over others.
3. The Industrial psychologists challenged the assumption of ‘one best way’ and criticized treating workmen as cogs in a machine without giving them an opportunity to think about their jobs and methods of work.
4. The human approach got subordinated to mechanical approach. Many vital aspects of management were overlooked.
5. His insistence on detailed planning was flawed as such plans were not flexible and any new circumstance or situation rendered the plan clueless.

Taylor's methods have also been challenged by socialist intellectuals. The arguments put forward relate to **progressive defanging of workers** in the workplace and the subsequent **degradation of work as management, powered by capital**, uses Taylor's methods to render work **repeatable, precise yet monotonous and skill-reducing**. James W. Rinehart argued that Taylor's methods of transferring control over production from workers to management, and the division of labor into simple tasks, intensified the **alienation of workers** that had begun with the factory system of production around 1870–1890

**DAY-5**

**Henry Fayol:** A French Industrialist, he developed a theory of general management applicable equally to all kinds of organizations and in all fields whether social, political, economic or Industrial.

He was born in 1841 and graduated as a mining engineer. He worked as a director general for 30 years in a mine. During the period he brought the enterprise from bankruptcy to a great success. In 1916 he published his well-known work - *Industrial and General Administration*.

1. He identified six activities in a management setup:
2. Technical activities concerning production.
3. Commercial activities concerning buying, selling and exchange.
4. Financial activities concerning optimum use of capital.
5. Security activities concerning protection of property.
6. Accounting activities concerning final accounts, cost and statistics.
7. Managerial activities concerning planning, organising, commanding, coordinating and controling.

He suggested following principles of management:

1. **Division of work**: This emphsasizes the importance of specialization so as to produce more and better with same effort
2. **Authority and Responsibility**: These two terms are correlated and responsibility is a corollary of authority.
3. **Discipline**: It is essential for successful management. In essence it is obedience, application, energy, behaviour and outwards mark of respect shown by subordinates to the superiors.
4. **Unity of Command**: An employee must receive orders from one and one person alone.
5. **Unity of direction**: Each group of activities with common objectives should have one head and one plan.
6. **Subordination of individual interest to group interest**: Group interest must always prevail over individual interest.
7. **Remuneration of personnel**: It should be fair and afford maximum satisfaction to both the organization and its employees.
8. **Centralization**: Everything that increases the importance of the subordinate’s role is decentralized, everything that reduces it is centralized. Degree of concentration of authority varies according to the needs of the situation.
9. **Scalar chain**: It denotes the line of authority from the highest executive to the lowest one for the purpose of communication. An employee should feel free to contact his superior.
10. **Order**: There must be a place for everything and everything must be kept in its place. Similarly a place should be assigned to each employee and every employee should be at his assigned place.
11. **Equity**: Equity is the combination of kindliness and justice in a manager. This helps in creating loyalty and devotion among the employees.
12. **Stability of Tenure of Personnel**: Management should strive to minimise employee turnover. High turnover is detrimental to the organization.
13. **Initiative**: It refers to freedom to propose a plan and execute it. Freedom to take initiative helps in incresing zeal and energy of the employee and makes him more responsible.
14. ***Espirit de Corps***: The need for teamwork and the importance of effective communication.

Fayol made it clear that this list was not complete and more may be added to it. He also emphasized that none of these principles are inflexible. However he did emphasize the universality of management principles.

**Compare and Contrast Taylor and Fayol**

Taylor an Fayol.

* Both were Engineers
* Both employed scientific approach to revolutionize Management
* Both were extremely successful
* Both were contemporaries
* Both advocated
  + Fair wage for fair work
  + Discipline
  + Subordination of individual interest to group interest
  + Division of work
  + Order

Both differed:

1. Taylor was involved with Operations Management whereas Fayol with general management
2. Taylor experience pertained to grass root functions; Fayol had the view from the top
3. Taylor suffered criticism towards the end but Fayol remained above criticism
4. Tayor favored centralization; Fayol autonomy.
5. Taylor had no place for initiative; Fayol believed in Initiative
6. Taylor could not comprehend the importance of human motivation; Fayol emphasized *Espirit the corps*.

**DAY-6**

**Contribution of Frank Gilberth (1868-1924)**

He and his wife (Lilian Gilberth - 1878-1972) made substantial contribution to management thought. Their contribution included:

* **Motion Study**: This technique went on to revolutionize the work efficiency and efficacy. They defined it as "The science of eliminating wastefulness resulting from unnecessary, ill-directed and inefficient motions."
* He evolved the principles of **motion economy**.
* He evolved the concept of **flow-charts**.
* He identified 17 (to which subsequently an 18th was added) **Therbligs** - the fundamental motions involved in performing a manual task.
* He introduced **micromotion study** and **simo chart**.
* To perform the above he invented Microchronometer, Cyclegraph, Chronocyclegraph and two-handed charts.
* He successfully applied motion analysis to enhance efficiency and effectivity in office procedures.
* While serving in US army he developed astonishingly efficient method for assembling and disassembling weapons.
* He analysed the fatigue, the reasons behind it and came out with practical solutions to overcome it.
* The very concept of **systems management was evolved by him**. He provided 231 rules for mixing cement!

He understood that productivity is also linked to **personality** and **working environment**. He listed fifteen chracterstics such as anatomy, experience, habits, health, temparament, nutrition etc as parameters to understand peronality and productivity. He also proposed 19 elements such as clothes, entertainment, lighting, reward and punishment to define working environment and its possible relationship with productivity.

**DAY-7**

**Mary Parker Foliet:** A pioneer contributor to the management thought in the ‘Human relations’ period. She interpreted classical management principles in terms of human factors and held psychology as the foundation of all human activities and applied these to business condition. Her view point was:

**Group**: Human group is something more than the sum total of its individuals.

**Authority**: She showed that authority and responsibility go with function and suggested that authority should be depersonalised. Thus she believed that employer-employee relationship should depend upon functional cooperation rather than status and facts of a given situation would determine the basis of authority. She suggested the substitution of the concept of power over employees by the concept of power with the employees.

**Conflict:** There are three ways of removing conflict in an organization - a) domination, b) compromise and c) integration: According to Foliet domination offends the feelings of the dominated hence is not acceptable. Compromise too should be rejected as it involves surrendering a part of what both the parties are demanding. She was for integration of objectives of the parties to the dispute.

**Integration**: Integration within the organisation was not her only concern. She felt integration of the interests of the workers, investors and consumers.

**Leadership**: For her leadership was not a matter of dominating, aggressiveness and autocratic personality. Se believed in situational theory of leadedship and subscribed to the view that leader guides the group and is himself guided by the group and is a part of the group not apart from it. The power of leadership according to her is power of integrating. A person who inspires others to do great jobs was her leader and not the one who himself was capable of doing great jobs.

**Coordination**: Her four well known principles of coordination as the basis of good management were:

1. Coordination by direct contact of the responsible people.
2. Coordination in early stages of planning and policy making.
3. Coordination as reciprocal and relating to all the factors in a situation.
4. Coordination is a continuous process.

**George Elton Mayo**: Elton Mayo was born and educated in Australia, joined the faculty of Howard University in 1926. He studied the outout of a few workers in relation to the changing conditions of the work and prescibed the following:

1. Optimum and proper lighting arrangement.
2. Optimum Rest periods
3. Optimum number of working hours.

He also propounded that it is not just the relationship between the management and the workers but that between workers themselves also which was an important consideration. He wrote two books viz., *The Industrial Civilization* and *social problems of Industrial Civilization*. He pointed out that attitude and motivation of workers are the result of of a number of factors. To understand human behaviour, therefore, one has to take an overall view of the situation.

The **Hawthorne Studies** were, without question, *the* most important contribution to the developing OB field.

1. These were a series of experiments conducted from 1924 to the early 1930s at Western Electric Company’s Hawthorne Works in Cicero, Illinois.

2. The studies were initially devised as a scientific management experiment to assess the impact of changes in various physical environment variables on employee productivity.

3. Other experiments looked at redesigning jobs, making changes in workday and workweek length, introducing rest periods, and introducing individual versus group wage plans.

4. The researchers concluded that social norms or group standards were the key determinants of individual work behavior.

5. Although not without critics (of procedures, analyses of findings, and the conclusions), the Hawthorne studies did stimulate an interest in human behavior in organizations

The major finding of the study was that almost regardless of the experimental manipulation employed, the production of the workers seemed to improve. One reasonable conclusion is that the workers were pleased to receive attention from the researchers who expressed an interest in them. The study was only expected to last one year, but because the researchers were set back each time they tried to relate the manipulated physical conditions to the worker's efficiency, the project extended out to five years.

Four general conclusions were drawn from the Hawthorne studies:

* **The aptitudes of individuals are imperfect predictors of job performance.** Although they give some indication of the physical and mental potential of the individual, the amount produced is strongly influenced by social factors.
* **Informal organization affects productivity. The Hawthorne researchers discovered a group life among the workers.** The studies also showed that the relations that supervisors develop with workers tend to influence the manner in which the workers carry out directives.
* **Work-group norms affect productivity.** The Hawthorne researchers were not the first to recognize that work groups tend to arrive at norms of what is "a fair day's work," however, they provided the best systematic description and interpretation of this phenomenon.
* **The workplace is a social system.** The Hawthorne researchers came to view the workplace as a social system made up of interdependent parts.

**The first experiments** were with illumination - lighting in the factory. It was thought that workers might work better when there was more light, but light was very expensive, so they needed to find the optimum level to satisfy both requirements.

They assigned workers making induction coils to 2 groups: test and control. Both started with same amount of light. Then the Test group was given more light. Productivity went up. But, unfortunately, it also went up in the control group. So then they increased the light in the Test group again. Once again, productivity went up or stayed the same in both groups. Again they raised the light level, and again the same result.

So then they reduced the lighting in the Test group way down, below the level in control group. Productivity soared in the Test group, and continued to go up in the control group. They reduced light some more: same result. They finally got down to a level of light equivalent to a moonlit night, and found that productivity was still the same or higher. This really confused the researchers. As one of the researchers put it at the time, they were "knocked galley-west" by the results.

They finally took two workers and put them in a closet with no light at all -- just the crack under the door. Productivity was just fine.

They had to conclude that light didn't seem to matter in the way they expected. And there was something very strange about why output kept going up relative to the rest of the factory. So they planned a more elaborate experimen

The **second experiment** was the relay assembly test room. Six women who assembled telephone relay switches were taken out of the main area and placed in special test room where they could be observed. All immigrants (as were most factory workers).

It was a 5 year experiment. Productivity was measured the whole time by a machine that counted the number of relays that each person assembled as she dropped it down a little chute. They gauged the effects of rest pauses, shorter work days, shorter work weeks, wage incentives and different supervisory practices on output.

The results were just like the results of the lighting experiment. No matter what change they introduced, it always seemed to either have no effect, or it improved productivity, even when the change was just returning the variable to its original state!

As a result of these two studies, the Hawthorne team theorized that there was a key variable that managers had been ignoring, which had to do with workers' relationships, attitudes, feelings, and perceptions. By separating people into groups and then making lots of changes in working conditions, the researchers inadvertently did two things:

1. Made workers feel like management actually cared about them. They felt important and special. This is a problem with the experimental design.
2. They created bonds among people in the test and control groups -- in effect turning them into true groups as described above. People work better when they are part of a clear social structure.

So an important conclusion (in spite of the experimental design problem) was that people did not necessarily behave according to models of economic rationality. Social processes within the group that formed were much more important than purely material gains. Also, even material goods or physical events or wages or work hours etc. were perceived differently by different people in different situations and so it's not so much the money or the hours themselves that matter, it's what meaning they hold for people, and meaning is something that is socially mediated. The group affects

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**DAY-8**

**SCHOOLS OF MANAGEMENT THOUGHTS**

We have already seen that the development of management thought has been evolutionary in nature. The present position is therefore, best appreciated and understood in the light of its evolution over the years. The time periods in which different concepts have developed may be divided into five parts:

1. Pre-scientific management era (before 1880)

2. Scientific management era (1880-1930)

3. Human relations era (1930-1950)

4. Social Science era (1950-oneards)

5. Management Science era ( - do- )

**The management Theory Jungle**:

Prof. Harold Koontz in his famous article on “The Management Theory Jungle” has identified six major schools of management thoughts.

1. The Management Process School

2. The Empirical School

3. The Human Behaviour School

4. The Social System School

5. The Decision Theory School

6. The Mathematical School

7. The Systems Approach School

**The Management Process School**: It developed during Scientific Management era. **Fredrick Taylor** and **Henri Fayol** were the founders of this school of thought. They looked upon Management theory as a process of getting things done through and with people operating in organized groups.

The work of Taylor and Fayol was complementary. They both realized that the problem of personnel and its management at all levels is the key to Industrial Success. Both applied Scientific methods to this problem. Taylor worked primarily on the operative level from the bottom of the Hierarchy towards the top, while Fayol worked downwards. Fayol in addition to his general principles also gave a list of ‘Elements of Management’ which he later called the Functions of Management. They were - **a) Forecasting, b) Organising, c) Command, d) Coordination and e) Control.**

The Other important contributors of this School were:

**Charles Babbage** (1771-1858): A mathematics genius He advocated accurate data obtained from rigid investigation.

**Frank Gilbreth**: (1868-1924) was an Enginee and concentrated his attention on motion study. He is well known for:

1. Micromotion study - a technique to analyse individual motions.
2. Chronocyclograph - an improvement on above technique.
3. Therbglibs (Gilberth spelled backwards) which are 17 basic motions such as ‘hold’, ‘search’ etc.

**Oliver Sheldon**: A British industrial consultant he wrote, *Philosophy of Management*. He sought to formulate a theory of management as a whole.

**Lawrence Gantt**: An engineer from USA he is best known for his graphic methods in designing and operating charts. Gantt charts displaying the activity and time duration relationship are popular even today.

**The Empirical School**: It started around 1952. It was based on the premises that management problems can be solved better by drawing upon the experience of the managers. Earnest Dale, the founder of this school identified management as a study of experience rather than general principles. However this thought too starts making generalization on the basis of experience and research. Moreover experience is not useful in changed and new circumstances and dynamic situations.

**The Human Behaviour School**: This period is known as the legacy of **Elton Mayo** and **Mary Foliet**. They believed that an organization was more than a formal structure or arrangement of functions. Their insight represented a reaction to the dehumanizing aspects of scientific management. Proponents of scientific management looked upon workers as mere ‘economic men’ who could be motivated by monetary incentives alone. Human relations approach on the other hand recognized workers as a product of personal sentiments and emotional involvement. In fact Mayo went on to prove that beyond a point Motivation depends more on social status and personal appreciation and less on materialistic incentives. The supporters of this theory are heavily influenced by Psychology and indees most of them are trained psychologists. This school of thought has further two branches - **Interpersonal Behaviour Approach** and **Group Behaviour Approach.**

Interpersonal Behaviour Approach: It is based on the idea that managing involves getting things done through people, and therefore, its study should be centered on interpersonal relationships. Leadership, Motivation, emotions are the key considerations. It believes that a succesful manager is a good leader and an amateur psychologist.

No one can deny that managing deny that managing involves human behaviour. Also we know that leadership and motivation are vital aspects of management. Yet the fact remains that even good psychologists do not necessarily prove to be good managers. Even psychologists need to know something about planning, control and control techniques. Thus managers must extend their views far beyond psychological matters. It is being realized that leadership, for example, is very much a function of situation and circumstances also. Motivation is linked to operation theory techniques which show clearly who is responsible for what, and accurate and prompt feedback of information, on how well a person is doing.

Group Behaviour Approach. This approach is similar to the interpersonal approach and sometimes is confused with it but in this approach psychology of individual in a group becomes more important. Thus it tends to be based on socio-psychology. Its proponents look upon management as a study of of group behaviour pattern. Thus organizational behaviour becomes important in management. The cultural traits of the group, their average education etc. assumes greater importance. This approach further refined the management concept but this alone could never prove sufficient for good management performance.

One important contributor of this theory was **Douglas McGregor**. He wrote *The human side of enterprise* which is still regarded as landmark in management literature. He challanged the conventional management approach, questioning many myths in the process. His theory is known as the X and Y theory:

|  |  |  |
| --- | --- | --- |
|  | **Theory X** | **Theory Y** |
|  |  |  |
| **1** | Work is downright distasteful | Work is as natural and enjoyable as play or rest |
|  |  |  |
| **2** | The average human being dislikes and avoid work | The average human being likes work when it is source of satisfaction and dislikes it when it is source of punishment |
|  |  |  |
| **3** | Most people must be coerced, controlled, led, directed, threatened with punishment to make them work | Man will exercise self-direction and self-control in the service of objectives to which he is commited. Commitment is a function of achievment |
|  |  |  |
| **4.** | Average human being avoids responsibility, has little ambition, wants security. | Average person in proper condition, accepts and even more seeks responsibility. The capacity for imagination, ingenuity and creativity in finding solutions is popular. |

**Social Science Approach**: It would be obvious that Social Science approach is a natural extension of Human Relations Approach. In fact it would be impossible to demarcate them. Some experts, for example, look upon Theory X & Y a part of Social Science Approach. It is argued that the Social Science Era has largely utilized the Conclusions of Human Relations Era. Thus this period is characterized by process of refinement, extension and synthesis of management in the last period. The spiritual Father of this approach was **Chester Barnard**.

**Chester Barnard:** He viewed organization as a social system or a system of cultutral inter-relationships. His book The Functions of an executive is considered to be a pace-setter in management thought. He divides organization into formal and informal.

**Formal Organization** according to him is any cooperative system in which there are persons able to communicate with each other and who are willing to contribute towards a conscious common purpose.

Informal Organization he defined as any joint personal activity without any conscious joint purpose. He believed that informal organization is an essential part of the formal organization and it must be taken into account while determining managerial behaviour.

He also looked upon communication as the lifeline of management system. He said “In an exhaustive theory of organization, communication will occupy a central place, because the structure, extensiveness and scope of organization are almost entirely determined by communication techniques”.

Yet another aspect he put emphasis on was Leadership. Dynamism of leadership in the execution of business policies and securing the cooperation of employees through the use of incentives. He realized that material reward is crucial only upto a definite point. The incentives of status, power, good physical conditions, opportunities of participation and good social conditions are very important. He also pointed put that incentive should not be symbolic. It must be equal to or greater than the efforts involved..

He commented upon decision-making process and suggested participation of employees at all levels.

**Rensis Likert**: He conducted extensive research in human behaviour which he explained in his two books: *The new pattern of Management* and *Human Organization*. He came out with a basic theory of Leadership where he dealt with four basic styles of management.

**Exploitative authoritative**: Under this style, management has no confidence or trust in subordinates and also looks upon them as incompetent, dishonest and work-haters.

**Benevolent authoritative**: Under this style management condescending and patronizing confidence in subordinates just as a master has in his servants.

**Consultative**: Management has substantial but not complete confidence and trust in subordinates and therefore management consults them while making decisions.

**Participative**: Management has complete confidence and trust in subordinates and may be called truly participative form of management.

He was a strong supporter of participative form of management. He rejected close supervision of subordinates. He advocated general supervision which is associated with high productivity.

**Systems Approach**: This approach, in the recent years, is being increasingly emphasized and advocated to study and analyze management thought. A **system** is essentially a set or assemblage of things interconnected/interdependent, so as to form a complex unity. These systems could be physical (Engine), biological (human body) or theoretical (an idea or a concept). The study of different systems has helped in understanding systems knowledge and it has been found to be useful for exploring management theory and science.

A system works in a particular environment which my change or may be changing. Thus an understanding of environment and defining its boundaries is essential aspect of these study. Systems can be further subdivided into **planning systems, organizational systems; control systems; process systems** etc. A system has many **subsystems** within it such as systems of delegation, network planning and budgeting system.

This approach has become quite popular today but it does not make other approaches such as human relations approach or social science approach irrelevant. Also though considered recent, this in fact has been in use for a long time.

QUANTITATIVE APPROACH TO MANAGEMENT.

The **quantitative approach** to management involves the use of quantitative techniques to improve decision making. It includes applications of statistics, optimization models, information models, and computer simulations.

A. Important Contributions.

1. The quantitative approach evolved out of the development of mathematical and statistical solutions to military problems during World War II.

2. One group of military officers—the Whiz Kids—included Robert McNamara and Charles “Tex” Thornton

3. This approach has contributed most directly to managerial decision making, particularly in planning and controlling.

4. The availability of sophisticated computer software programs made the use of quantitative techniques somewhat less intimidating for managers

**Decision making Approach**: A successful management is the one which continuously and consistently makes correct decision. Thus if correct decisions are ensured management will be successful. In other words a good management is a function of correct decisions. Thus certain scholars such as R. Schlaifer and Herbert Simon advocated decision theory school. This is also known as decision Science, operation research and rationalistic model. It looks upon management as a logical process. It is quite useful in managing certain areas but it has following disadvantages:

1. It is oriented more towards technique than philosophy.
2. Decision is too narrow a premise to carry entire management thought.
3. It is useful to only those problem areas where parameters are quantifiable and clear or where parameters can be directly measured or reliably estimated.

**DAY-9**

**Basic concept of Quality**: Quality is often defined in three ways:

1. In absolute terms
2. Relative to perceived need
3. As conformance with stated requirements

In absolute terms, quality is a function of excellence, intrinsic value, or grade as determined over time by society generally or by designated bodies in specialized field. Gold and diamond has, for example, proved to be high quality materials. Some other items achieve this distinction for a short while that too in a given culture.

In business and industrial activities, quality is defined in terms of relationship to a need or a function. Thus in a battle-field a steel sword is considered of higher quality than even a gold sword. Once the specification has been finalized, quality is simply defined as conformance with the stated requirements.

**Quality in business, engineering and manufacturing** has a pragmatic interpretation as the *non-inferiority* or *superiority* of something; it is also defined as *fitness for purpose*. Quality is a perceptual, conditional, and somewhat subjective attribute and may be understood differently by different people. Consumers may focus on the **specification quality** of a product/service, or how it compares to competitors in the marketplace. Producers might measure the **conformance quality**, or degree to which the product/service was produced correctly.

Support personnel may measure quality in the degree that a product is reliable, maintainable, or sustainable. A quality item (an item that has quality) has the ability to perform satisfactorily in service and is suitable for its intended purpose

**Eight dimensions of product quality management** can be used at a strategic level to analyze quality characteristics. The concept was defined by David Garvin. Some of the dimensions are mutually reinforcing, whereas others are not—improvement in one may be at the expense of others. Understanding the trade-offs desired by customers among these dimensions can help build a competitive advantage. Garvin's eight dimensions can be summarized as follows:

1. Performance: Performance refers to a product's primary operating characteristics. This dimension of quality involves measurable attributes; brands can usually be ranked objectively on individual aspects of performance.
2. Features: Features are additional characteristics that enhance the appeal of the product or service to the user.
3. Reliability: Reliability is the likelihood that a product will not fail within a specific time period. This is a key element for users who need the product to work without fail.
4. Conformance: Conformance is the precision with which the product or service meets the specified standards.
5. Durability: Durability measures the length of a product’s life. When the product can be repaired, estimating durability is more complicated. The item will be used until it is no longer economical to operate it. This happens when the repair rate and the associated costs increase significantly.
6. Serviceability: Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and the behavior of the serviceperson.
7. Aesthetics: Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual’s personal preference.
8. Perceived Quality: Perceived Quality is the quality attributed to a good or service based on indirect measures

**Acceptance sampling** uses statistical sampling to determine whether to accept or reject a production lot of material. It has been a common quality control technique used in industry. It is usually done as products leave the factory, or in some cases even within the factory. Most often a producer supplies a consumer a number of items and a decision to accept or reject the lot is made by determining the number of defective items in a sample from the lot. The lot is accepted if the number of defects falls below where the acceptance number or otherwise the lot is rejected.

***The application of statistical techniques to determine whether a population of items should be accepted or rejected based on inspection of a sample of those items***

**SERVQUAL**, later called **RATER**, is a quality management framework.

The SERVQUAL service quality model was developed by a group of American authors, 'Parsu' Parasuraman, Valarie Zeithaml and Len Berry, in 1988. It highlights the main components of high quality service. The SERVQUAL authors originally identified ten elements of service quality, but in later work, these were collapsed into five factors - reliability, assurance, tangibles, empathy and responsiveness - that create the acronym RATER.

Businesses using SERVQUAL to measure and manage service quality deploy a questionnaire that measures both the customer expectations of service quality in terms of these five dimensions, and their perceptions of the service they receive. When customer expectations are greater than their perceptions of received delivery, service quality is deemed low.

In additional to being a measurement model, SERVQUAL is also a management model. The SERVQUAL authors identified five Gaps that may cause customers to experience poor service quality.

**Gap 1: between consumer expectation and management perception**

This gap arises when the management does not correctly perceive what the customers want. For instance, hospital administrators may think patients want better food, but patients may be more concerned with the responsiveness of the nurse. Key factors leading to this gap are:

* Insufficient marketing research
* Poorly interpreted information about the audience's expectations
* Research not focused on demand quality
* Too many layers between the front line personnel and the top level management

**Gap 2: between management perception and service quality specification**

Although the management might correctly perceive what the customer wants, they may not set an appropriate performance standard. An example would be when hospital administrators instruct nurses to respond to a request ‘fast’, but may not specify ‘how fast’. Gap 2 may occur due to the following reasons:

* Insufficient planning procedures
* Lack of management commitment
* Unclear or ambiguous service design
* Unsystematic new service development process

**Gap 3: between service quality specification and service delivery**

This gap may arise through service personnel being poorly trained, incapable or unwilling to meet the set service standard. The possible major reasons for this gap are:

* Deficiencies in human resource policies such as ineffective recruitment, role ambiguity, role conflict, improper evaluation and compensation system
* Ineffective internal marketing
* Failure to match demand and supply
* Lack of proper customer education and training

**Gap 4: between service delivery and external communication**

Consumer expectations are highly influenced by statements made by company representatives and advertisements. The gap arises when these assumed expectations are not fulfilled at the time of delivery of the service. For example, the hospital printed on the brochure may have clean and furnished rooms, but in reality it may be poorly maintained, in which case the patients' expectations are not met. The discrepancy between actual service and the promised one may occur due to the following reasons:

* Over-promising in external communication campaign
* Failure to manage customer expectations
* Failure to perform according to specifications

**Gap 5: between expected service and experienced service**

This gap arises when the consumer misinterprets the service quality. For example, a physician may keep visiting the patient to show and ensure care, but the patient may interpret this as an indication that something is really wrong.

1. Reliability: the ability to perform the promised service dependably and accurately
2. Assurance: the knowledge and courtesy of employees and their ability to convey trust and confidence
3. Tangibles: the appearance of physical facilities, equipment, personnel and communication materials
4. Empathy: the provision of caring, individualized attention to customers
5. Responsiveness: the willingness to help customers and to provide prompt service

**DAY-10**

**SIX SIGMA**

Six Sigma seeks to improve the quality output of process by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, mainly empirical, [statistical methods](https://en.wikipedia.org/wiki/Statistics), and creates a special infrastructure of people within the organization ("Champions", "Black Belts", "Green Belts", "Yellow Belts", etc.) who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has expertized value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

The term *Six Sigma* originated from terminology associated with manufacturing, specifically terms associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects (3.4 defective features / million opportunities). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.

**ISO-9000**

The **ISO 9000** family of quality management systems standards is designed to help organizations ensure that they meet the needs of customers and other stakeholders while meeting statutory and regulatory requirements related to a product. ISO 9000 deals with the fundamentals of quality management systems, including the eight management principles upon which the family of standards is based. ISO 9001 deals with the requirements that organizations wishing to meet the standard must fulfill

**Principles of ISO-9000**

Principle 1 – Customer focus

Principle 2 – Leadership

Principle 3 – Involvement of people

Principle 4 – Process approach

Principle 5 – System approach to management

Principle 6 – Continual improvement

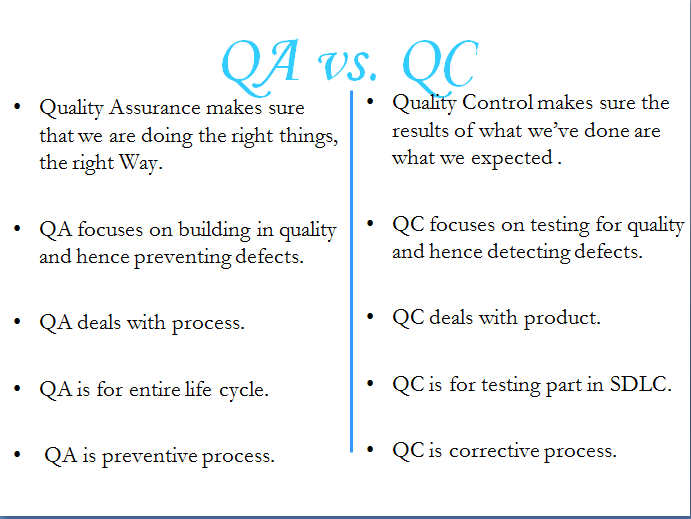
Principle 7 – Factual approach to decision making

Principle 8 – Mutually beneficial supplier relationships

* ISO 9001: *Model for quality assurance in design, development, production, installation, and servicing* was for companies and organizations whose activities included the creation of new products.
* ISO 9002: *Model for quality assurance in production, installation, and servicing* had basically the same material as ISO 9001 but without covering the creation of new products.
* ISO 9003: *Model for quality assurance in final inspection and test* covered only the final inspection of finished product, with no concern for how the product was produced

**Cost of Quality**

1. **Costs of control (Costs of conformance)**
   1. **Prevention cost**: Quality planning; Statistical process control; Investment in quality-related information systems; Quality training and workforce development; Product-design verification; Systems development and management
   2. **Appraisal cost:** Test and inspection of purchased materials, Acceptance testing, Inspection, Testing, Checking labor, Setup for test or inspection, Test and inspection equipment, Quality audits, Field testing
2. **Cost of failure to control:** 
   1. **Internal Failure Cost:** Scrap, Rework, Material procurement cost
   2. **External Appraisal cost:** Complaints in warranty, Complaints out of warranty, Product service, Product liability, Product recall, Loss of reputation

**[](http://www.google.co.in/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0CAcQjRxqFQoTCJHf5ZCEuccCFUSzFAodbvINxQ&url=http://wallpaper222.com/explore/quality-assurance-quality-control/&ei=93_WVdGHC8TmUu7kt6gM&psig=AFQjCNHdBzKKQ84B8f8CpKHL2tRGyVFk9A&ust=1440207192137081)**

**Statistical Quality Control (SQC)**

**SQC:** The application of statistical techniques to determine whether a process is functioning as desired

Statistical process control (SPC) monitors specified quality characteristics of a product or service so as:

1. To detect whether the process has changed in a way that will affect product quality and
2. To measure the current quality of products or services.

**Variations**: Are of two types:

1) "Common Causes" - sometimes referred to as non-assignable, normal sources of variation. It refers to many sources of variation that consistently acts on process. These types of causes produce a stable and repeatable distribution over time.

2) "Special Causes" - sometimes referred to as assignable sources of variation. It refers to any factor causing variation that affects only some of the process output. They are often intermittent and unpredictable.

**Control** is maintained through the use of control charts. The charts have upper and lower control limits and the process is in control if sample measurements are between the limits

The data from measurements of variations at points on the process map is monitored using control charts. Control charts attempt to differentiate "assignable" ("special") sources of variation from "common" sources. "Common" sources, because they are an expected part of the process, are of much less concern to the manufacturer than "assignable" sources. Using control charts is a continuous activity, ongoing over time

**Normal Distribution:** The normal distributions are a very important class of statistical distributions. All normal distributions are symmetric and have bell-shaped density curves with a single peak. The normal distribution is the most widely known and used of all distributions. Because the normal distribution approximates many natural phenomena so well, it has developed into a standard of reference for many probability problems

****

Characteristics of the Normal distribution

• Symmetric, bell shaped

• Continuous for all values of X between -∞ and ∞ so that each conceivable interval of real numbers has a probability other than zero.

• -∞ ≤ X ≤ ∞

• Two parameters, μ and σ. Note that the normal distribution is actually a family of distributions, since μ and σ determine the shape of the distribution.

Why is the normal distribution useful?

• Many things actually are normally distributed, or very close to it. For example, height and intelligence are approximately normally distributed; measurement errors also often have a normal distribution

• The normal distribution is easy to work with mathematically. In many practical cases, the methods developed using normal theory work quite well even when the distribution is not normal.

• There is a very strong connection between the size of a sample N and the extent to which a sampling distribution approaches the normal form. Many sampling distributions based on large N can be approximated by the normal distribution even though the population distribution itself is definitely not normal.

**Skewness** is a measure of symmetry, or more precisely, the lack of symmetry. A distribution, or data set, is symmetric if it looks the same to the left and right of the center point. A distribution, or data set, is symmetric if it looks the same to the left and right of the center point

**Kurtosis** is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak. A uniform distribution would be the extreme case

**Unimodality**: unimodality means possessing a unique mode. More generally, unimodality means there is only a single highest value, somehow defined, of some mathematical object. One reason for the importance of distribution unimodality is that it allows for several important results.

**Mean**: The arithmetic mean is the most common measure of central tendency. It is simply the sum of the numbers divided by the number of numbers. The symbol "μ" is used for the mean of a population. The symbol "M" is used for the mean of a sample. The formula for μ is shown below:

μ = ΣX/N  
where ΣX is the sum of all the numbers in the population and  
N is the number of numbers in the population.

**Standard Deviation**: In statistics, the **standard deviation** (**SD**, also represented by the Greek letter sigma, **σ** for the population standard deviation or **s** for the sample standard deviation) is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

**DAY-11**

## ****Statistical quality control (SQC)****

The application of statistical techniques to measure and evaluate the quality of a product, service, or process.

**Two basic categories:**

#### ****I. Statistical process control (SPC):****

- the application of statistical techniques to determine whether a process is functioning as desired

#### ****II. Acceptance Sampling:****

- the application of statistical techniques to determine whether a population of items should be accepted or rejected based on inspection of a sample of those items.

### ****Quality Measurement:**** ****Attributes vs Variables****

**Attributes:**

Characteristics that are measured as either "acceptable" or "not acceptable", thus have only discrete, binary, or integer values.

**Variables:**

Characteristics that are measured on a continuous scale.

## ****Statistical Process Control (SPC) Methods****

Statistical process control (SPC) monitors specified quality characteristics of a product or service so as:

To detect whether the process has changed in a way that will affect product quality and

To measure the current quality of products or services.

**Control**is maintained through the use of control charts. The charts have upper and lower control limits and the process is in

control if sample measurements are between the limits.

**Control Charts for Attributes**

**P Charts -** measures proportion defective.

**C Charts -**measures the number of defects/unit.

**Control Charts for Variables**

X bar and R charts are used together - control a process by ensuring that the sample average and range remain within

limits for both.

**Day (12-14)**

**Basic Procedure**

1. An upper control limit (UCL) and a lower control limit (LCL) are set for the process.

2. A random sample of the product or service is taken, and the specified quality characteristic is measured.

3. If the average of the sample of the quality characteristic is higher than the upper control limit or lower than the lower control limit, the process is considered to be "out of control".

### ****CONTROL CHARTS FOR ATTRIBUTES****

### ****P-Charts for Proportion Defective****

p-chart: a statistical control chart that plots movement in the sample proportion defective (p) over time

### ****Procedure:****

1. Take a random sample and inspect each item

2. Determine the sample proportion defective by dividing the number of defective items by the sample size

3. Plot the sample proportion defective on the control chart and compare with UCL and LCL to determine if process is out of control

The underlying statistical sampling distribution is the binomial distribution, but can be approximated by the normal distribution with:

mean = u = np **(Note - add the bars above the means used in all the equations in this section)**

standard deviation of p: **sigmap** = square root of (p(1 -p ) / n)

where p = historical population **proportion defective** and n = sample size

**Control Limits:**

**UCL = u + z sigmap**

**LCL = u - z sigma p**

z is the number of standard deviations from the mean. It is set based how certain you wish to be that when a limit is exceeded it is due to a change in the process proportion defective rather than due to sample variability. For example:

If z = 1 if p has not changed you will still exceed the limits in 32% of the samples (68% confident that mean has changed if the limits are exceeded.

z = 2 - limits will be exceeded in 4.5 (95.5 % confidence that mean has changed)

z = 3 - limits will be exceeded in .03 (99.7% confidence)

### 

### ****c-Charts for Number of Defects Per Unit****

c-chart: a statistical control chart that plots movement in the number of defects per unit.

**Procedure:**

1. randomly select one item and count the number of defects in that item

2. plot the number of defects on a control chart

3. compare with UCL and LCL to determine if process is out of control

The underlying sampling distribution is the Poisson distribution, but can be approximated by the normal distribution with: **mean = c**

**standard deviation = square root of c**

where c is the historical average number of **defects/unit**

**Control Limits:**

**UCL = c + z c**

**LCL = c - z c**

### ****Control Charts for Variables****

Two charts are used together: **R-chart ("range chart") and X barchart ("average chart")**

Both the process variability (measured by the R-chart) and the process average (measured by the X bar chart) must be in control before the process can be said to be in control.

Process variability must be in control before the X bar chart can be developed because a measure of process variability is required to determine the -chart control limits.

**R-Chart for Process Variability:**

**UCLR = D4(R)**

**LCLR = D3(R)**

where is the average of past R values, and D3 and D4 are constants based on the sample size

**-Chart for Process Average:**

**UCLR = X bar + A2(R)**

**LCL = X bar - A2(R)**

where X bar is the average of several past values, and A2 is a constant based on the sample size

**Proportion charts (P(bar) Charts)**

UCL = P + ZσP

LCL = P - ZσP

σP = √P(1-P)/n

**Q.1** Fifteen samples of size 100 each are taken from a consignment of electric bulbs. Inspection results are give below:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| No. defective | 6 | 3 | 0 | 5 | 2 | 8 | 18 | 7 | 3 | 9 | 8 | 1 | 6 | 5 | 4 |

Prepare a STABLE (P Chart)

Q.2 15 samples of 100 units each are taken from a consignment of Integrated circuits (ICs) manufactured by Apollo Electronics based at Bangalore. Prepare a stable p Chart. The results of inspection are as follows:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| No. defective | 9 | 11 | 4 | 1 | 0 | 9 | 12 | 10 | 4 | 17 | 15 | 8 | 5 | 3 | 2 |

**Number of defects chart (C charts)**

**UCL = C+Zσc**

**LCL = C-Zσc**

**Zσc = √C**

Q.3 Vadodhara furniture s a manufacturer of executive tables for corporate institutions. In order to control the quality of its tables, the QC manager selects 15 tables at random and inspects for the number of scratches on each one of them. The results are given below. Prepare a stable c Chart.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| No. of defects | 13 | 9 | 19 | 7 | 8 | 10 | 12 | 0 | 2 | 5 | 7 | 11 | 9 | 13 | 1 |

Q.4 Calcutta glass is a manufacturer and supplier of window panes for a construction groups. In order to control the quality of its window panes, its QC manager selects 15 panes at random and inspects each of them for manufacturing defects. Results are shown in following table. Prepare a stable C Chart.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| No. of defects | 3 | 12 | 21 | 3 | 7 | 8 | 3 | 1 | 9 | 11 | 10 | 11 | 8 | 7 | 2 |

**Control charts for variables (R and X charts0**

|  |  |  |
| --- | --- | --- |
| **Sample No.** | **D2** | **D3** |
| 2 | 1.128 | 0.853 |
| 3 | 1.693 | 0.888 |
| 4 | 2.059 | 0.880 |
| 5 | 2.326 | 0.864 |
| 6 | 2.534 | 0.848 |
| 7 | 2.704 | 0.833 |
| 8 | 2.847 | 0.820 |
| 9 | 2.970 | 0.808 |
| 10 | 3.078 | 0.797 |
| 11 | 3.173 | 0.787 |
| 12 | 3.258 | 0.778 |
| 13 | 3.336 | 0.770 |
| 14 | 3.407 | 0.762 |
| 15 | 3.472 | 0.755 |
| 16 | 3.532 | 0.749 |
| 17 | 3.588 | 0.743 |
| 18 | 3.640 | 0.738 |
| 19 | 3.689 | 0.733 |
| 20 | 3.735 | 0.729 |
| 21 | 3.778 | 0.724 |
| 22 | 3.819 | 0.720 |
| 23 | 3.858 | 0.716 |
| 24 | 3.895 | 0.712 |
| 25 | 3.931 | 0.709 |
|  |  |  |

**µ charts**

UCL = µ + 3Sµ

UCL = µ - 3Sµ

Sµ = S/√n

S = R(Bar)/d2

**R Charts**

UCL = R(bar) + 3SR

UCL = R(bar) – 3SR

SR = d3s

|  |  |  |  |
| --- | --- | --- | --- |
| **SN** | **Diameter of pencil** | | |
|  | **Sample1** | **Sample-2** | **Sample-3** |
| 1 | 699.35 | 700.12 | 699.92 |
| 2 | 698.62 | 701.33 | 699.49 |
| 3 | 699.93 | 700.05 | 700.34 |
| 4 | 699.61 | 699.83 | 699.94 |
| 5 | 698.38 | 700.24 | 701.24 |

Diameter is the variable to be controlled (700±5). Prepare trial control charts and stable control charts. Also determine upper warning limits and lower warning limits.

Precision

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **Diameter of shaft** | | |
|  | **Sample1** | **Sample-2** | **Sample-3** |
| 1 | 1500.75 | 1501.67 | 1499.75 |
| 2 | 1499.25 | 1502.87 | 1500.02 |
| 3 | 1498.22 | 1497.59 | 1504.27 |
| 4 | 1522.38 | 1517.56 | 1511.82 |
| 5 | 1488.96 | 1499.92 | 1527.61 |
| 6 | 1498.2 | 1497.75 | 1497.43 |
| 7 | 1510.02 | 1511.65 | 1497.49 |
| 8 | 1500.34 | 1498.12 | 1496.72 |
| 9 | 1498.53 | 1499.3 | 1517.28 |
| 10 | 1525.49 | 1495.36 | 1498.31 |

Diameter is the variable to be controlled (1500±30). Prepare trial control charts and stable control charts. Also determine upper warning limits and lower warning limits.

**Day-15**

**Double-Sampling Plan:**

Specifies two sample sizes (n1 and n2) and two acceptance levels (c1 and c2)

1. if the first sample passes (actual defects c1), the lot is accepted

2. if the first sample fails and actual defects > c2, the lot is rejected

3. if first sample fails but c1 < actual defects c2, the second sample is taken and judged on the combined number of defectives found.

**Sequential-Sampling Plan:**

Each time an item is inspected, a decision is made whether to accept the lot, reject it, or continue sampling.

## ****Acceptance Sampling****

Goal: To accept or reject a batch of items. Frequently used to test incoming materials from suppliers or other parts of the organization prior to entry into the production process.

Used to determine whether to accept or reject a batch of products. Measures number of defects in a sample. Based on the number of defects in the sample the batch is either accepted or rejected. An acceptance level c is specified. If the number of defects in the sample is c the atch is accepted, otherwise it is rejected and subjected to 100% inspection.

|  |  |  |
| --- | --- | --- |
| |  | | --- | | **What is Process Capability?** | | |
|  | Process capability compares the output of an *in-control* process to the specification limits by using *capability indices*. The comparison is made by forming the ratio of the spread between the process specifications (the specification "width") to the spread of the process values, as measured by 6 process standard deviation units (the process "width").  **Process Capability Indices** |
|  | We are often required to compare the output of a stable process with the process specifications and make a statement about how well the process meets specification.  To do this we compare the natural variability of a stable process with the process specification limits.  A process where almost all the measurements fall inside the specification limits is a capable process. This can be represented pictorially by the plot below:  Diagram demonstrating a capable process  There are several statistics that can be used to measure the capability of a process:  Cp, Cpk, and Cpm.  Most capability indices estimates are valid only if the sample size used is "large enough". Large enough is generally thought to be about 50 independent data values.  The Cp, Cpk, and Cpm statistics assume that the population of data values is normally distributed. Assuming a two-sided specification, if μ and σ are the mean and standard deviation, respectively, of the normal data and USL, LSL, and T are the upper and lower specification limits and the target value, respectively, then the population capability indices are defined as follows. |
|  | Cp=USL−LSL6σ  Cpk=min[USL−μ3σ,μ−LSL3σ]  Cpm=USL−LSL6σ2+(μ−T)2−−−−−−−−−−−√ |
|  | *Sample estimators* for these indices are given below. (Estimators are indicated with a "hat" over them).  C^p=USL−LSL6s  C^pk=min[USL−x¯3s,x¯−LSL3s]  C^pm=USL−LSL6s2+(x¯−T)2−−−−−−−−−−−√  The estimator for Cpk can also be expressed as Cpk=Cp(1−k), where k is a scaled distance between the midpoint of the specification range, m, and the process mean, μ.  Denote the midpoint of the specification range by m=(USL+LSL)/2. The distance between the process mean, μ, and the optimum, which is m, is μ−m, where m≤μ≤LSL. The scaled distance is  k=|m−μ|(USL−LSL)/2,0≤k≤1.  (The absolute sign takes care of the case when LSL≤μ≤m). To determine the estimated value, k^, we estimate μ by x¯. Note that x¯≤USL.  The estimator for the Cp index, adjusted by the k factor, is  C^pk=C^p(1−k^).  Since 0≤k≤1, it follows that C^pk≤C^p. |
|  | To get an idea of the value of the Cp statistic for varying process widths, consider the following plot.  4 plots showing the value of Cp for varying process widths  This can be expressed numerically by the table below: |
|  | |  |  |  |  |  | | --- | --- | --- | --- | --- | | USL−LSL | 6σ | 8σ | 10σ | 12σ | | Cp | 1.00 | 1.33 | 1.66 | 2.00 | | Rejects | 0.27 % | 64 ppm | 0.6 ppm | 2 ppb | | % of spec used | 100 | 75 | 60 | 50 |   where ppm = parts per million and ppb = parts per billion. Note that the reject figures are based on the assumption that the distribution is centered at μ.  We have discussed the situation with two spec. limits, the USL and LSL. This is known as the *bilateral*or two-sided case. There are many cases where only the lower or upper specifications are used. Using one spec limit is called *unilateral*or one-sided. The corresponding capability indices are |

**DAY-16**

Reliability is defined as the probability that a product, piece of equipment, or system will perform its intended function for a stated period of time under specified operating conditions.

* Means quality over the long run.
* A product that “works” for a long period of time is a reliable one.
* Since all units of a product will fail at different times, reliability is a probability.

There are four factors associated with Reliability:

* 1. Numerical Value.
     + The numerical value is the probability that the product will function satisfactorily during a particular time.
  2. Intended Function.
     + Product are designed for particular applications and are expected to be able to perform those applications.
  3. Life.

How long the product is expected to last. Product life is specified as a function of There are four factors associated with Reliability:

* 1. Environmental Conditions
     + Indoors.
     + Outdoors.
     + Storage.
     + Transportation.

usage, time, or both.

The main reasons why failures occur include:

• The product is not fit for purpose or more specifically the design is inherently incapable.

• The item may be overstressed in some way.

Failures can be caused by wear-out

• Failures might be caused by variation.

• Wrong specifications may cause failures.

• Misuse of the item may cause failure.

• Items are designed for a specific operating environment

*Why is Reliability important?*

Unreliability has a number of unfortunate consequences and therefore for many products and services is a serious threat. For example poor reliability can have implications for:

• Safety

• Competitiveness

• Profit margins

• Cost of repair and maintenance

• Delays further up supply chain

• Reputation

• Good will

* Design: The most important aspect of reliability is the design.
* It should be as simple as possible.
* The fewer the number of components, the greater the reliability.
* Another way of achieving reliability is to have a backup or redundant component (parallel component).
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Reliability Curve

Distributions Applicable to Reliability:

* Exponential distribution.
* Normal distribution.
* Weibull distribution.

Reliability Curves:

* The curves as a function of time.

The reliability curves for the exponential, normal and Weibull distributions as a function of time

System Reliability

* As products become more complex (have more components), the chance that they will not function increases.
* The method of arranging the components affects the reliability of the entire system.
* Components can be arranged in series, parallel, or a combination.

**Series Systems:** For a series systems, the reliability is the product of the individual components. As components are added to the series, the system reliability decreases.

**Parallel System:**

Rs = 1 - (1 - R1) (1 - R2)... (1 - Rn)

**Day-17**

**Reliability and Design:**

* The most important aspect of reliability is the design.
* It should be as simple as possible.
* The fewer the number of components, the greater the reliability.
* Another way of achieving reliability is to have a backup or redundant component (parallel component).
* Reliability can be achieved by overdesign.
* The use of large factors of safety can increase the reliability of a product.
* When an unreliable product can lead to a fatality or substantial financial loss, a fail-safe type of device should be used.
* The maintenance of the system is an important factor in reliability.
* The second most important aspect of reliability is the production process.
* Emphasis should be placed on those components which are least reliable.
* Production personnel.
* The third most important aspect of reliability is the transportation.
  + Packaging
  + Shipment
* Performance of the product by the customer is the final evaluation.
* Good packaging techniques and shipment evaluation are essential.

**Availability and Maintainability**

For long-lasting products and services such as refrigerators, electric power lines, and front-line services, the time-related factors of availability, reliability, and maintainability are interrelated.

**Availability**

* It is a time-related factor that measures the ability of a product or service to perform its designated function.
* The product or service is available when it is in the operational state, which includes active and standby use.

**A = MTBF/MTBM+MTDT**

MTBM = mean time between maintenance

MDT = mean down time

MTBF = mean time between failures

MTTR = mean time to repair

**Maintainability**

Maintainability is the probability that a system or product can be retained in, or one that has failed can be restored to, operating condition in a specified amount of time.

* Maintainability is the totality of design factors that allows maintenance to be accomplished easily.
* Preventive maintenance reduces the risk of failure.
* Corrective maintenance is the response to failures.

**Probability of failure**

An exponential distribution is used to define the probability of failure of electronic and electromechanical components. The following holds:

F(t) = 1 – e –λt

Where

1. F(t) is the probability of failure
2. λ is the failure rate in 1/time unit (1/h, for example)
3. t is the observed service life (h, for example)

This correlation applies only for the phase of constant failure rate in the bathtub curve, i.e. for λ = constant. Under these conditions, the relationship below holds for the MTBF:

MTBF = 1 / λ or λ = 1 / MTBF

If you now replace the failure rate λ in F(t), you get the following result:

F(t) = 1 – e (-t/MTBF)

Thus, you can easily calculate the probability of failure from the MTBF specified by the manufacturer and an assumed constant failure rate.

**Example**

After one year’s delivery, there are 20,000 components in the field with an MTBF of 60 years. How high is the probability of failure of the components?

With F(t) = 1 – e (-1/60) where t=1a and MTBF=60a the result is:

F(t) = 0.0165, which means that the probability of failure of the components is 1.65%. For the assumed 20,000 components this means that from the statistical point of view 330 components may fail within one year. However, practice has shown that with electronic components in particular, there are much less failures.

**Determining the MTTF from the MTBF**

The MTTF (**M**ean **T**ime **t**o **f**ailure) and MTTFD (**M**ean **T**ime **t**o **f**ailure **d**angerous) are the mean time to failure and mean time to dangerous failure respectively. In practice you can determine the MTTF or MTTFD with known MTBF using the relationships below.

MTTF = 1 / λ or λ = 1 / MTTF (basic equation from IEC 62061)

In this way, the MTBF values are equivalent to the MTTF values also in the context of ISO 13849-1. However, this only applies for as long as there are no dangerous failures (MTTF without index “d”).

When considering dangerous failures, it is assumed that statistically only every other failure is a potentially dangerous failure. The following thus holds:

MTTFD = 2 · MTTF

With equalization of MTTF and MTBF the result is:

MTTFD = 2 · MTBF

This relationship that complies with IEC 61508 and ISO 13849-1 holds for electronic components under the following conditions:

1. The permissible ambient conditions must be met.
2. The Mean Time to Repair (MTTR) is significantly less than the MTBF.

**DAY-18**

**Root cause analysis** (**RCA**) is a method of problem solving used for identifying the root causes of faults or problems.[[1]](https://en.wikipedia.org/wiki/Root_cause_analysis#cite_note-1) A factor is considered a root cause if removal thereof from the problem-fault-sequence prevents the final undesirable event from recurring; whereas a causal factor is one that affects an event's outcome, but is not a root cause. Though removing a causal factor can benefit an outcome, it does not prevent its recurrence with certainty.

For example, imagine a fictional segment of students who received poor testing scores. After initial investigation, it was verified that students taking tests in the final period of the school day got lower scores. Further investigation revealed that late in the day, the students lacked ability to focus. Even further investigation revealed that the reason for the lack of focus was hunger. So, the root cause of the poor testing scores was hunger, remedied by moving the testing time to soon after lunch

**General Principles:**

1. he primary aim of root cause analysis is: to identify the factors that resulted in the nature, the magnitude, the location, and the timing of the harmful outcomes (consequences) of one or more past events; to determine what behaviors, actions, inactions, or conditions need to be changed; to prevent recurrence of similar harmful outcomes; and to identify lessons that may promote the achievement of better consequences. ("Success" is defined as the near-certain prevention of recurrence).
2. To be effective, root cause analysis must be performed systematically, usually as part of an investigation, with conclusions and root causes that are identified backed up by documented evidence. A team effort is typically required.
3. There may be more than one root cause for an event or a problem, therefore the difficult part is demonstrating the persistence and sustaining the effort required to determine them.
4. The purpose of identifying all solutions to a problem is to prevent recurrence at lowest cost in the simplest way. If there are alternatives that are equally effective, then the simplest or lowest cost approach is preferred.
5. The root causes identified will depend on the way in which the problem or event is defined. Effective problem statements and event descriptions (as failures, for example) are helpful and usually required to ensure the execution of appropriate analyses.
6. One logical way to trace down root causes is by utilizing hierarchical clustering data-mining solutions (such as graph-theory-based data mining). A root cause is defined in that context as "the conditions that enable one or more causes". Root causes can be deductively sorted out from upper groups of which the groups include a specific cause.
7. To be effective, the analysis should establish a sequence of events or timeline for understanding the relationships between contributory (causal) factors, root cause(s) and the defined problem or event to be prevented.
8. Root cause analysis can help transform a reactive culture (one that reacts to problems) into a forward-looking culture (one that solves problems before they occur or escalate). More importantly, RCA reduces the frequency of problems occurring over time within the environment where the process is used.
9. Root cause analysis as a force for change is a threat to many cultures and environments. Threats to cultures are often met with resistance. Other forms of management support may be required to achieve effectiveness and success with root cause analysis. For example, a "non-punitive" policy toward problem identifiers may be required.

**Ishikawa diagrams** (also called **fishbone diagrams**, **herringbone diagrams**, **cause-and-effect diagrams**, or **Fishikawa**) are causal diagrams  that show the causes of a specific event. Common uses of the Ishikawa diagram are product design and quality defect prevention to identify potential factors causing an overall effect. Each cause or reason for imperfection is a source of variation. Causes are usually grouped into major categories to identify these sources of variation. The categories typically include

* People: Anyone involved with the process
* Methods: How the process is performed and the specific requirements for doing it, such as policies, procedures, rules, regulations and laws
* Machines: Any equipment, computers, tools, etc. required to accomplish the job
* Materials: Raw materials, parts, pens, paper, etc. used to produce the final product
* Measurements: Data generated from the process that are used to evaluate its quality
* Environment: The conditions, such as location, time, temperature, and culture in which the process operates

**DAY-19**

**GANTT CHARTS**

The Gantt chart is a common time planning tool. This is also known as Bar chart and it was developed by Henry Gantt in 1900.

There are two co-ordinates, one to represent time and one to show the jobs or activities. The activities are represented as bars as shown below (Project is arranging a **friendly match**)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Activity** | **Activity Duration** | **Day1** | **Day2** | **Day3** | **Day4** | **Day5** |
|  |  |  |  |  |  |  |  |
| 1 | Fixing Venue | 2 | \*\*\*\*\* | \*\*\*\*\* |  |  |  |
| 2 | Informing Teams | 1 |  | \*\*\*\*\* |  |  |  |
| 3 | Arranging Kits | 1 |  |  | \*\*\*\*\* |  |  |
| 4 | Arranging food | 1 |  |  |  | \*\*\*\*\* |  |
| 5 | Arranging Drinks | 1 |  |  |  |  | \*\*\*\*\* |

**The advantages are**:

1. It is an excellent pictorial representation of a project.
2. It helps a manager to plan properly and logically.
3. It is easy to understand hence it is an important communication tool.
4. It is possible to use the chart to monitor the progress of the project, by shading a part of the box for time spent during each activity.

**Disadvantages are**:

1. It dos not describe the full nature of activity relationship. i.e. by looking at the chart, it is not possible to see which activities precede or succeed other activities.
2. After some work has been done, the chart is not sufficient to indicate real progress achieved.
3. Rescheduling involves drawing the chart again.
4. Resources required for an activity and used by an activity cannot be shown.

Draw a Gantt chart for the following task. Determine the date when the task will

be over if the task commences from October 14, Monday. Operations follow

five-days working week (10)

|  |  |  |  |
| --- | --- | --- | --- |
| Activity | Duration |  |  |
| A | 8 |  | B,C and H start only after A is completed |
| B | 4 |  | D can start 4 days after the completion of C |
| C | 11 |  | E and F can start simultaneously with D |
| D | 4 |  | G can start after completion of F |
| E | 10 |  | I can start only after completion of G |
| F | 15 |  | J can start two days after after the commencement of I |
| G | 6 |  |  |
| H | 6 |  |  |
| I | 5 |  |  |
| J | 7 |  |  |

**Day-20**

**PERT and CPM**

In complex, interrelated business activities, the manager or the administrator constantly looks forward to those techniques which help him in planning, scheduling and controlling such activities. PERT and CPM are two such techniques. PERT stands for **Program Evaluation and Review Technique** and CPM stands for **Critical Path Method.** Both these define and coordinate various activities of a project and successfully accomplish the objective on time. The techniques are no doubt very popular today.

These were first introduced by US Navy. A large, complicated and confidential project was undertaken by them. To maintain the secrecy they involved over 200 contractors. This obviously complicated the management and control of the project. To overcome the problems and hurdles concept of PERT was developed. The PERT and CPM helps in identifying all the basic building blocks for a project plan. They are:

1. Tasks and milestones
2. Relationships
3. Time Estimates
4. The project Network

In this context the questions that a project manager needs to answer are:

1. What is the minimum time for completion of your project?
2. Which are the tasks to which you must pay the most attention to ensure that your project does not get delayed?
3. What is the earliest time by which you can start each task?
4. Are their any tasks which you can delay slightly, without delaying the completion of the project?
5. What is the latest time by which you can start these tasks without delaying the project?

Answers to these questions help a project manager to:

1. Fix a target date for completing the project.
2. Fix target dates for starting and finishing each task.
3. Prepare budget for resources for each task.
4. Assign Task execution responsibilities to team members
5. Make arrangements to ensure that the resources required for each task are available when required.

**NETWORK:** A network is a graphical diagram which can be used to describe a project in terms of its **activities** and their **relationships**.

In the figure, the lines are called ***arcs*** and the points are called nodes. Some other important points while developing a network are:

(a) In a project network, all arcs have an implied direction. i.e.

from the tail event (1) to the head event (2)

(b) Between any two nodes there can be only one arc. e.g. following is not permitted.

(c) A project network should not have crossing lines (as far as possible). e.g. following is not permitted.

(d) A project network should have only straight lines Curves should be avoided. e.g. following is not permitted.

(e) Loop networks should be avoided. e.g. following is not permitted.

(f) There can be only one arc between two nodes. e.g. following is not permitted.

(g) There should be only one completion event and only one start event. e.g. following are not permitted.

**Terms related to Network planning methods:**

1. **Event:** An event means the start and/or end of an activity and it relates to a definite point of time. It is represented by a circle and the event number is written within the circle. Even and node are synonyms.
2. **Activity:** Every project consists of a number of job operations or tasks called activities. It is shown by an arrow and it begins and ends with an event. Activities could be **critical, non-critical** or **Dummy**.
3. **Critical activity**: Activities which when consume more than their estimated time delay the project. It is marked by a thick or double arrow.
4. **Non-critical activity**: Such activities do not delay the project even when they consume specified time over and above the estimated time.
5. **Dummy activities**: When two activities start at the same time, events are joined by a dotted arrow and this is called dummy activity. A dummy activity does not consume time.
6. **Critical Path**: It is that sequence of activities which decide the total project duration and is formed by critical activities.
7. **Duration**: It is the estimated or actual time required to complete a task or an activity.
8. **Earliest Start time (EST)**: It is the earliest possible time at which an activity can start and is calculated by forward pass.
9. **Earliest Finish Time (EFT**): It is the earliest possible time at which an activity can finish. Mathematically **EFT = EST + duration of that activity**.
10. **Latest Finish Time (LFT):** It is the last event time of the head event and is calculated by moving backwards.
11. **Latest Start Time (LST**): It is the latest possible time by which an activity can start. Mathematically:
12. **LST = LFT - Duration of that activity**
13. **Optimistic time**: This is the minimum time expected for completion of a given activity.
14. **Pessimistic time**: This is the maximum time required for completion of a given activity.
15. **Most realistic time**: This is the time most likely required for completion of a job.
16. **Forward pass**: When we proceed from start event and arrive at end event it is called forward pass.
17. **Backward Pass**; When we proceed from end event and arrive at start event it is called backward pass.
18. **Float**: These are Total Float, Free Float and independent float.
19. **Total Float**: It is equal to the latest start time for the activity minus its earliest start time.
20. **Free Float**: It is the difference between its earliest finish time and the earliest start time for its successor activities.

**PERT and CPM:** CPM differs from PERT in following aspects:

1. A CPM network is built on the basis of jobs or activities instead of events.
2. Only one time estimate is given in CPM, while for PERT three time estimates - most optimistic, most likely and most pessimistic times are given.
3. In CPM time is related to cost.
4. CPM assumes some previous experience with the work necessary for the completion of each event.
5. Where time is of essence, PERT is used, where cost is vital, CPM is used.
6. PERT terminology uses words like network diagram, events and slack. CPM terminology employ words like arrow diagram, nodes and float.
7. The use of dummy activities is required for representing the proper sequencing. In CPM use of dummy activities is not necessary.

**Fulkerson’s Rule for numbering the events:**

1. An initial event is one which has arrows coming out of it and none entering it. This event is numbered 1.
2. Delete all arrows emerging from even 1. This will create atleast one more initial event.
3. Number these initial events as 2, 3 ----.
4. Delete all emerging arrows from these numbered events which will create new initial events.
5. Follow step 3.
6. Continue until last even has been numbered.

The following information is given about a network:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Predecessor Event | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Successor Event | 2 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 8 | 8 | 9 |
| Duration | 9 | 16 | 15 | 11 | 10 | 12 | 13 | 13 | 10 | 15 | 10 |

a) Draw the network, indicate critical path and calculate Early start time, early finish time, latest start time, latest start time, latest finish time and total float

**DAY-21**

**PERT (Determine the probability of completing this task in 23 days)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Predecessor**  **Event** | **Successor**  **Event** | **Optimistic**  **time** | **Likely**  **Time** | **Pessimistic**  **Time** |
| 1 | 2 | 2 | 6 | 10 |
| 1 | 3 | 4 | 8 | 12 |
| 2 | 3 | 2 | 4 | 6 |
| 2 | 4 | 1 | 3 | 5 |
| 3 | 4 | 0 | 0 | 0 |
| 3 | 5 | 3 | 6 | 9 |
| 4 | 6 | 6 | 10 | 14 |
| 5 | 6 | 1 | 3 | 5 |

**(As Assignment)**

**Budget and Budgetary controls**

A number of tools and techniques have been developed for the purpose of management control. They may be classified into:

1. Budget controls
2. Non-budgetary controls

**Budgetary control** involves setting of targets for production, sale and other activities of business, comparing actual performance with budget figures and taking corrective actions in case of deviations.

It is essentially a time-bound programme to achieve specified objectives. It is often described as a system of logical decision making.

Business budgets cover all phases of operations for a definite period in future by giving formal expression to policies, plans, objectives and goals laid down in advance by to management. The business activities for which budgeting is done are:

1. Regulation of cash
2. Physical pogramming and scheduling of operations relating to sales, procurement, production, inventories, personnel and capitaloutlay.

The system of budgetary control involves the use of budgets and budgetary reports throughout the period to coordinate, evaluate and control day-to-day operations.

**Requisites for effective Budgetary controls**:

1. **Objectives:** The controller determines precisely the objectives to be achieved. The objectives could be to earn profit, have better financial position etc.
2. **Manual**: A budget manual is prepared incorporating forms for compilation and submission of budget information, time-table for budget preperation etc.
3. **Administration:** A budget committee is set up.
4. **Preperation and Operation**: The responsibility and authority for budget preperation, operation and supervision is defined.
5. **Participation of company officials**: Without securing whole-hearted support of all officials success is not possible.
6. **Employee participation**: View of employees on matters concerning them too should be invited.
7. **Period**: The period should be appropriate and well defined. e.g. R & D budget should not be of 1 year or less.
8. **Flexibility**: The budget should be flexible to adapt realistic changes. Too frequent budget alterations should, however, be avoided to ensure stability and integrity of the budget.
9. **Co-ordination and Cooperation**: Operation of budget does not take place automatically. Periodical meetings of the budget committiee should be called to remove differences and coordinate efforts.
10. **Location of limiting factors**: Limiting factors must be identified and assessed properly otherwise the budget is rendered unrealistic.
11. **Sound accounting system**: An integrated accounting system embracing financial accounting, cost accounting and budget accounting is useful.
12. **Budget education**: Training may be arranged for accountant and other executives to educate them about budgeting procedures, reports stc.
13. **Reporting**: A regular, orderly and prompt system of reporting current events must be developed to make control possible.

**Steps in introducing a budgetary control system**.

**Deciding the extent of Budgetary control**: If it is not possible to introduce the system at all the levels, then areas where it can be and it should be implemented should be clearly defined.

**Setting up Budget Organization**: A committee comprisin of members from each department should be set up. A budget controller/director should be appointed to link up the various functions, to coordinate efforts etc. He is more an advsor than a controller.

**Preperation of budget**: Various components of the budget are prepared and submitted by respective departmental heads. The budget controller seeks details, clarification and may even suggest modification and revisions in the light of the budgets of other departments. Controller then makes a master budget.

**Comparing actual performance with the budgeted standards and taking corrective actions**: Any deviation is identified, analysed and corrective measure proposed and implemented.

**Limitations of Budgetary controls**:

1. It is based on estimates about future course of events which may or may not be correct.
2. Under uncertain conditions I is difficult to make estimates.
3. The success of system depends upon willingness, cooperation and understanding among the participants. Their might be resistance to change.
4. The system does not replace management. It is a servant and not a master.
5. On most occasions form rather than substance is emphasized.
6. Budgeting may be cumbersome and time-consuming process.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

**Day 21**

**PRODUCTIVITY**

Productivity of a production ystem is analogus to the efficiency. In a broad sense it is the quantitative relationship between what is produced and the resources which are used. It is the ratio between output and input.

**Purpose of increasing productivity**:

**For Management**: To increase profits, to sell more and to stand better in the market.

**For workers**: Higher wages, better working conditions, job security and job satisfaction.

**For consumer**: Reduced prices and may be a better product.

**Steps to increase productivity**:

Improve basic process by R&D.

Provide more and improved phsical means of producing.

Hiring highly trained technical staff.

Simplify and improve the product and reduce variety.

Improve methods of operation.

Improve organization, planning and control.

Using better/cheaper material

**Decision Table-1**

You have been asked to select a site for establishing a hospital. After having evaluated 4 sites you have following data:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Factor** | **Wt.** | **A** | **B** | **C** | **D** |
| Patient Population | 0.4 | 8 | 4 | 6 | 8 |
| Communication Facilities | 0.1 | 3 | 7 | 3 | 2 |
| Skilled man-power | 0.1 | 3 | 5 | 7 | 2 |
| Support services | 0.1 | 6 | 7 | 8 | 4 |
| Availability of space | 0.25 | 9 | 2 | 5 | 7 |
| Price of land | 0.05 | 5 | 8 | 8 | 3 |

Identify the best site.

**Decision Table-2**

There are 120 sealing machines in your organization for smooth flow of production. You have been asked to decide number of spare machines to be kept to avoid production losses because of breakdown of machines. Cost of breakdown of one machine is Rs. 2800/hour and cost of having a spare machine not in use is Rs. 1600/hour. Record of breakdown of machines in last one year shows following pattern:

Break down of 5 machines at a time: 20 times

Break down of 4 machines at a time: 80 times

Break down of 3 machines at a time: 140 times

Break down of 2 machines at a time: 100 times

Break down of 1 machines at a time: 60 times

Make a decision using appropriate technique.

**Decision Tree**

You have the option to purchase Apartment building office, office building or a warehouse. In future there could either be good economic conditions (probability 0.6) or poor economic conditions (probability 0.4). With good economic conditions you expect to make a profit of Rs. 50,000, 100,000 or 30,000 with Apartment building office, office building or a warehouse respectively. On the other hand with poor economic conditions you expect to make a profit of Rs. 30,000, (-) 40,000 or 10,000 with Apartment building office, office building or a warehouse respectively.

1. Use the decision tree to analyze these decision alternatives.
2. what should be the company do based on your decision tree analysis?
3. What returns will accrue to the company if your recommendation is followed?

**Day 22**

**ABC Analysis**: Prioritization of inventory items into A, B and C type.

**ABC ANALYSIS**

The object of carrying out ABC analysis is to develop policy guidelines for selective control. It helps the manager to exercise selective control and focus his attention only on a few attention when he is confronted with a very large number of items. By concentrating on 'A' items he is able to control invntories and show 'visible' results in a short span of time. A comparison of A, B and C items:

|  |  |  |  |
| --- | --- | --- | --- |
| **S.N.** | **A Items** | **B Items** | **C Items** |
|  |  |  |  |
| 1 | Very strict control | Moderate control | Loose control |
| 2 | Very low safety stocks | Low safety stocks | Moderate safety stocks |
| 3 | Frequent ordering | Once a month ordering | Once a three month ordering |
| 4 | Daily control statement | Weekly control statement | Monthly/quarterly control statement |
| 5 | Continuous follow-up | Periodic follow-up | Follow-up rare |
| 6 | Rigorous value analysis | Moderate value analysis | Minimum value analysis |
| 7 | Procurement from Multiple sources | From 2-3 sources | Two reliable sources |
| 8 | Accurate forecast sought | Estimates based on past data | Rough estimates for planning |
| 9 | Minimization of waste, obsolete and surplus | Monthly review of waste, obsolete and surplus | Quarterly review of waste, obsolete and surplus. |
| 10 | Individual postings | Small group postings | Group postings |
| 11 | Maximum effort to reduce lead time | Modrate effort to reduce lead time | Minimum effort to reduce lead time |
| 12 | Central purchasing & storage | Slightly decentralized purchasing | Decentralized purchasing |
| 13 | Senior management involved | Middle-level management involved | Fully delegated to junior managers or supervisors. |

**Limitations of ABC anaysis**

* It ignores
  + Importance of item
  + Seasonality of item
  + Lead time of item
  + Perishablity of item

Hence should be accompanied by analysis such as VED; FSN; GOLF; SOS; SDE etc.

**FSN analysis**: The items are divided according to their dynamics into FAST-MOVING; SLOW-MOVING and NON-MOVING items. Obviously Fast-moving items require greater attention. Non-moving items should also be identified so that they can be disposed appropriately and profitably.

**VED Analysis**: The items are divided according to the degree of their necessity into, VITAL, ESSENTIAL and DESIRABLE categories. Vital items require maximum attention.

**GOLF**: Governmental; Organizational; Local; Foreign

**SOS**: Season, off Season

**SDE**: Scarcely available; Difficult to obtain and Easy to obtain.

Perform ABC analysis

|  |  |  |
| --- | --- | --- |
| A | 3800 | 2 |
| B | 80 | 68 |
| C | 320 | 12 |
| D | 1500 | 380 |
| E | 48 | 280 |
| F | 2400 | 4 |
| G | 38 | 120 |
| H | 48 | 180 |
| I | 480 | 3600 |
| J | 436 | 22 |
| K | 88 | 90 |
| L | 60 | 5600 |
| M | 66 | 96 |
| N | 5200 | 80 |

**Day 23**

**Break Even Analysis**

A business man sets up an Air conditioner making plant with an initial investment of Rs. 12,00,000. Variable cost of making one AC is Rs. 8,000.00. He sells them at Rs. 14,000. Calculate the breakeven point and breakeven sales. Also calculate the breakeven point if variable cost increases by Rs. 500.0.

A person sets up a shop to sell toys with Rs. 20,000 fixed cost. Variable cost for making a toy is Rs. 10. He can sell these for Rs. 20. Should he accept the opportunity if number of toys he expects to sell are (a) 1500 (b) 1900 (c) 2700?

You have been assigned the task to assess the viability of a factory. On investigation you find that the total fixed cost is Rs 3, 00,000.00 and the variable cost per unit is Rs 100. Determine the Break even point for the selling prices: a) Rs. 120.00 b) Rs 140.00 and c) Rs 150.00

Your organization can manufacture a component by initially investing

Rs 1,25,000.00. The variable cost per component would be Rs 55.00. Alternately you can purchase the component from the market at a cost of Rs 80.00 per pc. Will you recommend to make it or buy it in case the number of components required is (a) 3, 500 (b) 4,500 (c) 6,500?

You have option to make investment in any one of the following projects:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **A** | **B** | **C** |
| Initial Cost | 3,00,000 | 2,80,000 | 3,20,000 |
| Variable Cost | 600 | 9,000 | 280 |
| Selling Price | 900 | 16,000 | 320 |
| Sales Forecast | 1700 | 80 | 7,500 |

**DAY-24**

**EOQ**

**EOQ or Economic Order Quantity**:

A very important consideration to minimize inventory related investment pertains to determine the Economic Order Quantity. i.e. What would be most economic order.

Two basic categories of items associated with inventory are:

1. Inventory carrying cost.
2. Ordering Cost.

Inventory carrying cost is the cost associated with keeping an inventory and includes:

**Opportunity cost**: Money invested in inventory which could have earned the interest if invested elsewhere is called opportunity cost.

**Insurance cost**; Most inventories are vulnerable against theft, fire etc. and hence need to be insured.

**Property taxes**: Taxes are levied on assets, thus greater the asset value higher is the tax.

**Storage cost**: Maintaining store space itself is cost. Higher the inventory, higher is the storage cost.

**Obsolescence and deterioration**: Inventories always mean some loss due to spoilage, damage, pilferage or obsolescence. Higher the inventory, higher are such losses.

Mathematically speaking:

**CC = (Q/2)\*C\*I**

Where CC = Carrying cost per year for the material in question.

Q = Order quantity for the materials, in units.

C = delivered unit cost of the material

I = Inventory carrying cost for the material, expressed as a percentage of inventory value.

**Ordering Cost**: Placing an order involves cost. Smaller the size of order, more the number of orders required to be placed and higher is the cost. The cost associated with ordering are;

1. **A certain portion of wages and operating expenses** of purchase, production, receiving, inspection, stores and accounts department.
2. **The cost of supplies** such as envelops, stationary etc.
3. **The cost of services** such as computer time, transport, telephone etc.

Mathematically speaking

**OC = (U/Q)\*A**

Where OC = Ordering Cost

U = expected annual usage of the material, in units

Q = Ordering quantity

A = Ordering cost per order.

It must be obvious that these two kinds of costs are largely opposite to each other. Therefore, EOQ occurs when

**Annual carrying cost = Annual ordering cost**

**QCI/2 = UA/Q**

**or, Q2CI = 2UA**

**or, Q2 = 2UA/CI**

Q.1. Suppose A = 10,000; O = Rs. 8; c = Rs. 4 per unit. Calculate EOQ

Q.2. Plasma Cosmetics Ltd. Has an annual requirement of 10,000 units of special glass bottles for its nail polish brand *Glitter and Glow*. A bottle has a carrying cost of Rs. 10/unit/year and ordering cost per order is Rs. 500. Determine (a) EOQ (b) Number of orders per year (c) Total inventory cost; (d) Duration of an inventory cycle.

Q.3. XYZ Ltd procures 184832 motors annually. Ordering cost is Rs. 192; carrying cost is Rs. 3. Company presently has a policy of placing 10 orders per year. Advise management whether it should continue with its present policy or switch over to EOQ model.

2 M/s Arjun Computers procures 9000 SMPS for its computers. If ordering cost is Rs. 500; carrying cost is Rs. 4. Find (a) EOQ (b) Number of orders per year (c) Total inventory cost; (d) Duration of an inventory cycle

Q.4 Trinity Hospital at Bangalore sources 20,000 disposable syringes every year. Ordering cost is Rs. 100 and carrying cost is Rs. 1 per unit per year. The price of the syringe is Rs. 5. The supplier offers 5% discount if purchase is made in lots of Rs. 10,000 syringes or more. Determine if the discount model is better than EOQ model in this situation.

Q.5 Microcosm software sources 9000 blank CDs annually. OC is Rs. 10; CC is 10% of CD price. Price of CD is Rs. 20. Supplier offers following discount:

|  |  |
| --- | --- |
| Quantity | Discount |
| 100-499 | 2% |
| 500-899 | 4% |
| Above 900 | 5% |

**DAY-25**

**Location of the Plant**

The location of plant is of vital importance as it is almost a life-time decision and it affects the cost of the product, longevity and even the morale of the management and workmen. There is no set of rules o find a solution But there are number of factors that need to be considered before making a final choice. Choice of location:

There could be three situation for finding a new location of plant:

* Starting a new plant

1. Shifting an existing plant
2. Expanding a new plant.
3. **Integration with other group companies**: If the plant is one of a number operated by a group of companies, it should be so situated that its work can be integrated with the work of associated units.
4. **Availability of labour:** Labour at reasonable cost may be more readily available at one location than the other. Also certain areas are known for traditional skills. Since skills can be taught and procedures simplified, it is not necessary to go to a place at high cost where skilled people exist.
5. **Availability of housing:** Where staff has to be recruited other than locally, housing becomes vital for attracting staff.
6. **Availability of amenities:** A location which provides good external amenities - shops, theaters, restaurants, schools, post-office, banks and hospitals - is often much more attractive to staff than one which is more remote. This is particularly true where number of women are employed.
7. **Availability of transport:** Where heavy and bulky material is procured or dispatched regularly, transportation becomes vital. Organizations that intend to largely export prefer a location near a sea-port or large airport.
8. **Availability of materials:** Transportation is expensive. Therefore, even if good transportation is available effort is always to select a site which requires least transportation. Nearness to raw material and market for finished products are thus important determinants.
9. **Adequacy of circulation:** Movement of goods, people and visitors should be easy and control. There is also a need for emergency access, fire-fighting equipment or ambulances - which if impeded could endanger life and seriously affect the company.
10. **Availability of services:** There are five main services - gas, electricity, water, drainage and disposal of waste. For certain industries water (both quantity as well as quality) is vital for others it could be electricity or disposal of waste. These affect the choice of location.
11. **Suitability of land and climate:** Humidity, temperature, rainfall, dust kind of soil etc. many times are important factors for selecting a site
12. **Local building and planning regulations:** proposed project must not infringe any local regulations. Disposal of effluence has become a very sensitive issue today.
13. **Room for expansion:** It would be most unwise to not to have any space without giving a thought to future expansion. However sure one would be of future requirements it is always advisable to have some extra space.
14. **Safety requirement:** Many production processes pose potential danger and risks for the workers and surroundings. e.g. explosive factory should not be located in crowded areas.
15. **Site cost:** Though it is a one time cost, yet the cost should be reasonable and should not make the project unviable.
16. **Socio-political situation:** Local socio-political situation - crime, political interference, local sensibilities should be carefully evaluated before making a final decision.
17. **Tax benefits or special grants:** Many Governments offer tax benefits and other inducements for attracting Industries. Such offers at times could be very attractive.

**Selection of a particular location**: This is done by decision making techniques. For this;

1. Examine the various factors and assign them weight representing the importance of the factor. Extreme accuracy is not possible as it is quite a subjective exercise. However the results indicate that final decision is always objective and rational.
2. Each location is examined and ranked for each factor.
3. Each ranking is then multiplied by the appropriate weighting factor and the scores totaled for each possible location. A decision is made on mathematical value thus obtained.

**Location models: Breakeven and Deceion Table Model**

**Center of Gravity Method**

M/s Tridev Oils ltd. Has five go downs as given below. Identify a the site for a factoy that can feed to the go-owns using centre of gravity method. (10+10)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coordinates | Annual Load | Carrying Cost |
| A | (20, 60) | 287 | 11 |
| B | (80, 20) | 424 | 12 |
| C | (10, 70) | 556 | 20 |
| D | (80, 80) | 808 | 14 |
| E | (12, 90) | 365 | 12 |

**DAY-26**

**WAGE PAYMENT PLANS FOR DIRECT AND INDIRECT WORKERS**

In all societies, including the most primitive ones, people have been selling their services for wages. **Wage** may be defined as payment for the use of labour and may include both money and non-money payments. **Fair wage** is a wage paid to a worker which is fair as regards the work accomplished by him and which is sufficient to fulfill hi basic necessities of life. A good wage payment plan is one which satisfies the worker and at the same time brings profit to the management. Wage payment can be classified under two groups:

1. Non-incentive plans like Time or Day rate system, and
2. Incentive wage plans like piece rate and other schemes

**Incentive** is an inducement or a reward which is given to a worker for his efficiency and hardwork. Incentive encourages a worker o produce more and better. Incentives may be classified as direct & indirect or as financial, semi-financial and non-financial.

**Direct incentives** are given to a worker for his own contribution. **Indirect incentives** are paid to a group of workers. **Financial incentives** include Bonus and Profit sharing. Non-financial incentives include Job-satisfaction, better and healthy working conditions, chances of promotion, Job security, respect and recognition in the organization, housing, medical, recreational and educational facilities for workers and their families. Semi financial incentives include Subsidized lunch, Provident fund and pension.

**Wage incentive plans**: The various aspects of job-performance are:

(a) Quantity, (b)Quality, (c)Efficiency and (d) utilization of materials, plant, tools and services.

A good wage incentive plan should have following characteristics:

1. It should be simple, easy to understand and to operate. It should involve least clerical work.
2. It should be well planned and guarantee a minimum wage.
3. A worker should be rewarded in proportion to his efforts and achievements. Reward should be promptly paid.
4. It should be enough and adequate.
5. The scheme should preferably be based on Time-study data.
6. The scheme should not only be just but perceived as just by those concerned with it.
7. Standardization should preferably be the basis for all incentive schemes.
8. Worker should not suffer in his incentive for reasons beyond his control. (e.g. faulty material or machine).
9. The plan should be installed with the consent of the employee.
10. Once installed the incentive schemes should be rigidly followed.

**The objectives are**:

1. It should be profitable for both workers and management.
2. It should help increasing productivity.
3. The scheme should recognize a worker for his good contribution.
4. It should improve utilization of equipment, material and services.
5. It should help in reducing labour turnover and absentee rate.
6. It should help in improving relationship between workers and management.

**Drawbacks of incentive schemes are**:

1. It involves extra cost of:

(a) Standardizing - methods, allowed time, materials, product design.

(b) Installing and maintaining the plan.

(c) Keeping the record of worker’s performance.

1. An improperly designed plan can become the root of all kinds of trouble and dispute between the labour and management.
2. Most workers have differing opinion about the schemes hence there are disputes amongst them

These include:

**Straight piece rate**: A worker is paid straight for the number of pieces which he produces per day.

***Earning of a worker = No. of units produced\* rate per piece***

**Advntages**:

1. Simple,easy to understand and to operate.
2. A workers earning solely depends upon his contribution towards production and it is a good incentive for him.
3. This scheme boosts the production quickly.
4. Estimating overall labour cost is easy.

**Disadvantages:**

1. With the emphasis exclusively on quantity not enough attention is paid to (a) maintain product quality and (b) effective utilization of materials, equipment and tools.
2. The method does not assure job security.
3. A worker suffers unnecessarily because of forced idleness (lack of instructions, power, material etc.)
4. A work is not guranteed minimum wage.
5. With a desire to earn more and excel over others a worker may spoil his relationship with other workers.

**Straight Piece rate with a guaranteed Base**: It guarantees a minimum base wage. Its **advantages** are:

1. The system povides a guranteed minimum wage.
2. By guranteeing a minimum wage, this system automatically takes some care of the enforced idlenes beyond the control of workwer.

**Disadvantage**: It does not offer sufficient incentive for worker who exceeds the set output standard.

**DAY-27**

**Differential Piece rate system**: This is an improvement on the above. It guarantees a minimum wage but provides better motivation as the base itself is on differential wage rates. The disadvantage is that new workers and old workers are unable to reach output standards and thus can earn very little. This system was suggested by F.W. Taylor.

**Halsey’s plan**: Its features are:

1. A minimum wage is ensured.
2. An additional bonus is given to a worker who exceeds out put standard in a given time.
3. Output standards are based on previous production records.

Mathematically

**W = R.T. + (S - T)\*R/2**

Where W = Wage; R. = Hourly wage rate; T = Actual time taken; S = Standard time

Its **advantages** are, it gurantees minimum wage, It is simple to implement and management also shares a percentage of bonus.

Its disadvantages are that since it is based on historical records it is not scientific and also the workers resentthat management should share the bonus on the time saved solely because of thei effort.

This incentive plan was made by F.A. Halsey in 1891. It formula is given below. The bonus is fixed at 50%  
**Total Wage = Standard Time X Standard Rate + (Saved Time X Standard Rate) X 50/100**  
**Calculate the wage with incentive of a worker from following information.**  
Standard time to produce units 250 hrs.  
Time taken to produce the units 220 hrs.  
Hour rate of wages Rs. 4 /-

Method of payment Halsey premium plan  
**solution :**  
**Wage = Taken Time X Standard Rate** = 220 X 4 = Rs. 880  
**Incentive Wage or bonus = Time saved X Standard Rate X 50%**  
 = 30 X 4 X 50/100 = 60  
Total wage = Rs. 880 + Rs. 60 **= Rs. 940**

**Rowan Plan**: It provides a minimum guranteed base wage and relies upon historical output standards. But unlike Halsey’s plan gives abonus on (S - T)/ S rather than on (S - T). According to his plan

**W = R.T. + (S - T)/S) \* R.T.**

It is effective, provides minimum wage, inferior and fresh workers are not penalised. But it is difficult to understand and implement and incentive for higher productive workers is not sufficient.

**This incentive wage plan was made by James Rowan in 1901. Formula of this plan is below.  
  
Total Wage = (Standard timeX standard rate ) + ( time taken X standard rate )X ( Time saved)/ standard time**

**For Example  
A worker takes 9 hrs to complete a job where the standard time was 12 hrs .The rate of payment is Rs. 5/- per hr. Calculate his earning if he is paid on the basis of Rowan plan.  
Solution :  
By analysis, we get the following facts :  
Standard time = 12 hrs.  
Time taken = 9 hrs.  
hourly rate = Rs. 5/-  
Wage = time taken X standard rate = 9 X 5 = Rs. 45  
Incentive wage or bonus = ( time taken X time saved X standard rate ) / standard time   
= 9 X 3 X 5 / 12 = Rs. 11.25  
Total Wage = 45 + 11.25 =Rs 56.25**

**Gantt Plan**; A guranteed job is provided. Workers reaching output standard are paid higher wage. Workers attaining higher output standards are paid higher rate.

* Consider a piece having standard time 30 minutes . A slow worker has completed 12 pieces in a day compared to 16 by standard worker and 24 and 32 by fast workers . Estimate earning by Gnatt Plan . Guaranteed Minimum = Rs 80 per day , standard time rate = Rs 10 per hour .

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl No** | **Type of Worker** | **No of pieces per day** | **Standard hour** | **Allowed wages** | **Bonus** | **Total wage per day** | **Rate per piece** |
| 1 | Slow | 12 | 6 | 80 | NIL | 80 | 5 |
| 2 | Average | 16 | 8 | 80 | 16 | 96 | 6 |
| 3 | Fast | 24 | 12 | 120 | 24 | 144 | 6 |
| 4 | Faster | 32 | 16 | 160 | 32 | 192 | 6 |

**Group incentive plan**: This is preferred where output depends upon team effort. For this collective effort is evaluated, total earning are are calculated and the earnings are divided in the group.

Its **advantages** include that a group-spirit develops, less skilled workers get a chance to learn and it involves less clerical work. **Disadvantages** include

1. If the group is not coherent, such a scheme fails.
2. Further this can not be implemented if the work-force is too large.
3. Production rate of slow workers in the line may limit the production capacity of the speedy workers..
4. It may be difficult to achieve rapid increase in production.

**Day-28**

**METHOD STUDY (MOTION STUDY)**

Method Study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs. It consists of following six steps:

**(a) Select and define (b) Record (c) Critically Examine (d) Develop the best Method**

**(e) Install, and (f) Maintain**

**(A) Select and Define**:

1. Select the Job worth studying and define the objectives to be achieved.
2. Consider Economic & Technical aspects and human reactions.
3. Economic aspects refer to costs which is the basis for the selection of jobs for method study. Preliminary studies to determine the efficiency levels of working groups and associated plant, equipment and materials need to be conducted to define the problem clearly. Jobs with low economic gains and those which may be discontinued in near future are of no use.
4. One should make sure that adequate technical knowledge is available to carry out the study.
5. Attitude and human reactions are most difficult to foretell but they need to be anticipated. The Supervisor resents interference in his work, the workers feel threatened. Thus method study should begin with jobs unpleasant for the workers.
6. Jobs with following objectives may be among the first to be selected:

To reduce manufacturing cost

To avoid bottlenecks

To reduce fatigue

To avoid poor use of materials, labours or machine.

To improve upon operations involving repetitive work

**(B) Record:** The success of an investigation depends upon the accuracy with which facts are portrayed because they provide the basis of both the critical examination. Various recording techniques include

**(i) Charts**: Outline process chart, Flow process chart, Two handed process chart, multiple activity chart and travel chart.

**(ii) Diagrams**: Flow diagram, String diagram, cycle graph and chronocycle graph.

**(iii) Motion and film analysis**: Simo charts and P.M.T.S.

**(iv) Layout models**: two and three dimensional.

**(C) Critically Examine**:

***PLEASE REFER NOTES ON KAIZEN***

**(D) Develop the best Method**: Steps involved:

1. Record the method proposed through the critical examination.
2. Consult all levels of management and workers for their suggestions and objections.
3. Test thus modified proposed methods for the its expected advantage.
4. Prepare and put up the report on proposed method for approval and subsequent implementation.

This new method should be practical and feasible, safe and effective, economical and acceptable to design, production, quality control and sales department.

**(E) Install:** The proposed method is installed in two stages - **Preparation** and **implementation**.

Preparation involves three stages:

**Planning:** One person is made responsible and actual dates fixed for each stage.

**Arranging**:

1. Procure necessary plant, tools and equipment.
2. Ensuring availability and continuity of all materials, supplies and services.
3. Training selected workers.
4. Informing others of plans and time tables.

**(F) Maintain:** Method must be very clearly defined and specified and workers should not be allowed to slip back to the old method. This should be ensured by periodic checks and verification..

**PROCESS CHARTS**: A chart representing a process may be called a Process Chart. Process chart symbols are:

Operation - usually the part, material or product is modified or changed.

Transport - movement of workers materials or equipment from place to place.

Permanent Storage - A controlled Storage

Delay or temporary storage

Inspection - For quality and/o quantity

Operation cum transportation

Inspection-cum-operation

**Functions of a flow chart**:

1. Surveys and records an overall picture of the process.
2. It helps in visualizing and comprehending the full process.
3. It shows relationship between the different activities.
4. It is the first step towards a detailed analysis.

**FLOW PROCESS CHARTS**: It is a detailed version of Outline Process Chart and it records all the events. These could be of three types:

**For Man:** Records the activities of an operator

**For Equipment:** Records the manner in which an equipment is used.

**For Material**: Records the changes the material undergoes in location.

The details are recorded as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Activities** | **Symbol** | **Distance Moved** | **Time** | **Remarks** |
| 1 | Moved to gas cutting machine |  | 10 m. | 3 mnts. | by trolley |
|  |  |  |  |  |  |

**Two Handed Process Chart:** Records the activities of the left-hand and the right hand with a view to synchronize movements and eliminate wasteful, unnecessary and uneconomical movements. This also helps in examining repetitive jobs of short duration.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S. No** | **Left Hand** | **Symbol**  **L.H.** | **Symbol**  **R.H.** | **Right Hand** |
| 1 | Pick up bolt |  |  | Idle |
|  |  |  |  |  |
| 2 | Hold |  |  | Pickup Nut |
|  |  |  |  |  |
| 3 | Hold |  |  | To left hand |
|  |  |  |  |  |
| 4 | Hold |  |  | Assemble |
|  |  |  |  |  |

**MULTIPLE ACTIVITY CHARTS:** A multiple activity chart records simultaneously the activities of all the workers and machines on a common time scale and thus shows the interrelation between them. The purpose is:

1. To detect idle time
2. To optimize work distribution between workers and machines.
3. To decide number of workers in a group.
4. To balance the work teams
5. To develop an improved method

**Gang Process Chart:** This portrays the relationship of activities carried out by different members of a group with respect to one another. The aim is to improve the efficiency of gang operations.

**Flow diagram**: Steps involved are:

Draw to scale the plan of the work area

Mark relative positions of machines, tools, benches, store, racks etc.

Draw the actual path movements of material and workmen.

**String diagrams**: When paths are repetitive and many a string diagram becomes more useful. Pins are inserted in diagrams and different coloured threads are used to show the path.

**It is more useful**:

1. For complex movements
2. For clearly indicating backtracking, congestion, bottlenecks and over and underutilized paths.
3. For measuring distances

**Travel Charts**: It is a tabular record for presenting quantitative data (e.g. weight, distance and frequency).

**TEMPLATES and MODELS:** these are made of wood or cardboard. Two dimensional templates are least costly and can be readily interpreted. Making of duplicate copies is possible. Disadvantages are that overhead facilities can not be visualized.

**CYCLEGRAPH AND CHRONOCYCLEGRAPH**: These are used to trace movements which are too fast for the human eyes. Movie Cameras are utilized for the purpose.

**Principles of Motion Economy**: A set of rules were proposed by Gilbreth in order to develop better methods. A better method of doing a job is one which consumes minimum of time and energy in performing limb motions in order to complete the task. These principles can be divided into four categories:

1. Rules containing Human body
2. Rules concerning work place layout and Material Handling
3. Rules concerning Tools and equipment design
4. Rules concerning Time conservation

**Rules concerning human body**:

1. Both hands should be used for productive work.
2. Both hands should start and finish their motions at the same time.
3. Except for the rest period the two hands should not be idle at one time.
4. Motions of hands, or arms should be symmetrical, simultaneous and opposite.
5. Motions should be simple and involve minimum number of limbs.
6. Wherever possible momentum should be utilized to assist the worker.
7. Motions should be smooth and continuous.
8. Ballastic movements are easy fast and accurate hence should be preferred over controlled movements.
9. A worker may use mechanical aids to assist him to overcome muscular effort

**Rules concerning workplace, layout and material handling:**

1. There should be definite, fixed easily accessible location for materials and tools.
2. Material and tools should be kept close to workplace.
3. Gravity should be used wherever possible.
4. Hands should not be employed to perform non-productive work.
5. Tools and material should be located in a sequence.
6. optimum temperature, humidity and light should be maintained.
7. Appropriate relaxing postures should be determined and followed.
8. All heavy objects should be lifted mechanically.

**Rules concerning Tools and equipment design**:

1. Jigs, fixtures and foot operated devices should be employed to reduce the work load on hands.
2. Tools which can perform more than one operations should be preferred.
3. Tools and materials should be preplaced.
4. There should be maximum surface contact between tool and hand

**Rules concerning time conservation**:

1. Even temporary ceasing of work should not be encouraged.
2. Machine should not run idle.
3. Two or more tasks should be integrated wherever possible.
4. Number of motions involved in doing a job should be minimized.

**Therbligs:** These were suggested by Gilbreth and are used to describe the basic elements of movements. Every therbglib is represented by a symbol and a definite colour. Each macroscopic motion consists of several microscopic motions called Therbligs. e.g.

Operation of picking away a screw driver consists of

Reach hand for screw driver (Transport empty)

Grasp the same (Grasp)

Take away the screw driver. (Transport loaded)

It is a cumbersome process but it does possess advantages over study of macroscopic motions. Such as:

1. At times it may not be possible to eliminate a macromotion but an unnecessary micromotion cab definitely be avoided.
2. It is simpler to understand what precisely the worker is doing.
3. Therbligs colours make the chart more meaningful.

**Micromotion Study and analysis:** It involves the following three steps:

1. Filming the job being performed
2. Analysing the film
3. Presenting the data in Simo chart.

**Filming**: The usual speed is 16 frames per second or 1000 frames per minute with a 16 mm movie camera. Microchronometer or wink-counter is the timing device is kept in the field of view while filming. Floodlights and reflectors are also required.

**Film analysis**: The projector runs the film very slowly and the film can be stopped or even reversed whenever desired. A frame counter counts the frames as the film is being projected. Film analysis is carried out as follows:

1. Run the film at normal speed to familiarize with the pattern of movement.
2. Select a workcycle representing the existing method for study.
3. Each frame of the work cycle is studied as regards changes in limb movements.

**Constructing SIMO (Simultaneous motion-cycle) charts**:

**SIMO CHART**

Operation \_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of the worker \_\_\_\_\_\_\_\_\_\_\_\_\_ Film No. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Method : Present/Proposed Operation No. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Left hand description** | **Symbol** | **Time (Winks)** | **Symbol** | **Right hand description** |
| 1 | Grasp Chisel | G | 0-10 | G | Grasp hammer |
| 2 | To job | Tl | 10-20 | TL | To job |
| 3 | Position | P | 30-40 | AD | Idle |
| 4 | Hold | H | 40-50 | U | Use |

SIMO charts are useful for studying short-cycle repetitive jobs, high order skill jobs etc.

**Advantages of micromotion study**:

1. Film keeps a permanent record
2. Films can effectively draw out the difference between existing and proposed method.
3. Films can be shown to a large audience.
4. Observations can be timed more accurately.
5. It helps in making accurate and detailed analysis.

**Memomotion Study**: It similar to above but films are filmed at much slower speed. It is used for studying teamwork, flow of material, to analysing material handling activities, for training workers to study jobs involving long cycles and irregular sequenced events.

**DAY-29**

**WORK STUDY**

Principles of work study were employed since the very inception of Industries - even when Industries were simple and involved lesser problems. Today Industries are infinitely more complex and large and therefore principles of work study have become vital. Advantages of work study include:

Uniform and improved production flow.

Higher productive efficiency

Reduced manufacturing cost.

Fast and accurate delivery dates.

Better employer-employee relationship

Job security and job-satisfaction to workers

Better working conditions.

**Work measurement techniques for recording time and rate of working:** Are of following types

* **Time Study:** For short cycle repetitive jobs
* **Synthetic Data:** By totaling element times obtained previously from time studies on other jobs
* **Work sampling:** For long cycle jobs and heterogeneous operations
* **Predetermined Motion time Study:** Done on the basis of nature of tasks and conditions under which it was undertaken.

**Work Measurement** **(Time Study)**:

**Standard time = Basic time + relaxation allowance + contingency allowance + unoccupied time + interference time**

Basic time - Time required to complete a job by a qualified person.

Relaxation allowance - Time taken by a worker to relax in order to overcome fatigue - whether mental, physical or imaginary.

Contingency allowance: extra time required for small irregularities in work.

Unoccupied time: non-working time when machine has slowed down or

Interference allowance: Unavoidable idle time.

**Stop watch**: These are of three types - Non-fly back, Fly back and split hand type.

**Non-fly back**: First pressing of winding pipe starts the knob, second pressing stops and with 3rd pressing hand returns to zero.

**Fly back**: Pressing the winding pipe brings hand back to zero but it begins moving once again. It is useful for taking continuous observation.

**Split hand type**: When two elements are to be timed and one immediately follows the other. Pressing winding pipe makes one hand stop while other keeps on moving.

**Performance rating**: The ratings can be:

**Standard rating**: It is average rate at which a qualified worker naturally works if he is motivated.

**Normal rating**: It is the average rate at which a qualified worker naturally works even without any specific motivation.

Various rating techniques are as follows:

**(1) Speed rating**: Speed of movements is the only factor in speed rating.

**Normal time = time X (Workers speed/speed expected from the worker)**

**(2) Skill and effort Rating**: Units of work is expressed as B’s.60 Bs are considered normal. An efficient worker earns above 60 Bs and an inefficient below 60 Bs.

**B point for an element = (Observed time in minutes)\*(B points earned)\*Relaxation factor) 60**

(**3) Westing-house system of rating**: It is based on four factors

(i) Skill, (ii) Effort, (iii) Conditions, (iv) Consistency

Skill e.g. could be **superskill** (+1.15) , **Excellent** (+ 1.11), **Good**, (+ 1.08), **Average** (1.00), **Fair**, (- 095) and **poor** (- 0.85)

**(4) Synthetic rating**:

**Rating factor = Time value extracted from PMTS**

**Observed time**

**PREDETERMINED MOTION TIME SYSTEMS (PMTS)**

**PMTS** are the work measurement techniques whereby times established for basic human motions are used to build up the time for a job at a defined level of performance.

**Technique**:

It does not use stopwatch.

It assumes that all manual tasks are made up of certain basic human movements.

The average time taken by a normal worker is constant.

**Uses of PMTS**:

1. It is useful in method analysis.
2. It helps in modifying and improving work methods.
3. It sets time standards for different jobs.
4. It aids in prebalancing of manufacturing lines.
5. It provides for wage plans
6. It facilitates training

**Advantages**:

It eliminates inaccuracies associated with stopwatch

It is more accurate when applied to short cycle highly repetitive operations.

No rating factor is employed

It helps in tool and product design.

**FATIGUE STUDY**: Fatigue study may be defined as negative appetite for activity and a reduction in the ability to do work as a consequence of previous work. It includes tiredness, monotony and boredom. It is physiological also and is related to accumulation of lactic acid in the blood. Its effects include:

1. muscles, nerves and mind are adversely affected.
2. Decreases capacity to do the work.
3. Loss of efficiency.
4. Introduces a feeling of tiredness and weakness.
5. creates disinterest in work.
6. disturbs, chemical, physiological and psychological equilibrium.
7. increases tendency towards making accidents.
8. Increases absenteeism.

**Causes and Elimination of fatigue**:

**Hours of work**: Highest productivity is associated with 8 hour schedule.

**Rest pauses**: appropriate rest pauses should be provided. Each pause should be of 15-20 minutes.

**Working days of a week**: A five day week is found to be most productive.

**Nature of work**: Complex muscular work, minute precise work, high attention demanding work, works involving abnormal posture are more tiring.

**Working conditions**: insufficient light, ventilation, extreme temperature, heavy clothings, noise, bad smell, smoke, dust etc.

**Mental conditions**:

**DAY-30**

**AUTOMATION**

Development of Technology may be classified in three categories:

1. Manual Technology
2. Mechanized Technology
3. Automated Technology

Though massive changes have already taken place into field of technology but even today manual technology is quite appropriate in today’s high-tech environment. Advantages of manual technology are:

1. Low cost for low volume production
2. Since capital costs are low, risks are low.
3. Inherent flexibility (both operational and financial) that goes with it.
4. Capacity can usually be expanded or contracted very quickly (unless high skills are not required)
5. For some low volume customized products craftsmen can produce quality superior to mechanized technology.

But it has serious drawbacks and limitations associated with it. Some are:

1. It is terribly expensive for high volume production.
2. Quality problem is quite a problem because of human error and process variation inherent in manual processes.
3. Production cycle is quite long affecting the delivery response time.

**Mechanized Technologies**: Substitution of machines for human labour is as old as even the most primitive factory systems. Until a few years ago, mechanized technology was the technology of choice. General purpose machines were the first to be developed and special machines came to existence much later. The difference between general and special machine is vital for mechanized as well as special machines. Special machines are dedicated to the production of a single part or product and are useful for very high production rates. Thus if low cost is the defining criteria special purpose machine is useful and if flexibility of product or part design is required than flexible process technology is required. Both at the same time are not possible.

**Automated Technology**: Automation is not as new or as unfamiliar as it appears, although application of its principles is rather a recent occurrence. Thermostatic control of room temperature or electrical equipment is being used for many decades now. Use of common flat valve which automatically fills the tank upto a given level much more older. Automatic control of chemical processes has been possible for quite some time now. But today far more advanced technologies and concepts are being introduced, which include:

1. Robotics
2. NC machine (Numerically controlled machines where machine tools are computer controlled.
3. FMS (flexible manufacturing systems that combine NC machines in flexible system of production)
4. CAD/CAM (Computer aided design and management system that combine product design and manufacturing instructions).
5. CIM (computer integrated manufacturing in which all aspects of manufacturing are integrated through a design and manufacturing database.
6. GT (Group technology that organizes planning and facilities for small-lot manufacturing by grouping various parts and products with similar design.

**Robotics**: A robot is a programmable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.

What differentiates it from other machines is the similarity of their movements with that of humans and also the fact that like humans they are reprogrammable. They are gaining preference because they do not get tired, do not go for strikes, do not mind hot, dirty and dusty conditions, can work long hours without rest breaks and ***do not sue when injured***!

Some of the advanced capabilities being designed into robots in addition to their basic reprogrammability and manipulative skills are virtually all the human senses - vision, tactile sensing and hand-to-hand coordination.

**Robot applications**: The robots have some unique applications where human safety requires remote mechanical handling such as - **assembling high explosive shells in government arsenals, picking up hot steel ingots and placing them in presses, handling radioactive rods in nuclear power plants and other nuclear applications.** But they are in great use in ordinary mechanical handling such as spot welding and material handling. Auto industry is the dominant user.

**Economics of Robots**: An average robot costs $6 to $8 per hour including capital and operating costs where as an average worker is paid more than $ 26 per hour thus robots as such are a bargain. The accuracy and consistency of robots results in far greater saving. For precision jobs where rejection is about 10% when humans operate with robots becomes 0%. They also operate with far greater accuracy.

**Numerically Controlled (NC) Machines**: When position and paths of cutter tools are under the control of a digital computer, we have **numerical control**. When two dimensions are controlled we have **position control** and when three dimensions are controlled we have **contour control**. Contour controls require very complex programming. Advantages are that machine tools are not tied up for long time and repeat orders require virtually no set-up time. Thus it is quite popular for process technology for both high-volume, standardized types of products and customer design products.

**Comparative cost for NC**: The comparison of cost for three assembly methods namely - manual, NC and hard automation is shown in following chart. Thus NC becomes cheaper than manual at very low volumes and very much cheaper at higher volumes.

**Flexible Manufacturing Systems (FMS)**: The figure shows a schematic layout of an FMS, where NC machines of different types are positioned around a material handling system.

1. The system automatically moves the parts to be processed to computer-directed locations.
2. Robots move the part to and from the individual machines.
3. The individual NC machines are equipped with tool changers that load the required tool into the machine
4. Set up is solely in the programming of machine.
5. A wide variety of parts can be produced on the same flexible system.

**Advantages of FMS**: Greatest feature is its flexibility with no machine time for set up. Thus low cost parts can be produced cheaply in small volumes.. Even single part can be produced. The flexibility of such systems and their economy for smaller batches suggest smaller plants located closer to market. Since customer is the king in today’s world such an automation is becoming vital.

**Applications and economics of FMS**: It was pioneered in US but Japan has taken a considerable lead. GE produces 2000 different types of meters on same FMS with an output of more than a million meters per year. Fanuc Ltd. of Japan which makes robots at a plant costing $32 million. But a conventional plant would have cost them $320 million! They have employed only 100 workers with each worker supervising 10 machines. In another plant utilizing FMS only 215 workers are engaged against 2500 for an equivalent conventional plant. Obviously with such a system cost of production planning and control can be reduced drastically

Some examples of FMS are GROUP TECHNOLOGY and AUTOMATIC FACTORY.

**Group Technology**: This is a concept for organizing manufacturing resources to increase productivity in process-focused, small lot situations involving parts and products which are similar. The idea is to group similar parts, sizes or types of products into families to gain productivity advantages. It also includes a classification and coding system that is computerized and which can be coupled to CAD/CAM. Thus the system becomes numerically controlled . Modular programmes, stored in a master computer programme reduces programming time and other related costs of production planning, Similarly group tooling takes advantage of similar tooling requirements thus reducing or eliminating the need for individual tooling for each part.

**The Automatic Factory**: This is still a dream. But portions of factory that are automatic are not uncommon nowadays. e.g. ***Seiko*** has developed a system for the automatic assembly of watches in which no human input to the assembly process is required. we have already discussed some instances of automatic factory earlier.

**DAY-31**

**Production Planning and Control**

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Four parameters of optimizing production are - **Quality, Quantity, Cost** and **Adhering to** **Schedule**.

This includes **Preplanning, planning** and **control**.

**Pre-planning**: Sales estimation & forecaste; policy (make or buy), plant layout, product development and design.

**Policy (make or buy)**: This is done by a break even analysis. Sould you make or buy following items? (Labour cost Rs. 80/ hr.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Item** | **A** | **B** | **C** |  |
|  |  |  |  |  |  |
|  | **Quantity needed** | 4000 | 700 | 12000 |  |
|  | **Tot Material cost** | 6000 | 100000 | 90000 |  |
|  | **Total direct labour** | 200 hr. | 1500 hr. | 2000 hr. |  |
|  | **Lowest supplier bid** | Rs. 8.00 | Rs. 5.00 | Rs. 20.00 |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Item** | **Material cost** | **Labour cost (Lb hr\*80)** | **Total** | **Lowest supplier bid** | **Decision** |  |
|  |  |  |  |  |  |  |  |
|  | **A** | 6000 | 16000 | 22,000 | 32,000 | **Make** |  |
|  | **B** | 1,00,000 | 1,20,000 | 2,20,000 | 3,50,000 | **Make** |  |
|  | **C** | 90,000 | 1,60,000 | 2,50,000 | 2,40,000 | **Buy** |  |

**Production planning:**

**Aggregate Planning**: It is usually done for six months or for more: e.g. Aggregate planning for A.C. 20 H.P. motors:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Months** | January | February | March | April | May | June |
|  |  |  |  |  |  |  |
| **Number to be produced** | 20 | 35 | 40 | 55 | 45 | 35 |

**Master Schedule**: This is the sum of aggregate planning of all items:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Motors** | **January** | **February** | **March** | **April** | **May** | **June** |
|  |  |  |  |  |  |  |
| **AC 20 HP** | 10 | 20 | 15 | 20 | 25 | 15 |
| **5 HP** | 5 | 10 | 15 | 20 | 20 | 10 |
| **DC 50 HP** | 3 | 5 | 10 | 15 | 10 | 5 |

Production rate = Desired inventory at the end + Sales Forecaste - Starting Inventory

Number of days

**Scheduling**: It involves assignment, time for beginning and completing an operation. It is concerned with the activity which takes place within an operating system. An activity schedule will show the time or dates at hich all of these activities are to be undertaken. Preperation of a production chedules reuire following information:

1. Delivery dates.
2. Various job schedules
3. Capacity of various departments
4. Efficiency of various departmnts
5. Maintenance schedule.
6. Holidays.
7. Anicipated sickness/absenteeism
8. Existing commitmnts
9. Availability of materials
10. Allowance for scrap.

**DAY-32**

**Scheduling techniques**:

1. **Material requirement planning**: Its principal application is in batch manufacturing.
2. **Reverse Scheduling** (Gantt Charts): External due date considerations directly influence activity scheduling. The approach adopted in such cases involves a form of reverse scheduling.
3. **Forward Scheduling** (Gantt charts): For a manfacturer or supply organization a forward schedling procedure, opposite of the above would be more useful.
4. **Time tabling**:
5. **Batch scheduling**:
6. **Flow scheduling**.
7. **Priority decision making using thumb rules**: When there are many orders in hand a priority of jobs has to be made. A few priority rules are

First come First served (FCFS)

Least slack (Less number of days available)

Earliest due date (EDD)

Shortest processing time

Longest processing time

Preferred customer order.

Q. Shown below are the time remaining

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Job** | **Due date (a)** | **Process Time (b)** | **Slack (a-b)** |  |
|  |  |  |  |  |  |
|  | A | 8 | 7 | 1 |  |
|  | B | 3 | 4 | -1 |  |
|  | C | 7 | 5 | 2 |  |
|  | D | 9 | 2 | 7 |  |
|  | E | 6 | 6 | 0 |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **FIFS** | **EDP** | **LS** | **SPT** | **LPT** |
|  |  |  |  |  |  |
|  | A | B (3) | B (-1) | D (2) | A (7) |
|  | B | E (6) | E (0) | B (4) | E (6) |
|  | C | C (7) | A (1) | C (5) | C (5) |
|  | D | A (8) | C (2) | E (6) | B (4) |
|  | E | D (9) | D (7) | A (7) | D (2) |

Schedule the jobs given below:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Job** | **Due date (a)** | **Process Time (b)** | **Slack (a-b)** |  |
|  |  |  |  |  |  |
|  | A | 8 | 6 |  |  |
|  | B | 7 | 4 |  |  |
|  | C | 2 | 1 |  |  |
|  | D | 3 | 3 |  |  |
|  | E | 4 | 2 |  |  |

**Scheduling problems:** Scheduling thus is a very complicated process at times even an impossible one. A few measures suggested to overcome its impossibility are:

1. Reduce product range
2. Reduce component range
3. Examine available resources: Complex machine should be simplified. Uniformity in machine types too eases scheduling problems.
4. Job enlargement: Each worker should be trained to perform number of operations to increase flexibility.
5. Use subcontractors.
6. Separate important and not so important jobs (Prioritization).
7. Close liasion with marketing.
8. Reduce size of departmnt/sections
9. Increase autonomy of work-centres.
10. Accept alternatives.
11. Accept need for discipline.

**DAY-33**

**Routing/ Sequencing**: It involves planning of where and by whom work shall be done, the determination of the path that work shall follow and the necessary sequence of operations. For this it is necessary to make out a list of operations, the various machines in the plant and the precise time required.

**Jhonson’s two machine method:** This algorithm is applicable when

(a) when a job has to be processed through only two machines

(b) Sequence has to be m1m2 and not m2m1

(c) job breaking is not allowed

e.g.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Job No.** | **Activity** | **A** | **B** | **C** | **D** | **E** |  |
|  |  |  |  |  |  |  |  |  |
|  | 1 | Baking | 5 | 4 | 8 | 7 | 6 |  |
|  | 2 | Decorating | 3 | 9 | 2 | 4 | 10 |  |

According to this rule the job durations are scanned and the smallest processing time is identified. If it appears in machine I it is done first if it appears on machine II it is done last. The job thus scheduled is eliminated and the process repeated, untill or the jobs are scheduled.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **JOB** | **A** | **B** | **C** | **D** | **E** | **F** |
|  |  |  |  |  |  |  |  |  |
|  |  | Machine I | 0 | 4 | 6 | 3 | 5 | 2 |
|  |  | Machine II | 3 | 6 | 8 | 8 | 0 | 5 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **JOB** | **A** | **B** | **C** | **D** | **E** |  |
|  |  |  |  |  |  |  |  |  |
|  |  | Machine I | 3 | 6 | 9 | 4 | 7 |  |
|  |  | Machine II | 2 | 3 | 8 | 6 | 4 |  |

For more complicated situation such as follows:

**Machine**

**Product M1 M2 M3**

P1 100 40 80

P2 30 50 90 --------> No. of units made per hour

P3 90 150 80

Profit (Rs.) 6 12 10

**Through linear programming it can be determined how to route to maximize profit.**

**Despatching**: It is a doing function of production control and initiates actual manufacturing in accordance with the work of routing and scheduling. It is that technique of production control that translates the paper work into actual production. It involves movement of material and availability of tools at the correct place and movements of the operations according to routing and scheduling.

In any production sequence a great variety of activity takes place before actual manufacuring begins. These include:

1. Preparing manufacturing drawing
2. preparing material list
3. Allocating/purcahsing materials
4. preparing job layouts

This is done by despatch section which makes a material reqisition slip, a job order/works order, a uality control schedule, individul work responsibilities, cleanliness and maintenance responsibilities. etc.

**Network analysis**: A more useful approach for dealing with realistic sequencing problems is provided by dispatching procedures. The principle method of job dispatching is by means of priority rules . This is done by finding critical activitis/path, floats, early start, early finish, late start and late finish dates.

**DAY-34**

**Materials Resource Planning**

* *What* items are required?
* *How many* are required?
* *When* are they required?...

**Objective**s:

* **Reduction in Inventory Cost**: By providing the right quantity of material at right time to meet master production schedule, MRP tries to avoid the cost of excessive inventory.
* **Meeting Delivery Schedule**: By minimizing the delays in materials procurement, production decision making, MRP helps avoid delays in production thereby meeting delivery schedules more consistently.
* **Improved Performance**: By stream lining the production operations and minimizing the unplanned interruptions, MRP focuses on having all components available at right place in right quantity at right time.

**Inputs**

* Independent demand (Master schedule)
* Bills of materials. Details of the materials, components and sub-assemblies required to make each product
* Inventory status records

OUTPUTS

* Recommended production schedule
* Recommended purchase schedule.

Problems: Integrity of the data, Constant lead time, decentralized inventory, Changed designs,

Solutions

* Bill of material – The best practice is to physically verify the bill of material either at the production site or by disassembling the product.
* Cycle count – The best practice is to determine why a cycle count that increases or decreases inventory has occurred. Find the root cause and correct the problem from occurring again.
* Scrap reporting – This can be the most difficult area to maintain with any integrity. Start with isolating the scrap by providing scrap bins at the production site and then record the scrap from the bins on a daily basis. One benefit of reviewing the scrap on site is that preventive action can be taken by the engineering group.
* Receiving errors – Manual systems of recording what has been received are error prone. The best practice is to implement the system of receiving by ASN from the supplier. The supplier sends an ASN ([advanced shipping notification](https://en.wikipedia.org/wiki/Advance_ship_notice)). When the components are received into the facility, the ASN is processed and then company labels are created for each line item. The labels are affixed to each container and then scanned into the MRP system. Extra labels reveal a shortage from the shipment and too few labels reveal an over shipment. Some companies pay for ASN by reducing the time in processing accounts payable.
* Shipping errors – The container labels are printed from the shipper. The labels are affixed to the containers in a staging area or when they are loaded on the transport.
* Production reporting – The best practice is to use bar code scanning to enter production into inventory. A product that is rejected should be moved to an MRB (material review board) location. Containers that require sorting need to be received in reverse.
* Replenishment – The best replenishment practice is replacement using bar code scanning, or via pull system. Depending upon the complexity of the product, planners can actually order materials using scanning with a min-max system.

**DAY-35**

**Production control:**

**Follow-up**: The actual production may fail to match the targetted production. And therefore it is essential to adopt follow-up measures including production reports, variance reports (from predetermined time schedules). Productive and non-produtive labour hours, material rejection/damage/wastage report, maintenance recordsetc.

Production record contains details such as

total poduction in a day s against planned production

total poduction in a batch against planned production

Manhours and mchine hours utilized. Overtime if any

Machine breakdon/slowdon details

Excess material required and the reasons

**Requirement of an Effective Control System**:

It should report deviations promptly without loss of valuable time so that corrective action can be initiated.

It should be objective and not influenced by personality of any person.

It should point out variations from strategic positions.

It should be responsive

It should be economical

It should be understandable.

**Quality control**: It is n integral part of production system and it minimises wastes, reduces cost, improves goodwill and facilitates advertising and sales. Quality can be defined as ability to satisfy its intended purpose in relationship to the price.

Techniques of quality control are:

**Inspection**: This involves checking the product so tht it confirms to established standards in term of appearance, performance, packaging and weight. It is the inspction department which decides what to inspect, how much to inspect, how to inspect and where to inspect. It carries out following activities:

Goods inwards inspection: Incorrect/inappropriate material may lead to excessive loss o hamper production.

*‘*First-off’ inspection: If first few pieces come ou with requisite quality then the rest too will have same level of quality.

On-line inspection or piece-part inspection: This helps to identify whether or not process is operating within defined norms.

Finished goods inspection:

**Defect Detection System**: This is an age-old concept. After a batch of item has been produced at one step in the process, the items are inspected. Those that do not meet quality standard are rejected/ reworked/ recycled. This is done after each step. It has three problems:

1. There is duplication of inspection activity
2. A very large number items are inspected.
3. Defect is discovered only after mistake has been committed.

**Defect Prevention System:** In this process is monitored and any unacceptable variation is detected., cause for the variation is determined and corrective measures taken. The specific technique is called **Statistical Process Control (SPC).** Abnormal/random variations in process (which are caused by assignable causes) are detected by SPC and corrective measures are taken.

**Defect Avoidance**: It is often possible to reduce process variation significantly, thus enhancing the uniformity of product quality. Once again a Japanese concept and is based on use of design of experiments. Key variables are discovered and process is designed to drastically reduce variation and large number of unimportant variables are opened up to reduce cost.

Production Planning

Long-range planning: Decisions involving top management (e.g. CEO and VP of Manufacturing etc.) for one or more years into the future. Examples:

1. Corporate strategic planning
2. Business forecasting
3. Product and market planning
4. Financial and resource planning

Medium-range planning: Decisions involving middle level management (e.g. plant managers) for 3 to 18 months into the future. Examples:

1. Aggregate production planning (AP)
2. Item forecasting
3. Master production schedule (MPS)
4. Rough-cut capacity planning

Short-range planning: Decisions involving lower level management (e.g. shop superintendents) for days or weeks into the future. Examples:

1. Material requirement planning (MRP)
2. Capacity requirement planning (CRP)
3. Final assembly schedule (FAS)
4. Input/Output planning and control
5. Production activity control
6. Purchase planning and control

**Aggregate Production Planning (AP)**

Objective: To specify the optimal combination of production rate, work-force level, and inventory on hand to minimize the total production-related cost over the planning horizon.

1. AP requires a standard unit to measure output: e.g. tons, labor hours, or sales dollars etc.
2. AP is demand driven and the accuracy of demand forecast is very important.
3. The complexity of the real world would often makes AP more of an art than a science.

Basic AP strategies:

1. Chase: Matching the capacity with the demand forecast.
2. Level: Maintain a stable production capacity and use inventory to buffer the fluctuation of demand.
3. Counter-seasonal product mixing.
4. Mixed: A combination of strategies.

Some AP solution techniques:

1. Intuitive approach (including graphical method or computer spreadsheet).
2. Mathematical models: LP or transportation method (if the cost structure is simple).
3. Computer simulation.
4. Heuristic solutions: linear decision rules and management coefficients models, etc.

**Different Approaches to Production Planning and Control**

(1) Pond draining:

1. Buffer stocks are kept between each stage of production process.
2. Minimum amount of communication is required to coordinate work stations's schedules.
3. Requirement: Sound inventory policy.

(2) Push system:

1. Emphasis is on using information about customers, production and suppliers to control material flows.
2. The flow of material (timing, quantity etc) are planned and controlled by a series of schedules.
3. Requirement: Accuracy of information and schedules.

(3) Pull system:

1. Emphasis is on reducing inventory level at every stage of production.
2. The last (down-stream) production stage activates the production.
3. Implemented with the principle of JIT.
4. Requirement: Stable and level production schedule and small batch production.

(4) Systems focusing on bottleneck operations:

1. Optimized Production Technology (OPT).
2. Others such as Q Control.

**Order point or fixed order system**: To understand other concepts we must introduce some definitions:

**Lead-time**: It is the time required to receive material after placing an order. (Ordering time + receiving time + inspection time).

**Safety Stock/Buffer stock**: The stock that must be maintained to take care of extended lead-time, or increased consumption

**Maximum stock**: It is the level beyond which the stock should not be kept.

**Minimum stock**: Stock level by which the new ordered material should be delivered.

**Reorder level**: It is the stock level at which an order must be placed

**Danger level**: Level at which warning signals should be sent to procure material on war footing.

**Order quantity**: The quantity which has been ordered.

**Average consumption**: Quantity required on average per day/perweek/per month.

In **Order point System** the order is placed on order point rather than on time factor. This system requires:

1. Predetermination of an order point. (depends on lead time and average consumption)
2. Predetermination of a fixed quantity to be ordered.

This is achieved by maintaining a **perpetual inventory system**. This a system in which every day the receipt and issue of an item is noted and balance-in-hand calculated. The different stock levels such as reorder level, maximum stock, minimum stock, buffer stock, danger level are predetermined. Decisions can be made automatically depending upon the stock level on that particular day.

**Advantages:**

1. Gives excellent result when tie-up with ABC analysis.
2. EOQ concept too is valid and useful.
3. Utilizes time and effort of people efficiently and effectively.
4. It has a good control.

Disadvantages:

Based on historical data and not actual.

Functions correctly only if each material exhibits stable usage and lead-time characteristics.

An important variation is **Two-bin system**. In this the perpetual inventory system is not required and it is not based on records but on physical quantity. Thus the reorder level is stored separately and when surplus is exhausted automatically the message is received that order has to be placed.

Another important feature of this system is periodic physical stock verification. If the physical stock is much less than the recorded stock a situation may come when production will come to standstill even though theoretically one may have enough stocks on hand.

**DAY-36**

**Assignment Method**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | I | II | III | IV | V |
| A | 32 | 38 | 40 | 23 | 39 |
| B | 40 | 24 | 28 | 21 | 36 |
| C | 41 | 27 | 33 | 30 | 37 |
| D | 22 | 38 | 31 | 36 | 38 |
| E | 29 | 33 | 40 | 35 | 39 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | J1 | J2 | J3 | J4 |
| M1 | 120 | 100 | 80 | 90 |
| M2 | 80 | 90 | 120 | 100 |
| M3 | 110 | 140 | 120 | 100 |
| M4 | 90 | 90 | 80 | 90 |

**DAY-37**

**MATERIALS MANAGEMENT**

**Purchasing and Material Management Functions**

Objectives of purchasing and supply management: It has three levels:

**a) The Managerial perspective b)The functional perspective c) Strategy for specific buying plans**.

**From a top managerial perspective**, it is expressed as the five rights:

1. Of the **right** quality
2. From the **right** supplier
3. In the **right** quantity
4. At the **right** time
5. At the **right** price

A sixth factor implied in in here includes the desired services necessary for optional supply and utilization of material.

One can easily detect an obvious *apple pie and motherhood* syndrome reflected in five *rights*. Almost always one right gets pitted against other right and hence what we actually practice at best is a reasonable balance among them.

**From a functional perspective**: From the above eight basic objectives can be derived to provide practical and useful targets for decision-making purpose.

**To support company operations with an uninterrupted flow of materials and services**: This in fact is the justification of the very existence of the department.

**To buy competetively**: It involves an indeapth understanding of demand and supply forces operating in the market. It also involves supplier’s cost structure, coupled with an ability to improve this structure. - and then to negotiate price and service arrangements.

**To buy wisely**: This involves ceaseless attempts for improvement in terms of quality, price and service. this requires meaningful coordination with the user departments to define their NEED.

**To keep inventory investment and inventory losses at a practical minimum**: It has been estimated that it costs industries 25 - 30 % of average inventory value per yer for the convinience of having the inventory.

**To develop effective and reliable sources of supply**: Good suppliers could be of invaluable help to any organization. They not only supply material at competitive rate but also help in times of necessity and re excellent advisers and consultants. The catch word today is to *buy suppliers* rather than *buying goods*. The quest for quality, economy and efficiency would be impossible without the support of supplier.

**To develop good relationship with the supplier community and good continuing relationships with active suppliers:** Good relations with suppliers are important, and good relations with potential suppliers are vital. The achievment of long term goals is impossible withput a good and active longterm relations with the supplier. Problems in production and quality may be solved when relationship is sound and mutually beneficial. Suppliers naturally direct their research,provide advance information on new products and prices.

**To achieve maximum integration with the other departments of the firm**: It is essential for the purchasers to undrstand the major needs, constrains, objectives and purposes of user department. A production department requires support to maintain required quality, flow, in developing materials, standardization programmes, designing, forecasting future prices, general economic conditions etc.

**To handle the purchasing and supply management functions proactively in a professional, cost-effective manner**: Management should expect the preceding seven objectives to be achieved in a professional manner at a cost tht is commensurate with their value to the total organization. This involves among other things, the continuous examination of the purchasing process for possibilities to streamline it and enhance its ‘value added’ capabilities.

**INVENTORY Management**

In most manufacturing firms today, inventories constitute the largest category of assets shown on the balance sheet. Inventories often account for as much as 40 percent of the firm’s invested capital. Even more significant piece of statistics is that a typical manufacturing firm incurs inventory carrying costs of 20-40 percent of average inventory value!!!

**Functions of Inventories**: This was not to suggest that inventories are totally bad. In general they perform following functions:

1. They make possible smooth and efficient operation of an organization.
2. Purchase department has the time and opportunity to work independently and for experimentation.
3. Inventories allow additional flexibility to production department to plan, produce and deliver.
4. Finished goods inventory allow decoupling of production and distribution.
5. Production does not suffer from material quantity and quality problem.

Therefore we always talk in terms of optimum inventories and not minimum inventories.

**Definition of Inventories**: These are of four types:

1. **Production Inventories**: Raw material, packing material and miscellaneous items which are required by the production department.
2. **MRO Inventories**: Maintenance, repair and operating supplies which are consumed in production process. (Lubricating oil, soap, machine repair parts).
3. **In-process Inventories**: Semifinished products at different stages of production.
4. **Finished goods inventories**: Completed product ready for shipment.

**Inventory analysis**:

**ABC Analysis**: **The 80-20 concept**; In general even a medium-sized firm carries thousands of items. SAIL it is told has an inventory exceeding 50,000 items. Since it is virtually impossible and would be very expensive to control the inventory of each item, therefore it is better to prioritize items. Thereby important items can be identified for more effective inventory control. One method is **ABC analysis**.

It has been seen that for most companies 20% items make for 80% inventory investment In other words by concentrating on only 20% items we take care of our 80% total inventory!

**Procedure**:

1. List out all the items in the store.
2. List out the units of each item required every month or every year.
3. List out the present price per unit.
4. Calculate the total amount for each item by multiplying quantity and price.
5. List the amount of each item in descending order of amount.
6. Calculate the cumulative amount
7. Calculate % of cumulative amount. (Cumulative amount\*100/total amount)
8. Draw a Graph between item and % cumulative amount.
9. Identify A, B and C categories of items.

Inventory analysis can be made more effective using following analysis:

**Types of Inventory control System**:

1. Cyclical or fixed order interval system
2. Just-In-Time approach
3. Order point or fixed order quantity system
4. MRP-type system
5. Perpetual Inventory control system (including physical stock variation)

**Cyclical or fixed order interval system:** The oldest and the simplest system. Periodic reviews of inventories are conducted and order is placed to replenish the supply. A items are reviewed daily, B items weekly and C items monthly etc.

The important question is **when to order**. Determined by review dates and decisions. Second question is **how much should be ordered**. Determined by 3 factors:

1. Number of days between reviews.
2. The anticipated daily use during the cycle period.
3. Quantity in hand

**Just-In time approach**

This concept was introduced by Japanese firms to improve quality and reduce costs to become more competitive. Today it has become the survival strategy for many organizations. Though JIT is a philosophy and not just a method to reduce inventory, yet its basic theme is that **inventories are evil**. Following are the arguments:

1. It hides quality problem
2. It hides production inefficiencies and productivity problem.
3. It adds unnecessary and often crippling cost to the production operation.

Hence JIT believes in zero inventory concept. The focus obviously shifts to consistently high quality material and work. It also forces people to come closer, trust and respect each other and work as a close-knit team. It forces people to come out with their best.

**In conventional system**:

1. Incoming material was received, counted and logged into system
2. Standard visual receiving inspection system to detect quality problems
3. Submitted for thorough quality inspection
4. Prepackaging the material, parts and components for quicker stock picking.
5. Subassembly inventoried for future use.

The dramatic change that occurs because of implementation of JIT is only too obvious.

On average 15 day inventories were brought down to one day level. It has been most successful where:

1. Manufacturing operations where small number of different products in a continuous environment produced.
2. Product demand is fairly predictable.
3. Statistical process control is used.
4. Production requirement set up must be reduced.
5. Lead-time has been considerably reduced.
6. JIT must be reliable. i.e. people must be committed to it.

Just in Time manufacturing is a systems approach to developing and operating a manufacturing system. It is based on the total elimination of waste. **JIT** is not a new concept. It has been part and parcel of the Japanese manufacturing industry adopted approach for quite some time. It requires that equipment, resources and labor are made available only in the amount required and at the time required to do the job. It is based on producing only the necessary units in the necessary quantities at the necessary time by bringing production rates exactly in line with market demand. In short, **JIT** means making what the market wants, when it wants it. **JIT** has been found to be so effective that it increases productivity, work performance and product quality, while saving costs.

The goal of a **JIT** approach is to develop a system that allows a manufacturer to have only the materials equipment and people on hand required to do the job. Achieving this goal requires six basic objectives:

[Integrating and optimizing every step of the manufacturing process](jit2.htm#int1)  
[Producing quality product](jit2.htm#int2)  
[Reducing manufacturing cost](jit2.htm#int3)  
[Producing product on demand](jit3.htm#int4)  
[Developing manufacturing flexibility](jit3.htm#int5)  
[Keeping commitments and links made between Customers and Suppliers](jit3.htm#int6)

Requirements for JIT Manufacturing

* The corporate commitment to developing the internal structures and the customer and supplier bases to support **JIT**
* A significant financial commitment
* Management needs to come with grips during the early transition phase of implementing **JIT**.
* Trust and commitment between the supplier and the customer is a must,

Critical Elements in JIT manufacturing

* Partnerships
* Commitments
* Contracts Supporting Partnerships
* Quality for JIT
* Delivery of Purchased Material

**DAY-38**

**Quality, Standard and Inspection**

**Basic concept of Quality**: Quality is often defined in three ways:

1. In absolute terms
2. Relative to perceived need
3. As conformance with stated requirements

In absolute terms, quality is a function of excellence, intrinsic value, or grade as determined over time by society generally or by designated bodies in specialized field. Gold and diamond has, for example, proved to be high quality materials. Some other items achieve this distinction for a shortwhile that too in a given culture.

In business and industrial activities, quality is defined in terms of relationship to a need or a function. Thus in a battle-field a steel sword is considered of higher quality than even a gold sword.

Once the specification has been finalized, quality is simply defined as conformance with the stated requirements.

**The role of purchasing in quality management**:

1. ***Quality is nothing that you check in a product rather it is what you build in it.***
2. ***Quality is not an accident but a logical consequence of will and effort.***
3. ***An organization is as good as its suppliers***.

From the quotations it is obvious that a buyer plays a vital role in ensuring the quality. He has the responsibility to ensure that suppliers have the ability, motivation and adequate information to produce quality materials in a cost-effective manner. Four factors determine the long-run quality level of purchased material:

1. Creation of complete and appropriate specifications for quality requirements.
2. Selection of suppliers having the technical and production capabilities to achieve desired quality.
3. Development of realistic understanding with suppliers and raising his motivation level.
4. Monitor suppliers quality/cost performance.

**Material specifications**:

A sound material specification represents a blend of:

1. Design requirements
2. Production factors
3. Commercial purchasing considerations
4. marketing factors.

Purchaser should investigate:

1. Study the quality requirements
2. Ensure that quality requirements are completely and unambiguously stated.
3. Investigate their reasonableness, relative to cost.
4. Ensure that specifications are written so as to permit competition among potential suppliers.
5. Determine whether existing suppliers can ensure the desired quality.
6. Ensure the feasibility of the inspections and tests required to ensure quality.

**Selection of supplier**: Most quality related problems can be solved by choosing a competent and cooperative supplier. This can be done by:

**product testing**: The products of many suppliers can be tested. Test should be performed by a skilled person.

**Proposal analysis**: Firms should be asked to indicate how they intend to comply with the quality requirements. He should assess the proposal to detect areas of misinterpretation or overemphasis.

**Capability survey**: Once proposals have been chosen, the capability survey should be conducted by finding the answers to following questions:

1. What is firm’s basic policy and philosophy with respect to product quality
2. What is the general attitude of operators and supervisors towards quality.
3. What ideas and techniques they have to ensure quality.
4. What is their engineering/production experience.
5. Do they have the technique, process and machines to ensure quality.
6. How well is their quality control Dept. equipped - manpower, equipment, techniques ideas and knowledge. Does the top management support quality control dept.

**Motivation and control**: This needs no emphasis. Three systems exist to control defects - **Defect detection system, Defect prevention system and Defect avoidance.**

**Defect Detection System**: This is an age-old concept. After a batch of item has been produced at one step in the process, the items are inspected. Those that do not meet quality standard are rejected/ reworked/ recycled. This is done after each step. It has three problems:

1. There is duplication of inspection activity
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**Defect Avoidance**: It is often possible to reduce process variation significantly, thus enhancing the uniformity of product quality. Once again a Japanese concept and is based on use of design of experiments. Key variables are discovered and process is designed to drastically reduce variation and large number of unimportant variables are opened up to reduce cost.

**Process capability analysis**: A process has **normal variations** and **abnormal variations**. In normal variation a bell-shaped curve is obtained. The difference between the two extremes of the curve is defined as the **natural tolerance range** of the process. A buyer’s desired range of quality must correspond to supplier’s natural tolerance range. Before selecting a supplier, buyer must determine:

1. Whether the supplier knows natural capability range of his process?
2. Whether buyer’s quality requirements correspond to suppliers natural tolerance range. If not then (a) negotiate with supplier to narrow down his process capability to the required level or (b) Seek another supplier.
3. How the supplier ensures that process stays in control.

**Process Capability Index**: This is one more way of expressing process capability relative to buyer’s design requirements.

Process capability Index = Buyer’s absolute design tolerance

nat. capability range of process

**Supplier Certification**: This is useful and is based on three steps - Qualification, Education and certification performance process.

**Qualification** is in respect of quality, reliability, management philosophy, financial stability, R&D capability, shop management and manufacturing support capabilities. Two types of **education** required - first deals with people, mode of operation and resulting expectations for a performance and second focuses on specific quality concepts. **Certification performance process** means that supplier must demonstrate that it can meet buyer’s requirement. (Rubber meets the road).

**Standardization, ALL IN COST**

**Standardization**: This concepts has two aspects:

1. Standardization of things, their size, shape, colour, physical properties, chemical properties, performance.
2. Standardization of operating practices, procedures and systems.

***It is defined as the process of establishing agreement on uniform identifications for definite characteristics of quality, design, performance, quantity and service.***

**How standardization reduces cost**: Saves money by lower prices, lower processing cost, lower inventory costs and fewer quality problems.

1. The use of standards permit a firm to purchase fewer items, in large quantities and at lower prices. Thus fewer items are processed and stocked.
2. This reduces purchasing, receiving, inspection and payment cost.
3. Fewer items reduce inventory cost.
4. Number of defects in incoming material are reduced drastically.

**Simplification**: A natural corollary of standardization and some even consider it a part of standardization. It has many definitions, but essentially means reducing the variations without affecting the performance. Thus a company which stores fan-belt on the basis of machines can simplify by storing them in terms of fan-belt number. Lubricating material too can be brought down drastically.

**ISO 9000**: International Standard Organization (ISO) is a body comprising of members representing standard organizations from 91 countries. ISO9000 standards are not product standards but are process standards. And are designed to ensure that a firm does what it claims. Thus a company producing mediocre quality product too can comply with ISO 9000.

1. I**SO9000** - Provides guidelines and definitions used to select the standards most applicable for a given organization.
2. **ISO9001**: Provides a quality assurance model for assuring conformance in design, development, production, installation and servicing.
3. **ISO9002**: Provides quality assurance model for conformance with production and installation.
4. **ISO9003**: Model for conformance in final test and inspection procedures.
5. **ISO9004**: Provides guidance in the establishment and internal documentation of a quality system.

**TOTAL QUALITY MANAGEMENT (TQM)**: It essentially is a philosophy with four basic elements:

1. Quality is everybody’s responsibility.
2. Everyone should be committed and participate in the quest for quality.
3. Continuous improvement of quality.
4. Satisfaction of customer.

**DAY-39**

**PRICING PRINCIPLES**

It hardly needs to be emphasized that in today’s world of crippling competition buying gods at right (cheapest possible) price is vital. In fact survival of organizations literally depends on it. Right price does not mean a loss for the seller. Price must be fair to both - supplier as well as the buyer. Hence determining the right price is an important and a complicated process. Complicated because of multiple dynamic variables involved in it. Some of the important variables are:

1. Conditions of competitions
2. Variable margin pricing
3. Differences between the product.
4. Various costs.

**Conditions of Competition**: The market competition is broadly classified as: **Pure, Oligopoly, Imperfect and Monopoly.**

The **pure or perfect competition** is said to exist when roughly following conditions prevail in the market:

1. Number of sellers is very large.
2. Number of buyers is very large
3. Both producers and consumers have complete knowledge of product.
4. There is no product differentiation
5. Entry into and exit from the industry is free for firms.

Under such conditions of pure competition only the market forces of demand and supply and not the individual actions of buyer or sellers, determine prices.

1. The Monopoly has following characteristics:
2. Number of buyers is large
3. There is only one seller
4. Product is perfectly differentiated
5. Buyers may not have full knowledge of product
6. Entry for other firms into industry is difficult if not outright impossible.

The price under monopoly does not depend upon the market forces (Demand and Supply), rather they are determined by the seller who is free to maximize his profit by regulating output and forcing a supply demand relationship that is most favourable to the seller.

The competitive area between the extremes of pure competition and monopoly is called imperfect competition. These are of two types: **Imperfect competition** and **Oligopoly**.

1. Imperfect competition has following characteristics:
2. The number of sellers high but not as high as in perfect competition.
3. Number of buyers is high.
4. There are many products which are similar but slightly differentiated (mostly in buyer’s mind).
5. Buyers knowledge of the products is not very high although he thinks otherwise.
6. The prices differ according to perception but market forces can not be ignored altogether.

Sellers spend considerable money alongwith major promotional efforts to persuade buyers that their products are different. This is an important category as a large number of products are sold under this category.

**Oligopoly** is characterized by following characteristics:

1. Number of buyers is high
2. Number of sellers limited (2-6, when only 2 it is called duopoly)
3. Products are homogeneous.
4. Consumers may or may not possess good knowledge of product.
5. Entry into industry is difficult. Exit from industry is free but may not be easy.
6. Oligopolists at times may conspire and act together as monopolists

Oligopolist industries frequently hold firmly to their prices for long periods and appear non competetive. This however, is deceptive because they shift competition to areas other than price, such as service or quality or help seller with other schemes.

From this discussion it would be obvious that prices can be negotiated very little with firms in the market of perfect competition or monopoly. They can be negotiated a great deal with firms operating in the market of imperfect competition.

**Variable-Margin Pricing**:

Most industrial firms sell a line of products rather than just a single product. Very few firms attempt to earn the same profit margin on each product in the line. Such a variable-margin pricing policy permits maximum competition on individual products. The profit from maximum-profit products is used to offset the losses or the lower profit margins of the inefficiently products.

It is important for a buyer to understand this theory because it is useful to obtain right price while buying ‘low-margin’ products. The supplier may try to seek average margin or even maximum margin for low margin products. Thus while dealing with multiproduct firms, a buyer must know which items are low-margin and which are high-margin. This can be learnt by noting the differences in volumes, manufacturing skills and costs of various producers.

Unfortunately most buyers concentrate only on the product they are buying and have no information about other products of the seller to utilize this concept. Buyers are rewarded by directing their efforts towards the development of savings produced by recurring long-term cost reductions, rather than focusing on savings from short-term cost reductions.

**Differences between products**: We have already introduced the concept of ***differentiated*** and ***undifferentiated*** products. Differentiated products could further be intrinsically different or may be different because of psycho-emotional conditioning. (Some buyers are prepared to pay premium prices for a product even though it may be similar to other much cheaper products in the market.) And in such cases the advertising is directed towards ultimate consumer as they are more susceptible to advertising.

For both differentiated and undifferentiated products, producers compete on quality and service as well as price.

**Six categories of cost**: Price = cost + profit.. However a better understanding of cost is required to take advantage of this relationship. The cots are Variable, fixed, semiveriable, total, direct and indirect costs. They have a different implication for the ultimate price.

**Variable Cost**: Cost that vary directly and proportionally with the production quantity of a particular product. e.g. raw material and packing material. Thus variable costs represent money seller can keep if they do not accept the contract and money they must pay if they do perform it.

**Fixed Cost**: Fixed costs do not vary with volume. It is the cost they pay simply into the business. e.g. building and machinery cost, advertising and R&D cost. They are not dependent on volume of production.

**Semivariable cost**: These are costs which fall between the aforesaid two costs and depend partially on the production volume. Costs such as maintenance, utilities and postage fall under it. However a closer analysis may help to identify the fixed and variable cost inbuilt in it.

**Total cost**: The sum of the variable, fixed and semiveriable costs is called total costs. As the volume of production increases, total cost increases, however cost of each unit decreases. This is because fixed cost are spread over a large number of units.

**Direct and Indirect Costs**: Since it is not possible to divide costs as fixed, variable or semi-variable, accountant often divide them as **direct** or **indirect**. **Direct** costs are traceable to or caused by a specific project or production operation. Labour and material are two direct costs. This should however be not confused with variable cost. Direct cost relates to traceability while variable cost relates to the behaviour of cost as volume fluctuates. **Indirect cost** or **overheads** are associated with two or more operating activities. Once again these should not be confused with fixed cost. Because indirect cost could be fixed or variable.

**Regulation by competition**: Suppose five suppliers submit their quotation giving details of their costs such as cost of material, labour, overhead, profit etc. Despite the prevailing controlling factors, companies will submit different prices because the cost of production and profit are only two of the factors a seller considers in determining price.

**Regulated, Catalogue and Market prices**:

**Prices set by Law or Regulation**: No supplier can change these prices.

**Catalogue prices**: The price updation is important in this respect. The buyer should request a recent sales summary indicating that significant quantities are sold to a significant number of customers at the indicated price before accepting a catalogue.

**Market price**: A market price is generally for an item or a service that is generic in nature and is associated with perfect competition.

**Historical Prices**: Price analysis also requires comparison of a proposed price with historical quotes. It is essential to determine that the base price was fair and reasonable. Several issues must be considered:

1. How have conditions changed.
2. Were there one time engineering setup or tooling charges.
3. What should be the effect of inflation or deflation on the price.
4. Will the new procurement create a situation in which the supplier should enjoy the benefit of learning.

**Independent Cost Estimate**: If price analysis technique does not work, a buyer may use an independent cost estimate as the basis for comparison. This estimate should be fair and reasonable.

**ALL IN COST**: The professional buyer recognizes that price is only a component of All-in-cost. All-in-cost refers to the total acquisition and usage cost and includes price, transportation, storage and administration as well as costs resulting from defective material.

**Documenting a price analysis**: The price analysis report includes:

1. Information that was considered.
2. Weight given to each piece of information and why.
3. Logic supporting the determination that a price is reasonable or unreasonable.
4. Soundness of that logic.

**DISCOUNTS**: These are important part ofpricing and include **trade discounts, quantity discount, seasonal discount** and **cash discount.**

**Trade Discount:** Reduction from the list price allowed to various classes of buyers and distributors to compensate for performing certain marketing functions for the original sellers.

**Quantity Discount**: These price reductions are given to a buyer for purchasing increasingly larger quantities of materials and are offered under one of purchasing arrangement:

For purchasing material worth a specified amount of any number of different items at one time.

For purchasing material worth a specified amount of any number of item over an agreed-upon time.

**Seasonal discount**: It is based on the nature of certain products and is offered during off-season.

**Cash discount**: This is the discount offered for prompt payment of bills.

Legal implication of pricing are important to consider. Legislation, court orders etc.

**SOURCES OF SUPLY**

1. ***To produce the best product you need ideas, designs, specifications and good suppliers!***
2. ***Your roducts are only as strong as your weakest supplier.***

**A good supplier: An invaluable resource** - One ‘outsider’ who is vital for your firm’s success is the suplier. He not only suplies you the goods of right quality, right quantity, on right time and at right prive, but he assists you with product development, value analysis etc.

**Selection and Management of the right supplier**: Buyers must take six important supplier-oriented actions:

1. Develop and maintain a viable supplier base.
2. Address the appropriate strategic and tactical issue.
3. Ensure the suppliers are carefully evaluated.
4. Decide hether to use competetive bidding or negotiation as the basis of source selection.
5. Select the appropriate source.
6. Manage the selected supplier.

**Supplier base development**: Sources of supplier information include:

**Supplier Purchasing Information File**: Purchase department must maintain supplier information files on past, present, potential and future suppliers. The list includes name, address, phone numbers, FAX/Email number, a list of material available, delivery history, quality history and general information such as, management, plant and machinery, quality approach etc.

**Supplier catalogs**: A common and popular base and most firms maintain **catalog libraries**. It is useful for estimating prices also, thus facilitating planning and budgeting. Some large companies like L&T even appoint a full time Librarian to keep catalogs indexed and updated.

**Trade Registers and Directories**: Not very popular in India so far, these nevertheless are important base in developed countries and provide information such as addresses, numberof branches, affiliations of all leading manufacturers and financial standings.

**Trade journals**: Useful in India and developed countries. Most journals contain such advertisements.

**The yellow pages**: Rapidly gaining populaity in India and even smaller cities like Siliguri are in the process of developing their local yellow pages. Since they do not provide much information but are well-indexed hence they are a good starting point.

**Filing of mailing pieces**: Many mail advertisements are worth saving. They should be numbered,dated and indexed for methodical filing. Some organization like Ranbaxy ask prospective suppliers to fill a form giving basic information about themselves and their product.

**Sales Personnel**: Popular in India, as salesman are usually well informed about the capabilities and features of their product, but are also familiar with similar and competetive products as well. Salesman can also suggest new applications of their products, Since they provide useful information, salesman should be treated with coutsey and given ample time to make their presentation.

**Trade Exhibits**: Regional and National Trade shows are an excellent source of information. It helps in expanding knowledge of new products, new potential suppliers and new ideas.

**Company Personnel**: Personnel from other departments who have good contacts, are members of associations, societies etc. often provide valuable information. So do the scientific, technical and research personnel.

**Other purchasing and supply management departments**:

**Supplier development**: A partnership or even a voluntary collaboration with supplier has following advantages:

1. A new supplier means a new, expensive and time consuming process.
2. Communication problems are common when dealing with a new supplier.
3. Adaptations forced by changing technology and conditions are better weathered by ongoing relationships.
4. A continuing partnership is the best antidote for quality and delivery problems.
5. Open relationships can help to cushion bad times.
6. Oportunistic buyers are more subject to shocks resulting from capacity r supply problems.
7. Opportunistic buyers do not get benefit of knowledges, research findings of suppliers.
8. A supplier willingly invests in research, innovation and value analysis in long term relationships, thus reducing your costs.
9. In competetive bidding suppliers are given designd and speccifications thus they do not use initiative..
10. A partner supplier gets the oportunity to bring down his costs.

**But it has its disadvantages also**:

Partnering is a way to reduce purchase staff.

It can lead to complacency.

It can weaken leverage.

Purchasing and audit control can be lost.

Success can lead to excess.

Every supplier will want to be your partner 9including dishonest and incompetent ones.

**Strategic and Tactical issues**:

**Early Supplier Involvement (ESI):** A supplier is involved in early stage can help in material specification, tolerance, standardization, order size, process changes in suppliers manufacturing, packaging , inventory, transportation etc.

**One supplier vs, many supplier**: Single source is better when

1. Better pricing results from much higher volume.
2. Quality considerations dictates
3. The buyer obtains more clout with the suplier.
4. Lower costs are incurred to source process, expedite and inspect.
5. The JIT reduces other costs also.
6. Lower freight costs possible.

**Multiple sourcing is appropriate**:

1. To protect the buyers during time of shortges, strikes, lock-outs etc.
2. To maintain competition and provide backup source
3. To meet customer volume requirements.
4. When technological future is uncertain.

**Green and social purchasing**: Increasingly people are buying from sources which are environment-friendly or socially correct.

**Evaluating a potential supplier**:

**Proposal analysis**: Firms should be asked to indicate how they intend to comply with the quality requirements. He should assess the proposal to detect areas of misinterpretation or overemphasis.

1. Technological and quality competition
2. Price competition
3. Service competition

**Capability Survey**: Once proposals have been chosen, the capability survey should be conducted by finding the answers to following questions:

What is firm’s basic policy and philosophy with respect to product quality?

What is the general attitude of operators and supervisors towards quality?

What ideas and techniques they have to to ensure quality?

What is their engineering/production experience?

Do they have techniques, process and machines to ensure quality?

How well is their quality control Dept. eqipped - manpower, equipment, techniques, ideas and knowledge. Does the top management support quality control Dept.

Past major customers.

General reputation

Letters of references.

ISO-9000 or ISO-14000 certification

Good manufacturing practices (GMP)

**Financial conditions**: A financially unsound supplier can not maintain, quality, delivery, rush orders etc. Such firms are managerially and technically wek, have no R&D facility and face labour unrest.

**JIT capabilities**

**Service capabilities**:

**Competetive bidding Vs. Negotiation**:

**Competetive bidding** is dictated by five criterias:

The order value is large enough for both seller and buyer.

Specification of item and service are explicitely clear.

There are many sellers in the market.

The sellers in the market must be technically qualified and willing to supply.

Enough time to use this method for pricing.

**Competetive bidding** should not be used:

When it is impossible to estimate cost.

When price is a secondary consideration

When a purchaser anticipates a need to change specification.

When special tooling or setup costs are major factors.

**International sourcing**: Six common reasons for purchasing goods and services internationally are:

1. **Quality**: By far the most profound reason to seek international supplier.
2. **Timeliness**: Once initial difficulties of the new business relationship have been overcome, many international sources have proved to be remarkably dependable.
3. **Cost**: Total cost often is much cheaper when goods are sourced internationally.
4. **Broadening the supplier base.**
5. **Countertrade.**
6. **Unique product and process technologies:**

**Problms associated with international procurement**:

1. Culture and communication.
2. Payment terms and conditions.
3. Long Lead times
4. Additional inventories
5. Social and labour issues
6. Higher cost of doing business.

**Day-40**

**VALUE ANALYSIS AND VALUE ENGINEERING**

The concept of Value analysis/Engineering , like many other concepts has its genesis during the war years of the early 1940s. Within a short time it gained wide acceptance as the cornerstone of most purchasing research and cost reduction programmes. Ever since its inception enthusiasm for it has waxed and waned, diminishing its popularity, until periods of severe material shortage or very high prices.

The concept of Value analysis was first thought of during the second worldwar when many of the substitute materials were found to be even better and cheaper than the original ones. GEC management assigned the task to explore the possibilities further to L.D. Miles. He did do and called his systematic approach Value analysis.

Value engineering on the other hand was conceptualized by US Navy when they utilized the value analysis concept to reduce the cost of ships by directing its efforts at cost avoidance during the initial engineering design stage.

In an operational sense VE and VA are one and the same concept - only the timing differs. The VE finds its use in two kinds of companies - those that produce a limited number of units of a very expensive product and those that mass-produce products requiring expensive toolings. Value analysis is of not much use here as it is too late to incorporate changes economically. VE utilizes all the techniques of value analysis and involves very close liaison work between the purchasing and supply, production, and design engineering departments

**Value = Functional Benefit/cost**

**Value could be** Cost value , Exchange value, use value, Esteem Value and Emotional value

**Value analysis useful**:

* Reduce cost
* Cost prevention
* Cost elimination
* Understand customer better
* For increasing profits
* Enhance creativity
* Orient people better to do their jobs
* Better designs

**Application of VA/VE**:

* Cost prices higher than those of the competitor
* Decreasing market/market share
* Launch of new products
* Increasing Costs
* Decreasing profit levels
* Failure to meet delivery commitments

**VA/VE Tools:** Two general conceptual tools are basic to the operation of a VA/VE programmes.

**Design analysis** of the required Product, part or material

**Cost analysis** of the required product, part or material.

**Design Analysis**: It entails a methodical step-by-step study of all phases of the design of a given item in relation to the function it performs. The philosophy underlying this approach is not concerned with appraisal of any given part *per se*. Rather it focuses on the function which the part, or the larger assembly containing the part, performs. Both quality and costs are objects of the analysis.

One technique many firms use in analysing component parts of a subassembly is to dismantle the unit and lay it on a table to demonstrate visually the functional relationships of the various parts. Thus no part is viewed in isolation. Analysis of each component in this fashion attempts to answer four specific questions:

Can any part be ***eliminated*** without impairing the operation of the complete unit?

Modified?

Reduced

Reshaped

Integrated

Can standard parts be used

Can new process be developed

Can greater tolerance (quality parameters) be allowed

Can the design of the part be ***simplified*** to reduce the basic cost?

Can the design of the part be ***changed*** to permit the use of simplified or less costly production methods?

Can less expensive but equally satisfactory materials be used in the part?

When viewed in this manner - from the standpoint of composite operation and cost - possibilities for making component design simplifications frequently are more apparent than is possible under the original design conditions. This in no way discounts the work done earlier, rather it promotes analysis with a broader orientation.

The specific manner in which a value analyst approaches the problem of design analysis is a highly creative matter which differs from one analyst to another. Each possesses unique analytical abilities and develop unique patterns of thought. But some commonly used techniques include

1. The value analysis checklist.
2. The functional cost approach
3. The use of brainstorming.
4. The use of suppliers.

**Value analysis Checklist**: First determine the function of the item, then determine:

1. Can the item be eliminated?
2. If the item is not standard, can a standard item be used?
3. If the item is standard, does it completely fit the application, or is it a misfit?
4. Does the item have a greater capacity than required?
5. Can the weight be reduced?
6. Is there any similar item in inventory that could be substituted?
7. Are closer tolerance specified than are necessary?
8. Is unnecessary matching performed on the item?
9. Are unnecessarily fine finishes specified?
10. Is ‘commercial quality (which is of lowest price) specified?
11. Can you make the item less expensively in your plant? If you are making it now, can you buy it for less?
12. Is the item properly classified for shipping purposes to obtain lowest transportation charges?
13. Can cost of packaging cost be reduced?
14. Are suppliers being asked for suggestions to reduce cost?

This list is suggestive and not exhaustive. Further it is general and hence depending on the nature and peculiarities of product or process an entirely different list can be prepared. Once a vague answer is formed to any of these questions, a detailed analysis is required.

**The functional cost approach**: An additional question could be ***What does it cost to perform the function done by this part?*** or ***Does the importance of the importance of the function to be performed justify the cost of performing it?*** Such questions underline a separate approach to value investigation.

Experienced value analyst quickly establish benchmark costs for performing certain functions. encountered in their industry. As these kinds of data are accumulated, costs of particular functions appearing on new jobs can be compared with historical benchmarks. If there is a difference, analyst tries to identify the reason. Graphical methods can be used to determine the costs associated with increasing weight, thickness etc. Any item not conforming well with the resulting curve can be further analysed.

One important feature is comparison of current and past performance. Another important feature here is the concept that cost of performing a function must be reasonably proportionate to the value of function itself.

**Brainstorming**: It is a process designed to stimulate creative thinking. A group of individuals with different background meet for the purpose of generating ideas. useful in solving a particular problem. The emphasis here is on:

1. The sheer number of ideas
2. No criticism of idea.
3. Modification of idea.

In a shortwhile several hundred ideas are generated. This could be an integral part of the total value analysis procedure.

**The use of suppliers**: A supplier knows more about its product and its potential capabilities than do most of the consumers or manufacturers.. His technical expertise and profound experience qualify him to be an integral part of VA/VE. His participation could be formal (workshops, seminars etc.) and informal.

In formal approach a firm has numerous high-priority value analysis projects exhibited on display boards. Current and potential suppliers are invited to study the exhibits at their leisure for the purpose of offering possible cost reduction of quality improvement.

A second

**Quality Circle:** Quality is most often thought to be a staff (or an specialist) function performed by seeking cooperation of management and workers. Quality control department is supposed to be responsible for the quality. However Japanese trained the workers themselves in techniques and made them familiar with day-to-day problems. Thus quality became every-one’s responsibility. In quality circle:

Workers and management form teams.

These teams meet regularly to select, analyse and present solutions.

There are many such teams.

Thus rather than one technical person attempting to solve problems and impose solutions on others many minds work on the problems and come out with solutions acceptable to all.