LECTURE NOTES

ON

OPERATIONS MANAGEMENT

II SEMESTAR

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INTRODUCTION TO OPERATIONS MANAGEMENT

DEFINITION:

Operation is that part of as organization, which is concerned with the transformation of a range of inputs into the required output (services) having the requisite quality level . Management is the process, which combines and transforms various resources used in the operations subsystem of the organization into value added services in a controlled manner as per the policies of the organization.

The set of interrelated management activities, which are involved in manufacturing certain products, is called as production management. If the same concept is extended to services management, then the corresponding set of management activities is called as operations management.

PROCESS DESIGN

Process design is the design of processes for desired physical and/or chemical transformation of materials. Process design is central to chemical engineering, and it can be considered to be the summit of that field, bringing together all of the field's components.

Process design can be the design of new facilities or it can be the modification or expansion of existing facilities. The design starts at a conceptual level and ultimately ends in the form of fabrication and construction plans.

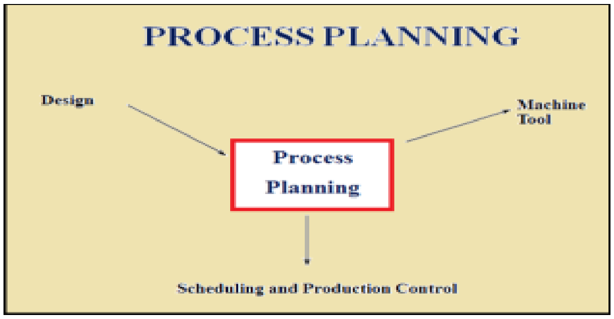
Process design is distinct from equipment design, which is closer in spirit to the design of unit operations. Processes often include many unit operations.

PROCESS PLANNING

In companies, planning processes can result in increased output, higher precision, and faster turnaround for vital business tasks. A process is described as a set of steps that result in a specific outcome. It converts input into output. Process planning is also called manufacturing planning, material processing, process engineering, and machine routing. It is the act of preparing detailed work instructions to produce a part.

It is a complete description of specific stages in the production process. Process planning determines how the product will be produced or service will be provided. Process planning converts design information into the process steps and instructions to powerfully and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to make simpler and improve process planning and realize more effectual use of manufacturing resources.

Process Planning



It has been documented that process planning is required for new product and services. It is the base for designing factory buildings, facility layout and selecting production equipment. It also affects the job design and quality control.

OBJECTIVE OF PROCESS PLANNING:

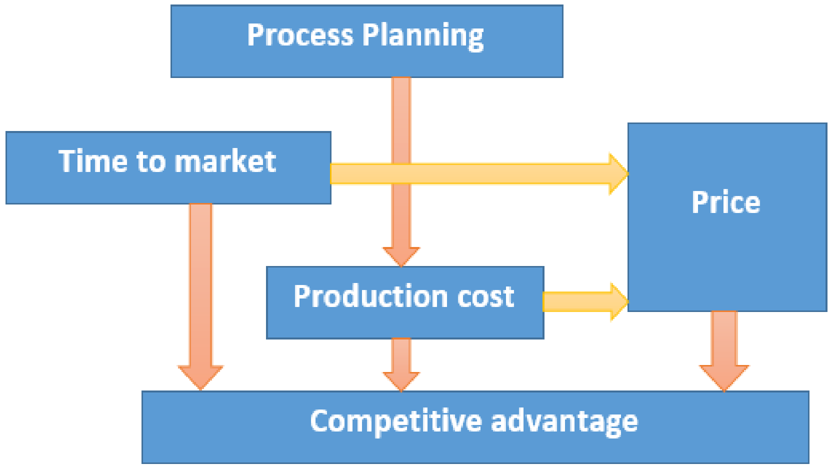
The chief of process planning is to augment and modernize the business methods of a company. Process planning is planned to renovate design specification into manufacturing instructions and to make products within the function and quality specification at the least possible costs.

This will result in reduced costs, due to fewer staff required to complete the same process, higher competence, by eradicating process steps such as loops and bottlenecks, greater precision, by including checkpoints and success measures to make sure process steps are completed precisely, better understanding by all employees to fulfill their department objectives.

Process planning deals with the selection of the processes and the determination of conditions of the processes. The particular operations and conditions have to be realized in order to change raw material into a specified shape.

All the specifications and conditions of operations are included in the process plan. The process plan is a certificate such as engineering drawing. Both the engineering drawing and the process plan present the fundamental document for the manufacturing of products. Process planning influences time to market and productions cost. Consequently the planning activities have immense importance for competitive advantage.

Effect of process planning on competitive advantage:



PRINCIPLES OF PROCESS PLANNING

General principles for evaluating or enhancing processes are as follows:

1. First define the outputs, and then look toward the inputs needed to achieve those outputs.
2. Describe the goals of the process, and assess them frequently to make sure they are still appropriate. This would include specific measures like quality scores and turnaround times.
3. When mapped, the process should appear as a logical flow, without loops back to earlier steps or departments.
4. Any step executed needs to be included in the documentation. If not, it should be eliminated or documented, depending on whether or not it's necessary to the process.
5. People involved in the process should be consulted, as they often have the most current information.

Process planning includes the activities and functions to develop a comprehensive plans and instructions to produce a part. The planning starts with engineering drawings, specifications, parts or material lists and a forecast of demand. The results of the planning are routings which specify operations, operation sequences, work centers, standards, tooling and fixtures. This routing becomes a major input to the manufacturing resource planning system to define operations for production activity control purposes and define required resources for capacity requirements planning purposes.

Process plans which characteristically offer more detailed, step-by-step work instructions including dimensions linked to individual operations, machining parameters, set-up instructions, and quality assurance checkpoints. Process plans results in fabrication and assembly drawings to support manufacture and annual process planning is based on a manufacturing engineer's experience and knowledge of production facilities, equipment, their capabilities, processes, and tooling. But process planning is very lengthy and the results differ based on the person doing the planning.

MAJOR STEPS IN PROCESS PLANNING:

Process planning has numerous steps to complete the project that include the definition, documentation, review and improvement of steps in business processes used in a company.

Definition: The first step is to describe what the process should accomplish. It includes queries like, what is the output of this process? Who receives the output, and how do they define success?, What are the inputs for the process?, Are there defined success measures in place - such as turnaround time or quality scores? And Are there specific checkpoints in the process that need to be addressed?

Documentation: During the documentation stage, interviews are conducted with company personnel to determine the steps and actions they take as part of a specific business process. The results of these interviews is written down, generally in the form of a flow chart, with copies of any forms used or attached. These flow charts are given to the involved departments to review, to make sure information has been correctly captured in the chart.

Review: Next, the flow charts are reviewed for potential problem area

Process planning in manufacturing may include the following activities:

1. Selection of raw-stock,
2. Determination of machining methods,
3. Selection of machine tools,
4. Selection of cutting tools,
5. Selection or design of fixtures and jigs,
6. Determination of set-up,
7. Determination of machining sequences,
8. Calculations or determination of cutting conditions,
9. Calculation and planning of tool paths,
10. Processing the process plan

PROCESS DESIGN

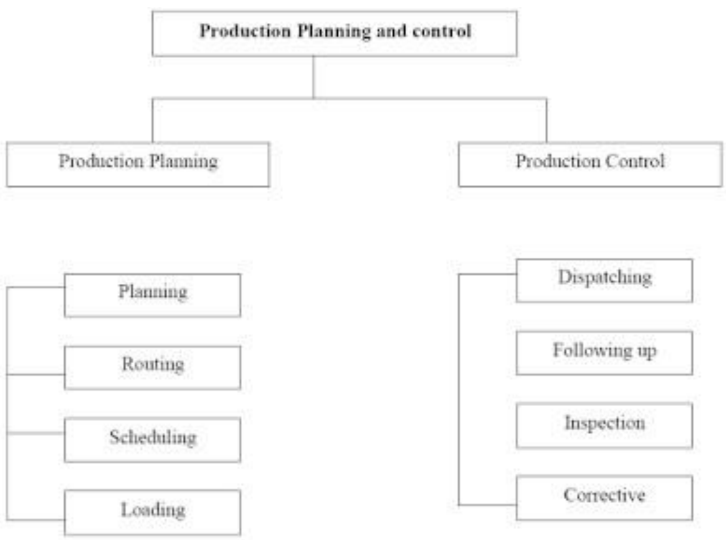
A successful process design has to take into account the appropriateness of the process to overall organization objective. Process design requires a broad view of the whole organization and should not have a myopic outlook. And the process should deliver customer value with constant involvement of the management at various stages.

In order to achieve a good process design, effective process strategy is required, which deals with a singular line items required to manufacture the end product. Effective process strategy deals with raw material procurement, customer participation, technology investment, etc.

Over a period of time process design has undergone change and new concepts like Flexible Manufacturing Systems have been developed, which delivers efficient and effective production design and analysis.

PRODUCTION PLANNING AND CONTROL (PPC)

Production Planning and Control (PPC) - Functions of Production Planning and Control (PPC)



The main functions of PPC are the coordination of all the activities, which exist during production or manufacturing.

Materials : This function is concerned with ensuring that the Raw material, standard finished parts, finished parts of products must be available while starting the operation within the time.

Methods : This function is concerned with the analysis of all methods of manufacturing and selecting the best appropriate method according to the given set of circumstances and facilities.

Machines and Equipments: It is important that methods of manufacturing should to be related to the available production facilities coupled with a detail study of equipment replacement policy. This function is concerned with the detailed analysis of the production facilities, maintenance procedures and equipment policy.

Routing: It refers to the flow of sequence of operation and processes to be followed in producing a particular finish product. It determines manufacturing operation and their sequence.

Estimating: This function is concerned with estimation of operations time. The operation time can be worked Out once the overall method and sequence of operation is fixed and process sheet for each operation is available.

Loading & Scheduling: It is important that machine should be loaded according to their capabilities performance the given and according to the capacity. It is concerned with preparation of machine loads and fixation of starting and completion dates for a particular operation.

Dispatching: It means the assignment of work to different machines or work places which involve authorities to start of production activities in order of their priority as determined by scheduling.

Expediting: It is also called Follow Up or Progress. Follow up which regulates the progress of materials and parts through the production process. It is closely interrelated with activities of dispatching.

Inspection : It is an important control tool. Its assessment is important in the execution of current program and planning stage of undertaking when the limitations of the processor, method and manpower are known. It forms a basis for future investigations with respect to method, process which is useful in evaluation phase

Evaluating: This is the integral part of control function. The evaluating function is concerned with providing a feedback mechanism on the long term basis so that the past experience can be evaluated with the aim of improving utilization of method and facilities

PRODUCTION CYCLE:

Production cycle is used in two meanings:

- **Broad:** a production process that begins with raw materials and ends with finished product,

- **Narrow:** time period of the production process from raw materials to finished product.

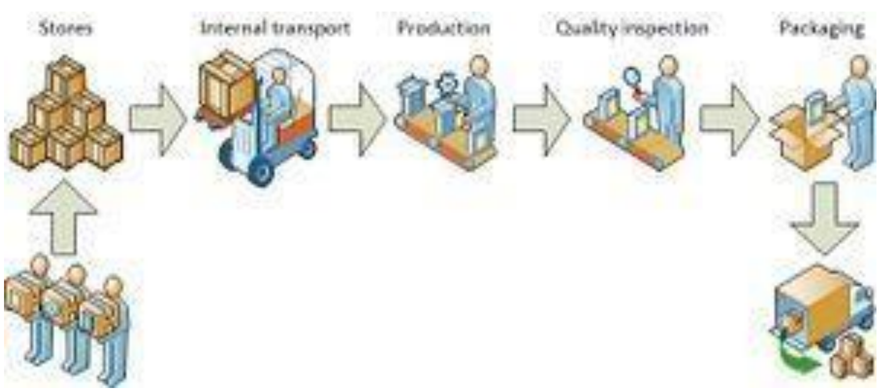
T he broad meaning is equal to concept of **production process**, while the narrow one describes **production cycle** itself as described here.

Elements of production cycle

- Working period.
- Break (Rest) Period.

Working period

- Technological operations.
- Natural processes.
- Inspection operations,
- Maintenance operations,
- Transport,
- Storage.



The **production cycle** is time period of production process

Break period

- breaks arising from the organization of the production process, including:
  - waiting time in magazines,
  - waiting in connection with the batch processing,
  - waiting in anticipation of the release of workplace.
- breaks arising from the organization of the working day, including:
  - including changes of employees
  - scheduling breaks
  - non-working days and holidays,
- other breaks.

Documents and methods used in production cycle planning and control

Following documents are used during production cycle design:

- bill of materials,
- operations list,
- production orders,
- material and equipment orders,
- machine configuration,

Production cycle often involves various IT systems and management methods, such as:

- Manufacturing resource planning (MRP-II)
- Lean manufacturing
- Master production schedule (MPS)
- Computer-integrated manufacturing (CIM)
- Process management,
- Quality management,
- Activity-based costing, etc.

Direct and indirect process technology

- This is another one of those distinctions which it is important to understand yet which is not, in itself, a clear and clean distinction. Direct process technology directly helps to create the service or product whereas indirect process technology helps to manage the process that creates the service or product.

- As an example of this distinction consider the legal industry. Because lawyers consider themselves part of the "professional service" industry does not mean that they cannot gain benefit by using process technology. The fact that lawyers "process" knowledge (and clients) means that technology can help them store, analyze and manipulate this knowledge (and these clients). Some of this technology is known as "litigation support" technology. These enable lawyers and clients to access databases, sometimes via the Internet, containing previous legal judgments. Such databases are designed to help law firms capture, share and recycle their accumulated collective experience. Search engines can help them search "practice area libraries" to obtain access to different types of legal information. By contrast, the indirect process technologies used by legal firms are less *client facing* and more *back- office* oriented. These systems concentrate on scheduling work, controlling activities within the firm and ensuring the efficiency and dependability of the delivered service. Remember though that some technologies can cross this direct/indirect divide. Some newer process technologies used in the legal industry are built around systems that can help clients directly to help track the progress of the work being undertaken for them and even answer questions and take part in the processing themselves.

The product/process matrix

Initially uses three dimensions of process technology. These are,

- The scale of the technology (that is, its capacity, not its physical size).
- The degree of automation of the technology (what the technology does itself as opposed to requiring human intervention).
- The degree of coupling of the technology (the degree to which different parts of the technology are integrated or linked together).
- These three dimensions are very strongly related. So, for example, a small manufacturing jobbing shop will probably use "general purpose" machines requiring the use of the skilled labor and physically separated so as to allow flexibility of materials flow between them. At the other end of the scale, a large food processing plant will have many of its activities automated with each stage in the process being physically connected through materials handling devices

Although Chapter 8 does not pursue this issue fully, the type of tasks that operations managers will be concerned with will also change as technology moves down these three dimensions. With small, labor intensive and separated technologies there is likely to be an emphasis on managing and controlling the complexities that characterize such technology. On the other hand, large, capital intensive and integrated technologies once designed and implemented, to a large extent, run themselves. The key involvement of operations managers therefore is in that initial design.

The main purpose of the product/process matrix is to demonstrate two points. The first is that there is a "natural diagonal" or line of fit between the product or service offerings that a company has and the characteristics of its process technologies. Companies may move their position on this line of fit (often moving down the diagonal as they progress along the product/service life cycle, or choose to concentrate on inhabiting one particular position on the diagonal). The second point is that any deviation away from the natural line of fit has cost consequences. If technologies are too small, labor intensive and uncoupled for the volume and variety of products and services produced, then the costs of making those products and services will be higher than they could be using more appropriate technologies. Conversely, if the technologies are too large, capital intensive and integrated for the volume and variety of products and services produced, then the technology will be too rigid, which itself produces extra costs and/or lost opportunities.

The characteristics of "new" technologies

- Much of the basis for the product/process matrix came from academic work routed in the 1960s and 70s. At that time most process technology meant conventional manufacturing technologies. When dealing with process technology that has significant amounts of information-processing embedded in it, the dimensions need changing.

- Scale become scalability.
- Automation becomes analytical content.
- Coupling becomes connectivity.

- Although these modified dimensions are introduced in Chapter 8, do not think that they are the direct equivalent of the three original dimensions. Instead they are replacement dimensions.

- Scale is less important when technology can be brought together on an ad hoc basis because it isscalable.

- Automation as such is not relevant when all technology to some extent replaces human decision-making. More important is the extent to which it replaces human decision- making; this is its analytical content.
- Coupling was traditionally associated with the rigidity that comes from integrating physical technologies. But this rigidity can be overcome in IT-based technologies when they can easily communicate with each other because of their connectivity.

- It points out that these developments have, to some extent, changed the nature of the trade- off between cost and flexibility. However, remember the discussions in Chapter 3 regarding trade-offs. Rarely are they eliminated completely; rather they just shift to a higher level. There may still be a trade-off between cost and flexibility but the actual cost performance and flexibility performance of the technology is better than it used to be.

Selecting process technology

- It takes a particular view on how companies should choose between different process technologies. In doing so it does not cover all the conventional financial capital budgeting techniques. Rather it focuses on the overarching idea that technologies should be judged both on their impact in the market place and their impact on the resource base of the organization.

- It also introduces a simple three-stage approach to evaluating technology that distinguishes between:

- the feasibility of the technology – how difficult it is to get it operational.
- the acceptability of the technology – how much it improves competitiveness and gives us a return on investment as well as adding to the resource base.
- The vulnerability of the technology – how much risk is involved in terms of what could go wrong, especially during the implementation of the technology.

- Compared with the more narrow capital budgeting techniques, this is a far broader approach.

- It is worth remembering that, in practice, the choice of new technologies is far less rational and "clinical" than the impression given in Chapter 9. Usually, investment decisions of this type are made against a background of opposing factions in the managerial team with different views of how the market may chance, what risks are appropriate, which technologies represent the way of the future and which represent technological "dead-ends", and so on. The issues and questions outline in Chapter 9 should therefore be considered as providing a set of checklists and structures which can raise this debate to a higher level rather than give any answers as such.

PROCESS MANAGEMENT

Companies begin the process of organizing operations by setting competitive priorities. That is they must determine which of the following eight priorities are to be emphasized as competitive advantages:

1. Low-cost operations
2. High performance design
3. Consistent quality
4. Fast delivery time
5. On-time delivery
6. Development speed
7. Product customization
8. Volume flexibility

Although all eight are obviously desirable, it is usually not possible for an operation to perform significantly better than the competition in more than one or two.

The five key decisions in process management are:

- Process Choice
- Vertical Integration
- Resource Flexibility
- Customer Involvement
- Capital Intensity

These decisions are critical to the success of any organization and must be based on determining the best was to support the competitive priorities of the enterprise.

Types of Production Systems

A production system can be defined as a transformation system in which a saleable product or service is created by working upon a set of inputs. Inputs are usually in the form of men, machine, money, materials etc. Production systems are usually classified on the basis of the following:

- Type of product,
- Type of production line,
- Rate of production,
- Equipments used etc.

They are broadly classified into three categories:

- Job shop production
- Batch production
- Mass production

Job Production

In this system products are made to satisfy a specific order. However that order may be produced-

- only once
- or at irregular time intervals as and when new order arrives
- or at regular time intervals to satisfy a continuous demand

The following are the important characteristics of job shop type production system:

- Machines and methods employed should be general purpose as product changes are quite frequent.
- Planning and control system should be flexible enough to deal with the frequent changes in product requirements.
- Man power should be skilled enough to deal with changing work conditions.
- Schedules are actually non existent in this system as no definite data is available on the product.
- In process inventory will usually be high as accurate plans and schedules do not exist.
- Product cost is normally high because of high material and labor costs.
- Grouping of machines is done on functional basis (i.e. as lathe section, milling section etc.)
- This system is very flexible as management has to manufacture varying product types.
- Material handling systems are also flexible to meet changing product requirements.

Batch Production

Batch production is the manufacture of a number of identical articles either to meet a specific order or to meet a continuous demand. Batch can be manufactured either-

- only once
- or repeatedly at irregular time intervals as and when demand arise
- or repeatedly at regular time intervals to satisfy a continuous demand The following are the important characteristics of batch type productionsystem:
- As final product is somewhat standard and manufactured in batches, economy of scale can be availed to some extent.
- Machines are grouped on functional basis similar to the job shop manufacturing.
- Semi automatic, special purpose automatic machines are generally used to take advantage of the similarity among the products.
- Labor should be skilled enough to work upon different product batches.
- In process inventory is usually high owing to the type of layout and material handling policies adopted.
- Semi automatic material handling systems are most appropriate in conjunction with the semi automatic machines.
- Normally production planning and control is difficult due to the odd size and non repetitive nature of order.

Mass Production

In mass production, same type of product is manufactured to meet the continuous demand of the product. Usually demand of the product is very high and market is going to sustain same demand for sufficiently long time.
The following are the important characteristics of mass production system:

- As same product is manufactured for sufficiently long time, machines can be laid down in order of processing sequence. Product type layout is most appropriate for mass production system.
- Standard methods and machines are used during part manufacture.

- Most of the equipments are semi automatic or automatic in nature.
- Material handling is also automatic (such as conveyors).
- Semi skilled workers are normally employed as most of the facilities are automatic.
- As product flows along a pre defined line, planning and control of the system is much easier.
- Cost of production is low owing to the high rate of production.
- In process inventories are low as production scheduling is simple and can be implemented with ease.

Goto

The **characteristics** or features of project production flows are as follows

The requirement of resources is not same (it varies). Generally, the resource requirement at the beginning is low. Then in mid of production, the requirement increases. Finally, it slows down when the project is near its completion phase.

Many agencies are involved in the project. Each agency performs specialized jobs. Here, coordination between agencies is important because all jobs are interrelated.

Delays take place in completion of projects due to its complexity and massiveness.

As routing and scheduling changes with fresh orders, proper inspection is required at each stage of production.

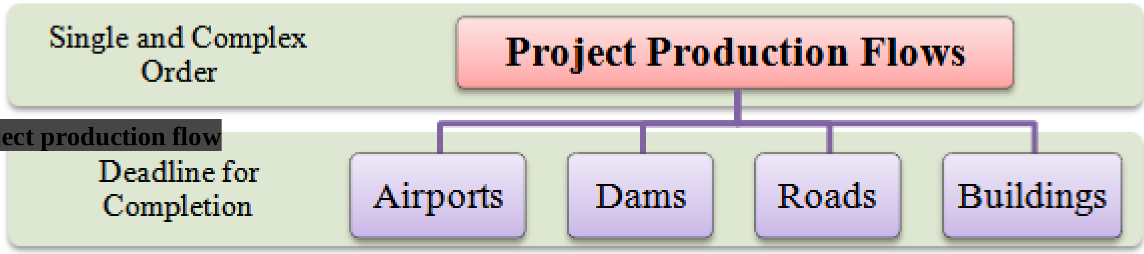
The production of items takes place in small lots. Sometimes only one product is produced at one time.

The items are manufactured strictly as per customer's specifications.

Highly skilled labour is required to perform specialized jobs.

There is disproportionate manufacturing cycle time. For e.g. the time needed to design the product may be more than the manufacturing time

Project production flow



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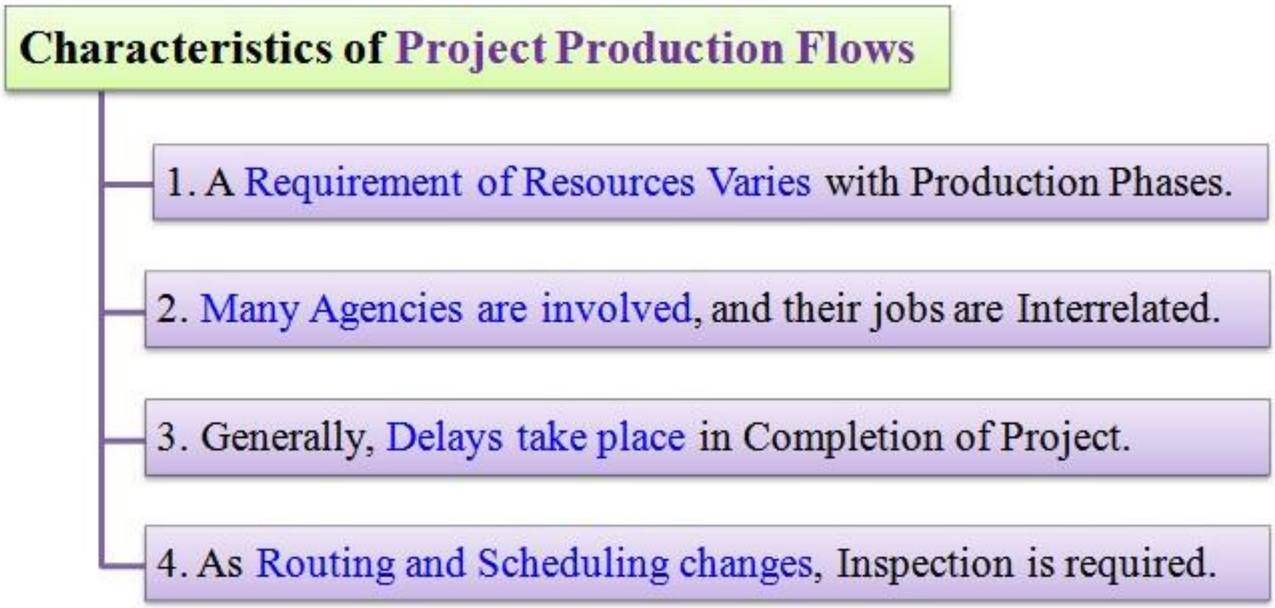
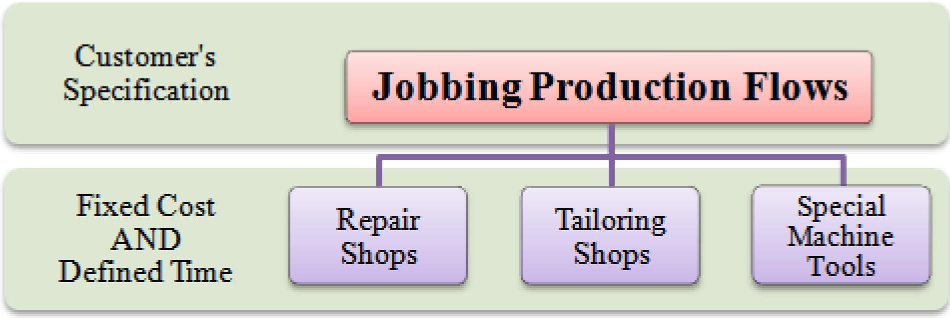
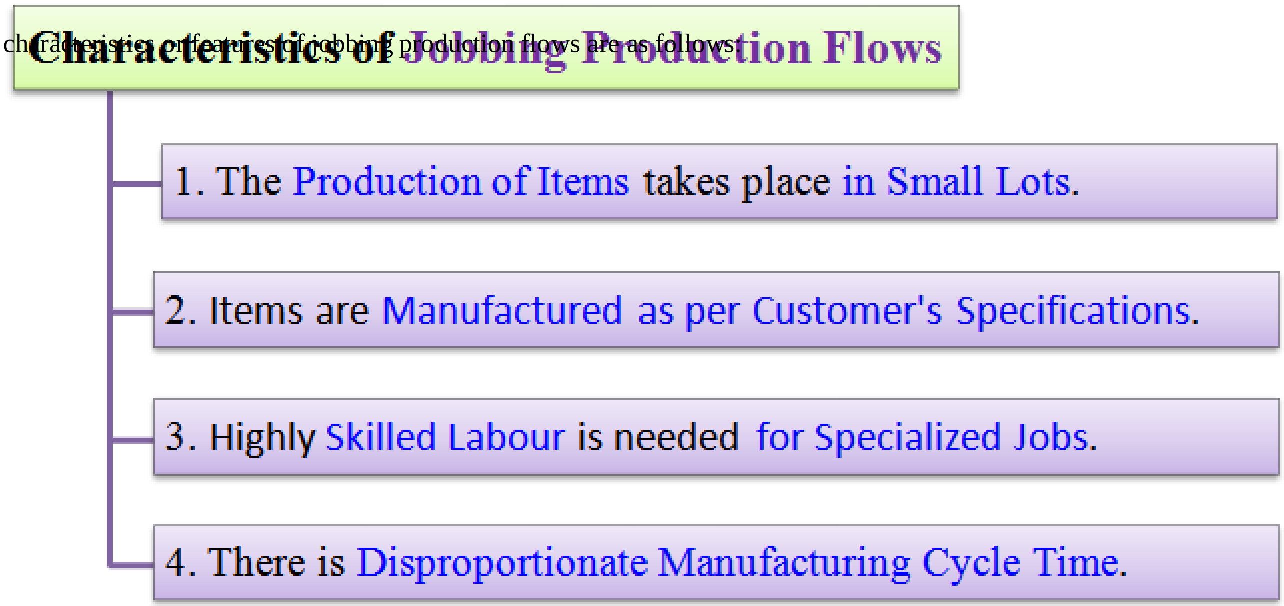


2. Jobbing production flows



The characteristics or features of jobbing production flows are as follows:



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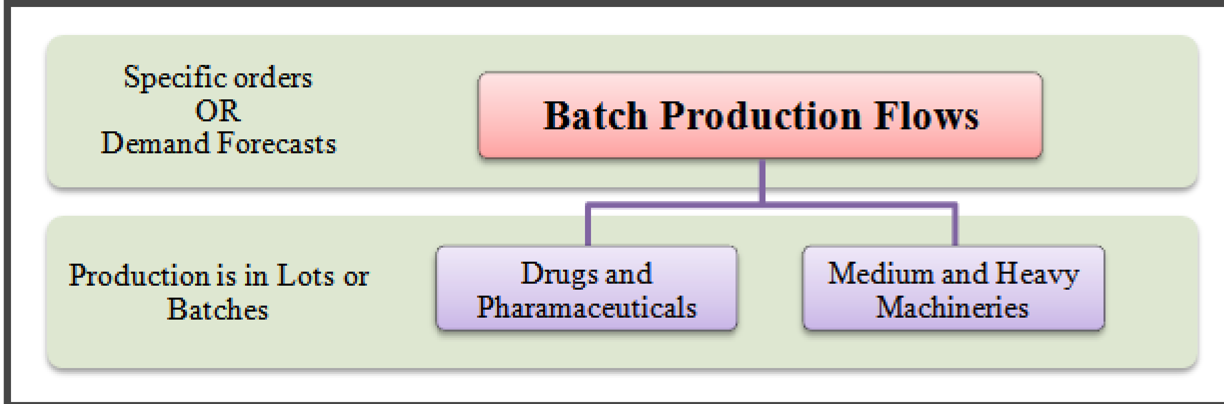
3. Batch production flows

In batch production flows, the production schedule is decided according to specific orders or are based on the demand forecasts. Here, the production of items takes place in lots or batches. A product is divided into different jobs. All jobs of one batch of production must be completed before starting the next batch of production.

Examples of batch production flows include, manufacturing of drugs and pharmaceuticals, medium and heavy machineries, etc.



The characteristics or features of batch production flows are as follows:

The products are made and kept in stock until their demand arises in the market.

General purpose machines and handling equipments, which can do many different jobs quickly are installed. This is because large varieties of items are to be produced.

There is a possibility of large work-in-progress due to many reasons.

There is a need for detailed production planning and control.

Assembly Line

An assembly line is a manufacturing process in which interchangeable parts are added to a product in a sequential manner to create an end product. In most cases, a manufacturing assembly line is a semi-automated system through which a product moves. At each station along the line some part of the production process takes place. The workers and machinery used to produce the item are stationary along the line and the product moves through the cycle, from start to finish.

Assembly line methods were originally introduced to increase factory productivity and efficiency. Advances in assembly line methods are made regularly as new and more efficient ways of achieving the goal of increased throughput (the number of products produced in a given period of time) are found. While assembly line methods apply primarily to manufacturing processes, business experts have also been known to apply these principles to other areas of business, from product development to management.

The introduction of the assembly line to American manufacturing floors in the early part of the twentieth century fundamentally transformed the character of production facilities and businesses throughout the nation. Thanks to the assembly line, production periods shortened, equipment costs accelerated, and labor and management alike endeavored to keep up with the changes.

Today, using modern assembly line methods, manufacturing has become a highly refined process in which value is added to parts along the line. Increasingly, assembly line manufacturing is characterized by "concurrent processes"—multiple parallel activities that feed into a final assembly stage. These processes require sophisticated communications systems, material flow plans, and production schedules. The fact that the assembly line system is a single, large system means that failures at one point in the "line" cause slowdowns and repercussions from that point forward. Keeping the entire system running smoothly requires a great deal of coordination between the parts of the system.

Computer power has enabled tracking systems to become more sophisticated and this, in turn, has made it possible to reduce the costs associated with holding inventories. Just-in-time (JIT) manufacturing methods have been developed to reduce the cost of carrying parts and supplies as inventory. Under a JIT system, manufacturing plants carry only one or a few days' worth of inventory in the plant, relying on suppliers to provide parts and materials on an "as needed" basis. Future developments in this area may include suppliers establishing operations within the manufacturing facility itself or increased electronic links between manufacturers and suppliers to provide for a more efficient supply of materials and parts.

VARIATIONS IN ASSEMBLY LINE METHODOLOGIES

The passage of years has brought numerous variations in assembly line methodologies. These new wrinkles can be traced back not only to general improvements in technology and planning, but to factors that are unique to each company or industry. Capital limitations, for example, can have a big impact on a small business's blueprint for introducing or improving assembly line production methods, while changes in international competition, operating regulations, and availability of materials can all influence the assembly line picture of entire industries. Following are brief descriptions of assembly line methods that are currently enjoying some degree of popularity in the manufacturing world.

- Modular Assembly—This is an advanced assembly line method that is designed to improve throughput by increasing the efficiency of parallel subassembly lines feeding into the final assembly line. As applied to automobile manufacturing, modular assembly would involve assembling separate modules—chassis, interior, body—on their own assembly lines, thenjoining them together on a final assembly line.

- Cell Manufacturing—This production method has evolved out of increased ability of machines to perform multiple tasks. Cell operators can handle three or four tasks, and robots are used for such operations as materials handling and welding. Cells of machines can be run by one operator or a multi-person work cell. In these machine cells it is possible to link older machines with newer ones, thus reducing the amount of investment required for new machinery.

- Team Production—Team-oriented production is another development in assembly line methods. Where workers used to work at one- or two-person work stations and perform repetitive tasks, now teams of workers can follow a job down the assembly line through its final quality checks. The team production approach has been hailed by supporters as one that creates greater worker involvement in the manufacturing process and knowledge of the system.
- U-shaped assembly "line"—A line may not be the most efficient shape in which to organize an assembly line. On a U-shaped line, or curve, workers are collected on the inside of the curve and communication is easier than along the length of a straight line. Assemblers can see each process; what is coming and how fast; and one person can perform multiple operations. Also, workstations along the "line" are able to produce multiple product designs simultaneously, making the facility as a whole more flexible. Changeovers are easier in a U-shaped line as well and, with better communication between workers, cross-training is also simplified. The benefits of the U-shaped line have served to increase their use widely.

As new assembly line methods are introduced into manufacturing processes, business managers look at the techniques for possible application to other areas of business. One such application is called Joint Application Development, or JAD. It is a process originally developed for designing a computer-based system. It brings together those working in business areas and those working in the information technology area into a single workshop. The advantages of JAD include a dramatic shortening of the time it takes to complete a project. The JAD process does for computer systems development what Henry Ford did for the manufacture of automobiles (a method of organizing machinery, materials, and labor so that a car could be put together much faster and cheaper than ever before—the assembly line).

In a similar way the fundamentals of assembly line theory have been applied to business processes with success. These new methods of organizing work all share the common goal of improving throughput by reducing the amount of time individual workers and their machines spend on specific tasks. By reducing the amount of time required to produce an item, assembly line methods have made it possible to produce more with less.

the January–February, 1979, issue of HBR, we reviewed the concept of the "process life cycle," in contrast with the more familiar "product life cycle," and suggested that a framework that incorporates both concepts provides a more useful vehicle for exploring strategy options than does a framework based on only one of them.[1] We proposed the "product-process matrix" as a way of combining these concepts into a framework for describing alternative business strategies and examining their implications for the company's manufacturing organization.

In our earlier article, we limited ourselves essentially to exploring issues related to corporate "positioning" on

the matrix; that is, to choosing how a company prefers to compete (see Exhibit I):

EXHIBIT I Matching Major Stages of Product and Process Life Cycles

Process structure / Process life cycle stage	Product structure / Product life cycle stage: I Low volume–low standardization, one of a kind	II Multiple products low volume	III Few major products higher volume	IV High volume–high standardization, commodity products
I Jumble flow (job shop)	**Commercial printer**			**None**
II Disconnected line flow (batch)		**Heavy equipment**		
III Connected line flow (assembly line)			**Automobile assembly**	
IV Continuous flow	**None**			**Sugar refinery**

Exhibit I Matching Major Stages of Product and Process Life Cycles

- To the left or to the right of the matrix diagonal (implying, respectively, greater product diversity and more rapid product change, or fewer, more stable products).
- Above or below the matrix diagonal (implying either flexible, less capital-intensive processes or more mechanized, cost-efficient, and rigid processes).

We next examined the familiar concept of distinctive competence—the notion that each company should identify and exploit those resources, skills, and organizational characteristics that give it a comparative advantage over its competitors—and we used this concept to link a company's manufacturing competence with its product and market competence.

We also considered the management implications of selecting a product and a process position vis-à-vis others in the industry. While related to a company's distinctive competence, this choice reflects the added dimension of viability and dominance in considering various positions on the matrix.

Finally, we explored the problems that multidivisional companies face when their different divisions position themselves in different areas of the matrix. We suggested ways in which such companies might organize their manufacturing functions to better cope with such diversity.

If nothing changed in the world, this matrix framework might serve only as an interesting adjunct to more traditional strategy formulation models—adding a nuance here and some extra insight there. The problem for corporate management is that everything is always changing, and simultaneously. Markets are evolving and maturing, processes are undergoing technological change, and costs and prices are continually being buffeted by forces ranging from the Organization of Petroleum Exporting Countries (OPEC) to the operating changes that result in the learning curve.

The impact of such external forces is often to change a company's position on the matrix, relative to many of its competitors, whether or not the company makes any changes in its own product or process structures. If such changes and their implications go unrecognized, the result can be a series of severe internal problems. These problems cannot be "managed away," typically, since they arise out of basic structural inconsistencies and inadequacies. Good managers who are assigned to deal with them may become sacrificial lambs.

In our observation of a number of manufacturing companies that have gotten into trouble, we have been struck by the sense of aimlessness, the low esprit de corps, and the lack of perspective that usually tend to permeate them. While there may be a variety of causes for their problems, two stand out as being particularly important. The first is that coordination and mutual understanding between the marketing and manufacturing functions have broken down. Second, one or both functions have lost their sense of focus; they no longer feel the sense of competence and the implicit understanding of priorities that come when both marketing and manufacturing know they are doing something that the company is particularly good at and that the market desires.

Change in Position

The framework of the product-process matrix concept provides an excellent vehicle for understanding why these problems occur and how they can be minimized. No matter how tightly focused and coordinated a company might be, any change in the relative positioning of either its products or its production processes will expose it to two kinds of danger.

The first follows a change in either dimension without a corresponding change in the other so that there is a reduction in focus and increased difficulty in coordinating manufacturing and marketing.

A company that automates its production process without understanding the problems that such automation is likely to cause for its marketing organization is laying the groundwork for a potentially acrimonious future relationship between the two functions. It is also impairing its ability to compete as effectively as can companies that have coordinated and matched more closely the changes in their product and process structures.

The second difficulty, possibly even more dangerous than the first, follows when a company tries to respond to a change on one dimension by broadening its activity on the other; such as responding to a product shift, not with a corresponding shift in the production process but by adding an additional process.

Loss of Focus

The need for focus is quite well understood by marketing people. They segment markets and design products, prices, promotional strategies, and sales organizations to meet the specific imperatives of each segment. If the needs of one segment are quite different from those of another, they do not hesitate to pursue different strategies, and they often use different people in responding to these needs. Concentrating on a restricted segment of activities is just as important in manufacturing, but unfortunately the resistance to piecemeal changes and incremental expansion tends often to be lower there.

The packaging operation of a major consumer products manufacturer provides an illustration of this latter difficulty. The sole reason for the division's existence in the corporation was to offer a low-cost source for a highly specialized packaging product. This division, which was evaluated as a profit center, found that it could increase its revenues and profits considerably if it augmented its basic product lines with some new, less standardized, higher priced products. However, as the division pursued this additional business, it encountered pressure to change its process so that it could better meet the needs of its new customers. Responding to such pressures, the division began to dilute the focus it had maintained for several years.

Another example is a company that found its standardized product line being challenged by other, more marketing-oriented companies that were seeking to segment the market and target specialized forms of the product for each segment. When the company responded by expanding its own line to offer specialized products, it found that its high-volume, standardized production processes were not economical at those lower volumes and that it could not compete effectively with other companies which had designed their processes for the specific volume and product standardization of their segments of the market.

In both of these examples, if the company had considered coordinated, compensating changes in both the product and the process dimensions, it would have selected options that maintained or increased its competitive competence rather than simply tried to broaden its activity on one dimension or the other, which diluted its past competence.

While the matrix concept can explain the causes of many failures in previously healthy companies, it can provide even more useful insights for planning product and process changes. Since planning for growth concentrates management attention on decisions regarding both product and process activities, growth is a natural framework for the next segment of this discussion.

INTERRELATIONSHIP BETWEEN PRODUCT AND PROCESS LIFE CYCLE

Planning for Growth

Companies typically pursue four major types of growth. Going from the simpler types to the more complex, these can be summarized as follows:

1. Simple growth of sales volume within an existing product line and market.

2. Expansion of the product line within a single market, using an existing process structure (often called product proliferation).

3. Expansion of the process structure (usually termed vertical integration).

4. Expansion into new products and markets.

While other forms of growth exist, they can generally be viewed as variations or combinations of these four types. Thus an understanding of the demands that each might place on manufacturing and marketing can do much to aid in planning for continued coordination and focus of these functions.

Type 1: Simple Growth

The simplest form of growth consists of increased volume that is met with an existing product line and existing production process. This type of growth opportunity requires that extremely stable conditions exist—in terms of competitors, technology, and market tastes—with the only change occurring in the size of the market.

Unfortunately, such conditions are the exception rather than the rule, and thus even when a company limits itself to fairly narrow product and process activities, periodic changes will be required as markets and technologies mature.

In the context of a single product line and a single process structure, incremental changes in each reflect a type of simple growth. However, the company must now make two kinds of decisions. The first relates to both the entrance and the exit strategies for a specific market, and the second to the strategy to be pursued while the company is participating in that market. The matrix concept is useful for examining and planning for both of these.

Entrance-exit strategies. In the first area, the company tends to follow one of four entrance-exit strategies. In summary, the company:

A. Enters early and then, when technology stabilizes, profit margins narrow, and the larger companies following strategy C begin to appear, it leaves that product and attempts to exploit the company's superior flexibility and technological skills in the introductory phases of some new product.

B. Enters early and grows up with the industry, seeking to be a major factor in the business throughout the product's entire life cycle.

C. Waits on the sidelines until some degree of product and process stabilization has occurred and then enters the industry, so that it can better exploit its more massive production, distribution, and marketing resources.

D. Waits to enter, anticipating that it is following strategy C, but when it does enter, fails to gain a sustainable market position and consequently chooses to withdraw without having made an adequate return on its investment.

As shown in Exhibit II, the four segments of the product-market dimension of the matrix can be used to form a Latin square representing the combinations of entrance and exit strategies available to a company.

EXHIBIT II Combinations of Entrance and Exit Strategies

Entrance strategy	Exit strategy	
	Maturity	Decline
Rapid Growth	D Mistake	C Efficient, standardize, high volume
Start-Up	A Innovative, flexible	B Starts flexible, shifts to standardized and high volume

Exhibit II Combinations of Entrance and Exit Strategies

Until relatively recently, strategy B was considered the “normal” or most desirable, while A and C were examples of either lost nerve or lucky accidents, respectively. The model of a successful company was one that developed a new product that became the basis for a major industry and then “rode on its back” to success.

Polaroid and Xerox provide classic examples.

But such a strategy can put an enormous strain on a company, particularly when its industry matures rapidly. The same people who managed the introduction of the new product may be called on to manage its evolution into a commodity item. The type of production process, the level of capital intensity, the marketing skills, the distribution channels, in fact the whole personality of the company, must undergo profound change in the space of a relatively few years.

An example of such change is provided by the microwave oven business. As the market leader since the early 1960s, Litton Industries Atherton Division has emphasized flexibility in its production facilities to respond to the frequent product changes required by a young, rapidly growing market.

With the maturing of the market expected in the late 1970s, however, the entry of more traditional appliance manufacturers, and increased competition from Japanese imports, Litton recently has been forced to review its earlier policies as to how far it should move toward vertical integration and more automated production processes. By the early 1980s, Litton-Atherton will be a very different company, requiring different skills, organizational practices, and probably a different management style, if it is to continue to mature with the market successfully and maintain its earlier position.

Strategy C is particularly favored by large national or multinational companies whose production systems emphasize high, stable volumes and low, variable costs. These companies can exploit their large sales forces’ distribution channels, advertising expertise, and overall "market clout," and they have easy access to capital markets for the funds required by the scale and capital intensity of their mode of competition.

A number of large companies which were seduced by the "go go" atmosphere of the late 1960s into entering small, rapidly changing markets found to their regret that they simply were not very good—or, at best, no better—than the smaller companies which were competing in the same markets. Most of them have since retreated to doing the things they can do best.

Although strategy A is still regarded largely as a strategy for the "little guys," it is becoming increasingly attractive to companies that prefer not to compete in high-volume—low-margin businesses, and to many highly diversified companies whose managers look on their job as one of managing a portfolio of assets. The managers of such companies are willing to use the cash flow from mature products, at the end of their product life cycles, to finance the growth and success of products or subsidiaries in earlier stages, and to liquidate such products (and often their associated companies) entirely when they can no longer meet the company's profitability goals.

Strategy D, of entering late and leaving early, is probably never pursued intentionally, since there is not sufficient time to reap the rewards necessary to justify the initial investment. Nevertheless, this strategy is seen from time to time, as illustrated by the experience in calculators of Rockwell International.

In 1974 Rockwell entered the calculator business but exited only a couple of years later, having failed to gain a tenable position in that industry. Rockwell had several problems, but these may simply represent the cumulative challenges a company faces by waiting to enter a business until the industry has proceeded far down the diagonal. Even with relative success, the costs associated with starting up a high-volume operation at that stage can be substantial, as Kodak's entry into instant photography illustrates.

A further form of late entry difficulty that the matrix concept clarifies is entry into the lower right quadrant with a totally new production process. Since the product is already a commodity item, the process must be continuous and highly efficient to be competitive. Successful entry at this point would be extremely challenging with a proved process but is doubly so if a new process must be developed without the benefit of passing incrementally through the early stages of the process life cycle. Recent efforts at coal gasification and oil shale processing appear to be examples of this.

Paths on the matrix. Once a company selects an entrance-exit strategy for a market, management must select a strategy for both product and process developments. While these must be based in part on assessments of how the market will develop and competitors will react, management should consider a variety of strategies. One way to view these options is as possible paths on the matrix.

An industry usually progresses down the diagonal of the matrix. Of course, if this always occurred, it would be possible to collapse the two-dimensional matrix into a single dimension and to base analyses and projections on either a product life cycle or a process life cycle footing. But, even though movement along the diagonal is the composite pattern (the industry average, in a sense), it is a much less likely pattern for any individual company to follow. This is because companies tend to make only one kind of change at a time—either a product structure change or a process structure change.

At a given point a company will usually face a clear choice either between alternative product structures, given an existing production process structure, or between alternative process structures for producing an existing product structure. Progression down the diagonal, *if* it occurs, therefore usually involves a series of roughly alternating vertical and horizontal steps.

Moreover, both the size and the frequency of these steps are dictated more by the rate of product maturation and technological innovation than by corporate wishes. As a result, it is seldom possible to move smoothly down the diagonal. A company can, however, through consistency in its decisions over time, “lean” in one direction or the other—moving roughly parallel to the diagonal but either above or below it—or attempt to stay as close to the diagonal as possible.

There is no best choice; it is simply a matter of corporate preference for one mode of competitive behavior or another. Maintaining a position above the diagonal will maintain flexibility to change products, production volumes, and processes quickly, and will reduce the company’s capital needs. However, it will make the company vulnerable to competitors who can undercut its price, offer greater delivery dependability and, possibly, tighter product specifications as well.

If the product life cycle moves too rapidly toward fewer, more standard products, such companies may suddenly find themselves too far above the diagonal, with old, outmoded, inefficient, high-cost plants and unneeded product and volume flexibility.

Nor is it necessarily preferable for a company to try to position itself below the diagonal. The appropriateness of such a strategy depends highly on how rapid and inexorable the product’s evolution along the product life cycle is. Moving vertically down the process dimension usually implies a reduction in cost per unit but an increase in capital investment and the breakeven point. As long as there is no major change in the design of individual products, or the volume mix across products in the product line, a company may achieve a significant competitive advantage from such a decision.

Conversely, seeking to maintain a position below the diagonal can lock the company into a set of facilities and manufacturing capabilities that will make it difficult to respond to the market changes that usually accompany movement along the product life cycle. Moreover, if the product progresses too rapidly, the company may not receive its expected return from an investment in increased mechanization until after the next step in product evolution renders it obsolete. This explains why the required investment payback period in the electronics industry is typically less than 18 months and sometimes as low as 6 months, while it is typically 8 years or more in the steel and oil industries.

A company also has to protect itself against the possibility of the product life cycle "reversing direction" after it has moved toward a more standardized production process. This is the familiar phenomenon of product proliferation that companies often succumb to when trying to stimulate sales in a relatively mature market.

This can cause a company's manufacturing strengths to become incompatible with its marketing strategy,

particularly if it was already below the diagonal before the shift.

William Abernathy's research in the automobile industry has suggested that product innovation tends to lead in the early stages of the product's progression through the product life cycle, while process innovation takes the lead later on.[2] Although this analysis may hold in the majority of cases, a number of counter-examples can be identified. These suggest that innovation may follow a much more intricate pattern, with process and product interchanging leadership roles more than once.

An example of such a pattern in the electronics industry is the radio. It followed the standard life cycle until about 1955, when a process innovation (printed circuit boards using transistors) produced the miniature battery-powered radio, and product innovation (FM and stereo receivers) followed. Recently, another process innovation (micro circuitry) has resulted in the development of another product, the low-cost CB radio (a transmitter as well as a receiver). For the radio, maturity appears to have been a transitory phenomenon.

The Model T Ford provides another example of a product that was rushed to maturity. When Alfred P. Sloan of General Motors competed against this commodity product by offering product variety, he caused the industry to be reborn. A recent HBR article argues that such rebirth—the ability to create variety in a standard product, which in effect is moving it back along the product life cycle continuum—is the key to success for marketing organizations.[3]

A related issue that is perhaps even more interesting is determining why some products never seem to complete their progression down the matrix diagonal. Instead, they appear to have stalled at some point. Classic examples are home building and furniture, both of which seem to be victims of an arrested product development. Processes already exist that would carry both products further down the diagonal if increased product standardization were to be allowed by the consumer. In the case of home building, this appeared to become possible with the popularization of the mobile home, but, if anything, this product has become *less* standardized over the past decade. The mobile home industry now finds itself in the same frustrating predicament as the more traditional home industry.

Once an industry stops progressing (other examples include construction equipment, sailboats, and clothing), a key question is how it can get started again. The answer to that question does not appear to lie in process innovation, given the abortive attempts in both home building (modular homes built from plastic or metal components) and furniture (molded or pressed plastic forms). The failure of these industries to achieve the systematic efficiency of the auto industry is not due to the lack of process opportunities but to the inability of the market to standardize.

As might be expected, as a company moves too far away from the matrix diagonal in either direction, it becomes increasingly dissimilar from its competitors. This may or may not (depending on its success in exploiting the advantages of its niche), make it more vulnerable to their attacks. This position may also make coordinating marketing with manufacturing more difficult, since the two functions will develop different skills and priorities and will tend to respond to different sorts of opportunities.

Not infrequently, companies find that, either inadvertently or by conscious choice, they have become “outliers” on the matrix and must consider drastic remedial action. Most small companies that enter a mature industry start off as outliers, of course, and therefore they have to solve the problems associated with moving closer to the matrix diagonal at the same time they are coping with the usual small company problems of lack of working capital, lack of management depth, and the conflict between entrepreneurial and bureaucratic management styles.

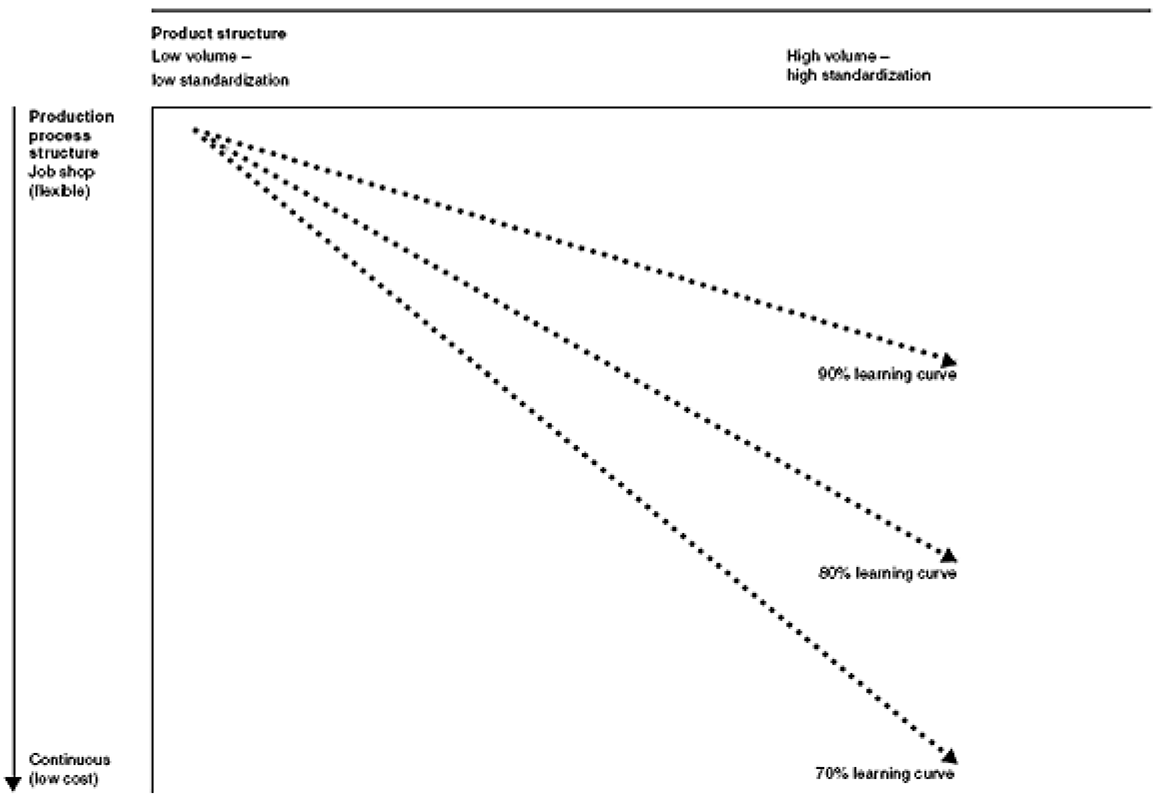
Learning curve. A final aspect of the movement along both the product and the process dimensions of the matrix that is particularly relevant for a company planning the simple Type 1 growth is the notion of learning. Some companies have used the so-called experience effect, or learning curve, which argues that product costs (in constant dollars) should decline at a steady rate every time cumulative production volume doubles, as the basis for their competitive strategy.[4] This learning phenomenon explains, for example, why companies with higher market shares tend to be more profitable (as measured in terms of return on investment) than their competitors.[5] Unfortunately, the term *learning curve strategy* suggests a black-or-white choice: one either follows it or one does not.

Progression along the product life cycle alone, without any change in the process used (i.e., proceeding horizontally across the matrix), would still provide numerous opportunities for cost reduction—through product redesign, product-line simplification, development of improved raw materials and parts, increased sales volume, use of less costly distribution channels, and the fact that over time the whole organization simply learns to do its job better.

Similarly, moving vertically down the matrix provides other cost-reduction opportunities, through economies of scale, improved materials-handling technology, and better tools and equipment as well as reduced labor costs through automation. What is called the experience curve is simply the combination of these two effects resulting in movement down the matrix diagonal. In other words, the experience curve depicts the total improvement in unit costs obtainable by combining product evolution with process evolution.

A company that prefers to follow a path above the diagonal (see Exhibit III) will thereby limit its cost- reduction opportunities, so that, when it reaches a given level of product standardization, it may be able to reduce its unit cost only 90% of its previous value after each doubling of cumulative volume. It will, however, preserve its flexibility to follow market movements quickly, and it will limit its capital investment.

EXHIBIT III Possible Learning Curve Strategies



Note: An 80% learning curve implies that unit costs will be reduced to 80% of their previous value each time cumulative volume doubles.

Exhibit III Possible Learning Curve Strategies > Note: An 80% learning curve implies that unit costs will be reduced to 80% of their previous value each time cumulative volume doubles.

A company that chooses to follow a path below the diagonal may achieve even greater cost reductions for a given level of product standardization than those pursuing a path on the diagonal. The danger of this strategy is that those cost reductions may make the company very inflexible to product changes, and the benefits may be short lived.

A company that follows a more balanced progression of product and process changes so as to remain near the matrix diagonal can often achieve faster rates of learning than those consistently above it but slower rates of learning than those below it. However, such an approach takes advantage of potential cost improvements coming from both dimensions while maintaining flexibility to respond to market shifts. For many companies, this flexibility is worth the forgone cost improvements available through more aggressive pursuit of process standardization.

As with the other aspects of strategy examined in this article, no single answer fits all companies. The best strategy for a given company will depend on its resources, skills, market situation, competitive pressures, and general business philosophy.

The real issue is not whether learning improvements will be pursued as *the* driving force for marketing and production decisions but rather the degree to which such improvement possibilities will guide management's actions. Depending on whether a company seeks simple Type 1 growth by pursuing product and process movements on the diagonal, rather than above or below it, will largely determine the learning improvements that are likely to be realized.

Type 2: Product Growth

In the context of our matrix, this type of growth represents a broadening of the product line. Such growth can occur in two ways. One is by adding more standardized products while maintaining existing, less standardized products. The addition of new products, combined with a reluctance to drop a part of the product line, represents a shift to the left on the product dimension. Marketing believes that "good service" requires a "full line." Manufacturing thinks that almost any sale can be shown to make a net contribution to overhead and fixed costs. As a result, even when a company is at capacity, it can sometimes be extremely difficult to get a consensus on a decision to narrow the product line.

The other way that this type of growth can occur is to add special features to an existing, more standardized product line. Such product expansion also represents movement on the matrix from right to left that goes against the prevailing current of the product life cycle (which assumes continual standardization of products). This is often a cyclical problem in capital intensive industries as companies seek to use existing capacity to meet the specialized needs of a number of secondary markets

The real danger of such product proliferation growth, as many companies know too well, is that it may cause the company's product structure to put unreasonable strains on its production processes. To avoid such problems, management must add products selectively and take actions related to physical facilities, organizational structures, and operating procedures that will compensate for many of these strains. (We discussed these and other actions in our earlier article.)

Type 3: Vertical Integration

Growth based on broadening the scope of the production process (vertical integration) can also be understood more clearly by using our matrix. In a manner analogous to product proliferation, this form of growth occurs when a company maintains existing processes and adds either less standardized, more flexible processes (forward integration) or more standardized, less flexible processes (backward integration) in hopes of either increasing sales volume and market responsiveness or reducing costs and improving dependability.

The problems that companies often encounter when they vertically integrate, even in the simplest case where they begin making a part that they formerly bought from an outside supplier, can be significant. What is usually involved is not simply an expansion of the company's processes but the production of a completely different product that may be at a very different point on the matrix.

In other words, the company may have to think in terms of an additional matrix for that component part or raw material and develop strategies for it that are very different from those selected for the original end product. If this is not done, the company may be tempted to produce the new part with a process and an organizational structure that are completely inappropriate.

An example of one approach to this problem is provided by the experience of the Trus Joist Corporation, which manufactures custom floor and roof support systems for both residential and commercial construction.

Before 1970, the company used sawed lumber as the major raw material in its joist products, which were fabricated and assembled in a number of regional plants. These small, flexible plants were consistent with the company's product line and markets and its made-to-order strategy. However, when it developed and introduced Micro-Lam, a unique laminated structural material, as a replacement to sawed lumber in many of its products, the company's span of process became much broader than it had been.

Given the capital intensity of the Micro-Lam production process and its high degree of standardization, Trus Joist chose to separate the two stages of its production process and to organize itself as if it were in two separate markets, even though it anticipated using all of its Micro-Lam output as raw material for its joist plants.

Type 4: New Markets

Growth through expansion into new markets, Type 4, is even more difficult to deal with than the other three types, because it may follow any of several paths. If the company can avoid product proliferation, for example, market expansion may simply imply an increase in scale (Type 1 growth). Alternatively, a company may want to reflect the individual requirements of the new market by creating a new matrix for it and plotting a separate strategy for that market. This mirrors the approach followed by Trus Joist when it broadened its process.

More commonly, a company's involvement in a new market subjects it to pressures to expand its product line—in effect, to retreat horizontally on the matrix. This creates a situation that most companies find particularly difficult to deal with, because both the production and the marketing sides of the business encounter problems (different, but complementary) at about the same time—marketing because it is trying to adapt itself to a new market for which its process is not adequately suited, and production because it is trying to adapt to new products that put analogous strains on its process.

This situation often leads to what can be described as the "creeping breakeven" phenomenon. In an effort to stimulate demand, a company enters a new market or introduces a new product. This step is successful at first, but the existing process is incapable of meeting the added scale and complexity without additional investment (more capacity, different equipment, more make rather than buy, or a more powerful inventory control system). Success tends to breed failure. The increased investment raises the company's breakeven point, offsetting the expected gains from the increased sales volume. This motivates the company to pursue additional markets and products so as to break out of the box in which it finds itself.

UNIT –II

SCHEDULING AND CONTROL OF PRODUCTION OPERATIONS

Aggregate planning is an "intermediate-range capacity planning technique, usually covering a time frame of 2-12 months for a production process, in order to keep the costs of operations at a minimum." Companies use aggregate planning to help make decisions about their capacity because seasonal variations in demand are difficult to predict accurately. The main goal of the company is to match resources with the expected demand. This goal is achieved by taking into account a diverse amount of factors such as: decisions on output rates, overtime, employment levels and changes, inventory levels and changes, backorders ,and subcontracting work.

A more extensive form of aggregate planning is sales and operations planning. *Sales and operations planning* are "intermediate-range decisions to balance supply and demand, integrating financial and operations planning". Sales and operations planning decisions are made using demand forecasts, financial limits, and organization's capacity constraints. The sales and operations plan carries information that impacts the supply chain.

Factors Affecting Aggregate Planning

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- A complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

Aggregate planning will ensure that organization can plan for workforce level, inventory level and production rate in line with its strategic goal and objective.

Aggregate planning as an Operational Tool

Aggregate planning helps achieve balance between operation goal, financial goal and overall strategic objective of the organization. It serves as a platform to manage capacity and demand planning.

In a scenario where demand is not matching the capacity, an organization can try to balance both by pricing, promotion, order management and new demand creation.

In scenario where capacity is not matching demand, an organization can try to balance the both by various alternatives such as.

- Laying off/hiring excess/inadequate excess/inadequate excess/inadequate workforce until demand decrease/increase.
- Including overtime as part of scheduling there by creating additional capacity.
- Hiring a temporary workforce for a fix period or outsourcing activity to a sub-contrator.

Importance of Aggregate Planning

Aggregate planning plays an important part in achieving long-term objectives of the organization. Aggregate planning helps in:

- Achieving financial goals by reducing overall variable cost and improving the bottom line
- Maximum utilization of the available production facility
- Provide customer delight by matching demand and reducing wait time for customers
- Reduce investment in inventory stocking
- Able to meet scheduling goals there by creating a happy and satisfied work force

Aggregate Planning Strategies

There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. **Level Strategy**

As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to increase or decrease production in anticipation of lower or higher customer demand. Advantage of level strategy is steady workforce. Disadvantage of level strategy is high inventory and increase back logs.

2. **Chase Strategy**

As the name suggests, chase strategy looks to dynamically match demand with production. Advantage of chase strategy is lower inventory levels and back logs. Disadvantage is lower productivity, quality and depressed work force.

3. Hybrid Strategy

As the name suggests, hybrid strategy looks to balance between level strategy and chase strategy.

Scheduling is an important tool for **manufacturing** and engineering, where it can have a major impact on the productivity of a process. In manufacturing, the purpose of scheduling is to minimize the production time and costs, by telling a production facility **what to make, when, with which resource**, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs.

Production scheduling provides scheduler with powerful graphical interfaces which can be used to visually optimize real-time workloads in various stages of production, and pattern recognition allows the software to automatically create scheduling opportunities which might not be apparent without this view into the data.

For example, an airline might wish to minimize the number of airport gates required for its aircraft, in order to reduce costs, and scheduling software can allow the planners to see how this can be done, by analyzing time tables, aircraft usage, or the flow of passengers.

MASTER PRODUCTION SCHEDULE (MPS): AN OVERVIEW

A Master Production Schedule (MPS) is a plan for production, staffing, inventory and resources. It is usually linked to manufacturing where the plan indicates when and how much of each product will be demanded. This plan quantifies significant processes, parts, and other resources in order to optimize production, to identify bottlenecks, and to anticipate needs and completed goods.

Master Production Scheduler’s schedules every possible aspect of production such as forecast demand, production costs, inventory costs, lead time, working hours, capacity, inventory levels, available storage, and parts supply. The MPS is a statement of what the company expects to produce and purchase(i.e. quantity to be produced, staffing levels, dates, available to promise and projected balance).

The MPS translates the business plan, including forecast demand, into a production plan using planned orders in a true multi-level optional component scheduling environment. Using MPS helps avoid shortages, costly expediting, last minute scheduling, and inefficient allocation of resources. Working with MPS allows businesses to con solidate planned parts, produce master schedules and forecasts for any level of the Bill of Material (BOM) for any type of part.

Scheduling Types

Companies use backward and forward scheduling to allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

Forward scheduling is planning the tasks from the date resources become available to determine the shipping date or the due date.

Backward scheduling is planning the tasks from the due date or required-by date to determine the start date and/or any changes in capacity required.

MPS Purpose & Relationship

The Master Schedule’s primary purpose is to translate the strategic initiatives of top manage ment into workable day to-day actions that result in making and shipping products to customers, providing service and earning their satisfaction. MPS relationships between three important processes**:** Master Planning, Detail Planning and Planning Execution.

Supporting these three processes is the Information System represented by the Bills of Material, Inventory, Process/Routings and other important data bases. Holding all these processes together are the linkages and feedback loops that show how information flows between each functional area. The gauge for finding out the effectiveness of the total process is Performance Measurement.

- **Master Production Schedule Planning (MPS)**
- **Material Resource Planning (MRP)**
- **Capacity Requirements Planning (CRP)**

Master scheduling (MS) calculates the quantity required to meet demand requirements from all sources. Material requirements planning (MRP) is used to calculate the quantity required. The MS enables marketing to make legitimate delivery commitments to field warehouses and final customers. It enables production to evaluate capacity requirements in a more detailed manner. It also provides the necessary information for production and marketing to agree on a course of action when customer requests cannot be met by normal capacity.

Finally, it provides to management the opportunity to ascertain whether the business plan and its strategic objectives will be achieved.

Benefits of MPS · Production plan with resource, schedule and available inventory (It all starts with what do we want to make, when do we want to make, what does it take to make it, What we have got)

- Increased visibility and operational control
- Process change-over reduction
- Translates a business plan with forecasted demand
- Inventory reduction, leveling
- Reduced production bottlenecks and idle equipment – Reduce manual and inconsistent scheduling efforts at each production level
- Increase production efficiency- Increased resource utilization and lowered manufacturing costs
- Labor load leveling
- Accurate delivery date quotes – Improved on-time delivery performance

Real time information

OPERATIONS SCHEDULING

Scheduling pertains to establishing both the timing and use of resources within an organization. Under the operations function (both manufacturing and services), scheduling relates to use of equipment and facilities, the scheduling of human activities, and receipt of materials.

While issues relating to facility location and plant and equipment acquisition are considered long term and aggregate planning is considered intermediate term, operations scheduling is considered to be a short-term issue. As such, in the decision-making hierarchy, scheduling is usually the final step in the transformation process before the actual output (e.g., finished goods) is produced. Consequently, scheduling decisions are made within the constraints established by these longer term decisions . generally s che duling obje ctive s de a ls with trade offs among conflicting goa ls for efficie nt utiliza tion of labor a nd e quipme nt, lea d time , inve ntory le ve ls, a nd processing time s .

Byron Finch notes that effective scheduling has recently increased in importance. This increase is due in part to the popularity of lean manufacturing and just-in-time. The resulting drop in inventory levels and subsequent increased replenishment frequency has greatly increased the probability of the occurrence of stock-outs. In addition, the Internet has increased pressure to schedule effectively. "Business to customer" (B2C) and "business to business" (B2B) relationships have drastically reduced the time needed to compare prices, check product availability, make the purchase, etc. Such instantaneous transactions have increased the expectations of customers, thereby, making effective scheduling a key to customer satisfaction. It is noteworthy that there are over 100 software scheduling packages that can perform schedule evaluation, schedule generation, and automated scheduling. However, their results can often be improved through a human scheduler's judgment and experience.

There are two general approaches to scheduling: forward scheduling and backward scheduling. As long as the concepts are applied properly, the choice of methods is not significant. In fact, if process lead times (move, queue and setup times) add to the job lead time and process time is assumed to occur at the end of process time, then forward scheduling and backward scheduling yield the same result. With forward scheduling, the scheduler selects a planned order release date and schedules all activities from this point forward in time.

With backward scheduling, the scheduler begins with a planned receipt date or due date and moves backward in time, according to the required processing times, until he or she reaches the point where the order will be released.

Of course there are other variables to consider other than due dates or shipping dates. Other factors which directly impact the scheduling process include: the types of jobs to be processed and the different resources that can process each, process routings, processing times, setup times, changeover times, resource availability, number of shifts, downtime, and planned maintenance.

LOADING

Loading involves assigning jobs to work centers and to various machines in the work centers. If a job can be processed on only one machine, no difficulty is presented. However, if a job can be loaded on multiple work centers or machines, and there are multiple jobs to process, the assignment process becomes more complicated. The scheduler needs some way to assign jobs to the centers in such a way that processing and setups are minimized along with idle time and throughput time.

Two approaches are used for loading work centers: infinite loading and finite loading. With infinite loading jobs are assigned to work centers without regard for capacity of the work center. Priority rules are appropriate for use under the infinite loading approach. Jobs are loaded at work centers according to the chosen priority rule. This is known as vertical loading.

Finite loading projects the actual start and stop times of each job at each work center. Finite loading considers the capacity of each work center and compares the processing time so that process time does not exceed capacity. With finite loading the scheduler loads the job that has the highest priority on all work centers it will require. Then the job with the next highest priority is loaded on all required work centers, and so on. This process is referred to as horizontal loading. The scheduler using finite loading can then project the number of hours each work center will operate. A drawback of horizontal loading is that jobs may be kept waiting at a work center, even though the work center is idle. This happens when a higher priority job is expected to arrive shortly. The work center is kept idle so that it will be ready to process the higher priority job as soon as it arrives. With vertical loading the work center would be fully loaded. Of course, this would mean that a higher priority job would then have to wait to be processed since the work center was already busy. The scheduler will have to weigh the relative costs of keeping higher priority jobs waiting, the cost of idle work centers, the number of jobs and work centers, and the potential for disruptions, new jobs and cancellations.

If the firm has limited capacity (e.g., already running three shifts), finite loading would be appropriate since it reflects an upper limit on capacity. If infinite loading is used, capacity may have to be increased through overtime, subcontracting, or expansion, or work may have to be shifted to other periods or machines.

SEQUENCING

Sequencing is concerned with determining the order in which jobs are processed. Not only must the order be determined for processing jobs at work centers but also for work processed at individual work stations. When work centers are heavily loaded and lengthy jobs are involved, the situation can become complicated. The order of processing can be crucial when it comes to the cost of waiting to be processed and the cost of idle time at work centers.

There are a number of priority rules or heuristics that can be used to select the order of jobs waiting for processing. Some well known ones are presented in a list adapted from Vollmann, Berry, Whybark, and Jacobs (2005):

- Random (R). Pick any job in the queue with equal probability. This rule is often used as a benchmark for other rules.
- First come/first served (FC/FS). This rule is sometimes deemed to be fair since jobs are processed in the order in which they arrive.
- Shortest processing time (SPT). The job with the shortest processing time requirement goes first. This rule tends to reduce work-in-process inventory, average throughput time, and average job lateness.
- Earliest due date (EDD). The job with the earliest due date goes first. This seems to work well if the firm performance is judged by job lateness.

- Critical ratio (CR). To use this rule one must calculate a priority index using the formula (due date–now)/(lead time remaining). This rule is widely used in practice.
- Least work remaining (LWR). An extension of SPT, this rule dictates that work be scheduled according to the processing time remaining before the job is considered to be complete. The less work remaining in a job, the earlier it is in the production schedule.
- Fewest operations remaining (FOR). This rule is another variant of SPT; it sequences jobs based on the number of successive operations remaining until the job is considered complete. The fewer operations that remain, the earlier the job is scheduled.
- Slack time (ST). This rule is a variant of EDD; it utilizes a variable known as slack. Slack is computed by subtracting the sum of setup and processing times from the time remaining until the job's due date. Jobs are run in order of the smallest amount of slack.
- Slack time per operation (ST/O). This is a variant of ST. The slack time is divided by the number of operations remaining until the job is complete with the smallest values being scheduled first.
- Next queue (NQ). NQ is based on machine utilization. The idea is to consider queues (waiting lines) at each of the succeeding work centers at which the jobs will go. One then selects the job for processing that is going to the smallest queue, measured either in hours or jobs.
- Least setup (LSU). This rule maximizes utilization. The process calls for scheduling first the job that minimizes changeover time on a given machine.

These rules assume that setup time and setup cost are independent of the processing sequence. However, this is not always the case. Jobs that require similar setups can reduce setup times if sequenced back to back. In addition to this assumption, the priority rules also assume that setup time and processing times are deterministic and not variable, there will be no interruptions in processing, the set of jobs is known, no new jobs arrive after processing begins, and no jobs are canceled. While little of this is true in practice, it does make the scheduling problem manageable.

GANTT CHARTS

Gantt charts are named for Henry Gantt, a management pioneer of the early 1900s. He proposed the use of a visual aid for loading and scheduling. Appropriately, this visual aid is known as a Gantt chart. This Gantt chart is used to organize and clarify actual or intended use of resources within a time framework. Generally, time is represented horizontally with scheduled resources listed vertically. Managers are able to use the Gantt chart to make trial-and-error schedules to get some sense of the impact of different arrangements.

There are a number of different types of Gantt charts, but the most common ones, and the ones most appropriate to our discussion, are the load chart and schedule chart. A load chart displays the loading and idle times for machines or departments; this shows when certain jobs are scheduled to start and finish and where idle time can be expected. This can help the scheduler redo loading assignments for better utilization of the work centers. A schedule chart is used to monitor job progress. On this type of Gantt chart, the vertical axis shows the orders or jobs in progress while the horizontal axis represents time. A quick glance at the chart reveals which jobs are on schedule and which jobs are on time.

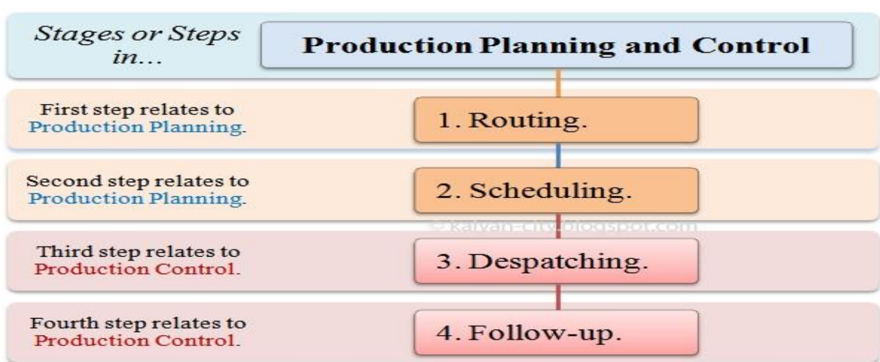
Gantt charts are the most widely used scheduling tools. However, they do have some limitations. The chart must be repeatedly updated to keep it current. Also, the chart does not directly reveal costs of alternate loadings nor does it consider that processing times may vary among work centers.

SCHEDULING SERVICE OPERATIONS

The scheduling of services often encounters problems not seen in manufacturing. Much of this is due to the nature of service, i.e., the intangibility of services and the inability to inventory or store services and the fact that demand for services is usually random. Random demand makes the scheduling of labor extremely difficult as seen in restaurants, movie theaters, and amusement parks. Since customers don't like to wait, labor must be scheduled so that customer wait is minimized. This sometimes requires the use of queuing theory or waiting line theory. Queuing theory uses estimate arrival rates and service rates to calculate an optimum staffing plan. In addition, flexibility can often be built into the service operation through the use of casual labor, on-call employees, and cross-training.

Scheduling of services can also be complicated when it is necessary to coordinate and schedule more than one resource. For example, when hospitals schedule surgery, not only is the scheduling of surgeons involved but also the scheduling of operating room facilities, support staff, and special equipment. Along with the scheduling of classes, universities must also schedule faculty, classrooms, labs, audiovisual and computer equipment, and students. To further complicate matters, cancellations are also common and can add further disruption and confusion to the scheduling process.

Instead of scheduling labor, service firms frequently try to facilitate their service operations by scheduling demand. This is done through the use of appointment systems and reservations.



MAINTENANCE MANAGEMENT

Maintenance management is the process of overseeing maintenance resources so that the organization does not experience downtime from broken equipment or waste money on inefficient maintenance procedures. Maintenance management software programs can assist with the process. The primary objectives of maintenance management are to schedule work efficiently, control costs and ensure regulatory compliance.

Importance

Maintenance management is essential to the success of any organization because a poorly- organized maintenance program can bring the entire company to a halt. For instance, if maintenance employees are fixing a broken photocopier instead of an essential piece of production equipment, a factory can stop producing anything. If the maintenance manager doesn't understand company processes well enough to know what is most important, this type of scheduling problem becomes more likely. If the maintenance manager schedules four employees when only one is needed, the company will lose money. If materials such as chemicals are not stored and disposed of properly, the company could have compliance issues.

IMPORTANCE AND OBJECTIVES OF MAINTENANCE MANAGEMENT

Maintenance is an important factor in quality assurance, which is another basis for the successful competitive edge. Inconsistencies in equipments lead to variability in product characteristics and result in defective parts that fail to meet the established specifications. Beyond just preventing break downs, it is necessary to keep equipments operating within specifications (i.e. process capability) that will produce high level of quality.

Good maintenance management is important for the companyâ€™s cost control. As companies go in for automation to become more competitive, they increasingly rely on equipments to produce a greater percentage of their output. It becomes more important that, equipments operate reliably within specifications. The cost of idle time is higher as equipment becomes more high- tech and expensive e.g. NC/CNC machines and robots.

Dependability of service is one of the performance measures by which a company can distinguish itself from others. To establish a competitive edge and to provide good customer service, companies must have reliable equipments that will respond to customer demands when needed. Equipments must be kept in reliable condition without costly work stoppage and down time due to repairs, if the company is to remain productive and competitive.

Many manufacturing organizations, particularly those with JIT (Just-In-Time) programs are operating with inventories so low that, they offer no protection in the event of a lengthy equipment failure. Beyond the cost of idle equipment, idle labor, and lost ales that can result from a breakdown, there is a danger of permanently losing market shares to companies that are more reliable. Maintenance function can help prevent such as occurrence.

Organizations like airlines and oil refineries have huge investments in the equipment. Equipment failure will be disastrous for such companies. They need proper maintenance to keep the equipment in good condition.

Impact of Poor Maintenance

Maintenance operations include all efforts to keep production facilities and equipments in an acceptable operating condition. Failure or ml-functioning of machines and equipments in manufacturing and service industries have a direct impact on the following:

1. Production capacity:

   Machines idled by breakdowns cannot produce, thus the capacity of the system is reduced.

2. **Production costs:**

   Labor costs per unit rise because of idle labor due to machine breakdowns. When machine malfunctions result in scrap, unit labor and material costs increase. Besides, cost of maintenance which includes such costs as costs of providing repair facilities, repair crews, preventive maintenance inspections, spare parts and stand by machines will increase as machines break down frequently.

3. **Product and service quality:**

   Poorly maintained equipments produce low quality products. Equipments that have not been properly maintained have frequent break downs and cannot provide adequate service to customers. For example, air craft fleets of the airline, railway and road transport services not maintained well can result in poor service to customers.

4. **Employee or customer safety:**

   Worn-out equipment is likely to fail at any moment and these failures can cause injuries to the workers, working on those equipments. Products such as two wheelers and automobiles, if not serviced periodically, can break down suddenly and cause injuries to the stress.

5. **Customer satisfaction:**

   When production equipments break own, products often can not be produced according to the master production schedules, due to work stoppages. This will lead to delayed deliveries of products to the customers.

Objectives of Maintenance Management

- The following are some of the objectives of maintenance management:

- Minimizing the loss of productive time because of equipment failure (i.e. minimizing idle time of equipment due to break down).
- Minimizing the repair time and repair cost.
- Minimizing the loss due to production stoppages.
- Efficient use of maintenance personnel and equipments.
- Prolonging the life of capital assets by minimizing the rate of wear and tear.
- To keep all productive assets in good working conditions.
- To maximize efficiency and economy in production through optimum use of facilities.
- To minimize accidents through regular inspection and repair of safety devices.
- To minimize the total maintenance cost which includes the cost of repair, cost of preventive maintenance and inventory carrying costs, due to spare parts inventory.
- To improve the quality of products and to improve productivity.

Types of Maintenance

1. Breakdown maintenance

It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

2. Preventive maintenance (1951)

It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into **periodic maintenance** and **predictive maintenance**. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2a. Periodic maintenance (Time based maintenance - TBM)

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

2b. Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

3. Corrective maintenance (1957)

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability

4. Maintenance prevention (1960)

It indicates the design of a new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

Breakdown maintenance is maintenance performed on equipment that has broken down and is unusable. It is based on a breakdown maintenance trigger.

It may be either planned or it can be unplanned. An example of planned maintenance is run-to- failure maintenance, while examples of unplanned maintenance include corrective maintenance and reactive maintenance.

Breakdown maintenance can be more costly than preventative maintenance.

Maintenance Policies:

1. Breakdown (repair) maintenance

2. Preventive maintenance

Breakdown maintenance is emergency based policy in which the plant or equipment is operated until it fails and then it is brought back into running condition by repair. The maintenance staffs locate any mechanical, electrical and any other fault to correct it immediately. Preventive maintenance policy prevents the probable breakdown and it ensures smooth and uninterrupted production by anticipating the breakdowns (failures) and taking corrective actions:

The preventive maintenance policy has four forms:

(a) **Time based:**

Which means doing maintenance at regular intervals? It is time dependent rather than usage dependent.

(b) Work based:

Maintenance after a set of operating hours of volume of work produced.

(c) Opportunity based:

Where repair and replacement takes place when the equipment or system is available.

(d) Condition based:

Which often relies on planned inspection to reveal when maintenance is required?

Preventive maintenance is used to delays or prevents the breakdown of equipment and also to reduce the seventy of any breakdowns that occur.

Two aspects of preventive maintenance are:

1. Inspection:

Inspection of critical parts will indicate the need for replacement or repair well in advance of probable breakdown. Regular inspection conducted by either by equipment or operator or by maintenance department is the most important direct means of increasing equipment reliability.

2. Servicing:

Routine cleaning, lubrication and adjustment may significantly reduce wear and hence prevent breakdowns. Frequently such duties are carried out by equipment operator or may be carried out by maintenance department.

Preventive versus Breakdown Maintenance:

Preventive maintenance is the routine inspection and service activities designed to detect potential failure conditions and make minor adjustments or repairs that will help prevent major operating problems.

Breakdown maintenance is the emergency repair and it involves higher cost of facilities and equipment that have been used until they fail to operate.

Effective preventive maintenance programmes for equipment requires properly trained personnel, regular inspection and service and has to maintain regular records.

Preventive maintenance is planned in such a way that it will not disturb the normal operations hence no down time cost of equipment.

Breakdown maintenance stops the normal activities and the machines and the operators are rendered idle till the equipment is brought back to normal condition of working

UNIT –III

QUALITY CONTROL

Meaning and Importance:

Present era is the ‘Era of Quality’.In this age of cutthroat competition and large scale production, only that manufacturer can survive who supplies better quality goods and renders service to-the consumers. In fact quality control has become major consideration before establishing an industrial undertaking. Proper quality control ensures most effective utilisation of available resources and reduction in cost of production.

The word quality control comprises of two words viz., quality and control. It would be appropriate to explain these two words separately to understand clearly the meaning of quality control.

According to Dr. W.K. Spriegel “The quality of a product may be defined as the sum of a number of related characteristics such as shape, dimension, composition, strength, workmanship, adjustment, finish and colour”.

In the words of John D. McIlellan, “Quality is the degree to which a product conforms to specifications and workmanship standards”.

It is clear from these definitions that quality refers to various characteristics of a product and their excellence. Quality is a relative term and is never absolute depending upon the use of the product and circumstances under which it is used.

To achieve and maintain a satisfactory level of quality of products is a very difficult task.

It involves many steps to be undertaken viz:

(a) Product must possess a minimum level of quality so that it could be easily sold in the market.
(b) In order to measure quality, accurate standard measurements must be established.
(c) Reasonable deviation from the pre-determined standards must be determined.
(d) Satisfactory level of quality must be achieved with a minimum cost.

Control refers to the use of all the ways and means whereby quality standards could be maintained. Control precisely aims at bringing the product up to predetermined standards by minimising deviations from established and present standards.

According to Henry Fayol, “Control consists in verifying whether everything occurs in conformity with the plan adopted, the instructions issued and principles established. It has objected to point out weaknesses and errors in order to rectify them and prevent recurrence. It operates on everything things, people, actions”.

In the absence of effective control over production operations, desired quality in products to be produced cannot be achieved. How it may be pointed out here that words quality and control cannot be studied separately in this context but as 'Quality Control'.

Quality control is concerned with the control of quality of the product during the process of production. It aims at achieving the predetermined level of quality in a product. In other words quality control is concerned with controlling those negative variances which ultimately affect the excellence of a manufacturer in producing the products.

—J.A. Shubin.

"Quality control is used to connote all those activities which are directed for defining, controlling and maintaining quality".

Objectives of quality control:

Following are the important objectives of quality control:

1. To establish the desired quality standards which are acceptable to the customers?

2. To discover flaws or variations in the raw materials and the manufacturing processes in order to ensure smooth and uninterrupted production.

3. To evaluate the methods and processes of production and suggest further improvements in their functioning.

4. To study and determine the extent of quality deviation in a product during the manufacturing process.

5. To analyse in detail the causes responsible for such deviation.

6. To undertake such steps which are helpful in achieving the desired quality of the product.

ISO Quality Control Standards and Specifications

Many inspection firms, like AQF, conduct inspections following the ISO Quality Control 9001 Standard. However, sometimes we get requests from a client to use other ISO specifications, like ISO 16949 for the automobile industry. But what is the exact difference between Standards and Specifications?

ISO standards are developed according to strict rules to ensure that they are transparent and fair. This requires a lot of negotiation before all 162 national members can reach a consensus that represents the state of the art; In fact, an international Standard requires 75% member approval. To ensure that ISO standards stay up to date, they are reviewed every five years. Technical experts can then decide whether a certain standard is still valid.

However, this obviously takes significant time, while some industries are so fast-moving that the experts are already thinking about the next version when one is being published. Technology changes quickly, and some specifications are needed faster than others. Therefore, to meet such needs, ISO has developed different categories of specifications, allowing ratification at an intermediate stage of development before full consensus: Technical Specifications can pass with only 67% approval.

There are 715 different ISO Technical Specifications. These Specifications can conflict, as long as they do not conflict with the Standards. Eventually, the aim of Technical Specifications is still to become Standards, but as they are reviewed regularly (no later than 3 years after their publication), they are quite unstable. While newer Specifications may indeed be a bit more *au courant*, there is no guarantee that it will still be standing come year's end. Thus, this is why AQF and many other firms generally inspect on the basis of the ISO 9001 Standard.

AQF also uses its years of experience in QC to constantly improve our audits. We update our audit template every month to keep up to date on the newest important issues. That being said, ISO 9001 is the base for every audit and is a critical standard to be followed!

Concept of Quality Circles (QC):

The concept of quality control originated in the U.S. and was taken to Japan by W. Edwards Deming who marked the beginning of revolution in quality control. As quality control awareness increased in Japan, the Japanese companies used statistical quality control to motivate their workers to produce high-quality products.

One of the mechanisms used by these companies to improve the quality not only of their products but also the personnel was quality circles which is in practice even today.

Quality circle is a group of labour and management who belong to a single department, do same or similar work, meet periodically to discuss and analyse manufacturing problems (for about an hour per week in paid time) and find solutions to quality problems.

Rather than developing technical staff that works with management and workers, quality circles train the workers who identify and solve the problems they face during the production process. Quality circle is "an approach to improving quality and reducing the cost of producing a product or service by the voluntary efforts of small groups of workers, who are generally led by a first- line supervisor".

However, the supervisor does not issue orders. The circle members analyze their problems, gather relevant information, find solutions and implement them. The QC members do not receive monetary rewards for presenting solutions to management but receive recognition for their services to the organization.

QCs improve the quality of products and the work atmosphere as members feel they are an important part of the organization who can positively contribute to product quality. Though initially started in the manufacturing area, the concept of QCs widely applies in service sector also (banking, insurance etc.).

Quality circles are regular short meetings that help to solve work-related problems.

(a) 5-10 people attend the meeting in work-time.

(b) Supervisor is nominated and he runs the meeting.

(c) Flip charts, audio-visual equipment, notice boards etc. are utilized.

(d) Problem areas are put forward by the group.

(e) Problems are prioritized.

(f) Information is collected, ideas are generated via brainstorming and force-field analysis.

(g) Effectiveness, costs, savings, consequences to other departments etc. are considered.

(h) Final solution is put forward to manager and implemented by the quality circle group.

Objectives of Quality Circles:

Following are the objectives of Quality Circles:

- To improve the quality of products.
- To improve productivity of the firm.
- T o develop sense of confidence in the workers that they can solve their own problems.
- To improve employees' morale.
- To improve employees' job satisfaction.
- To develop the personality of employees by making them aware of their importance in the work related areas and work atmosphere.
- To improve interpersonal relationship between management and workers.
- To improve employees' motivation and communication within the organisation.

Merits of Quality Circles:

Quality circles have the following merits:

(a) They focus on product quality in a planned way.

(b) They train employees to identify their problems, find solutions and implement them without seeking the advise of technical experts.

(c) They satisfy members' higher-order needs of recognition and self-actualisation.

(d) They improve members' participation in work-related problems and enhance their job satisfaction.

(e) They promote productivity, efficiency, cost reduction, design, testing, safety etc. of the products.

(f) Since teaching is done in an informal way, employees are not burdened with analysing and solving their problems. Rather, they feel motivated to offer suggestions to management.

Factors to Make Quality Circles Effective:

Quality circles are effective in achieving the goals if they are framed with the following factors in mind:

(a) They start with the analysis of small problems and gradually move to bigger problems.

(b) Members of the QCs are voluntary and not mandatory to get their maximum support.

(c) Members of the QC are taught the basic techniques of problem-solving in an informal way.

(d) Before members' proposal to solve the problem is put to implementation, it is checked by the supervisors.

(e) Management supports QC activities rather than leave them totally to the employees.

(f) Members are recognised for their contribution to organisational problems.

Though quality circles aim at improving organisational climate through constructive workforce, it may not always be able to do so because of the following limitations:

1. Different attitude of managers and workers to perceive the same problem.

a. Higher level managers may find it as dilution to their authority for decision-making.

b. Workers perceive quality circles as contributors to organisational growth and profits and not providing personal benefits to them in the form of sharing higher profits.

Workers and managers should view QCs as a positive contributor to organisation growth whose benefits would be shared by both managers and workers and not by management only.

2. Workers may not have requisite knowledge, skills and qualities to analyse and solve the organisational problems. They may prefer the directions to come from higher levels than to be self-directed.

The very purpose of QC's is to enhance the decision-making abilities of workers and therefore, workers should be trained to make decisions on their own rather than depending on their superiors.

3. Though workers give suggestions in QC, they may not be acceptable and implemented by the management. This can affect the efficiency of QCs.

In case the suggestions are not worthy of implementation, managers should convince the members in this regard. Workers should take the arguments positively rather than feeling offended for the same.

QUALITY ASSURANCE

A definition of quality assurance is:

The processes that ensure production quality meets the requirements of customers

This is an approach that aims to achieve quality by organising every process to get the product '**right first time'** and prevent mistakes ever happening. This is also known as a '**zero defect'** approach.

In quality assurance, there is more emphasis on '**self-checking'**, rather than checking by inspectors.

Advantages of quality assurance include:

- Costs are reduced because there is less wastage and re-working of faulty products as the product is checked at every stage
- It can help improve worker motivation as workers have more ownership and recognition for their work (see Herzberg)
- It can help break down 'us and them' barriers between workers and managers as it eliminates the feeling of being checked up on
- With all staff responsible for quality, this can help the firm gain marketing advantages arising from its consistent level of quality

Total Quality Management ("TQM")

This is a specific approach to quality assurance that aims to develop a quality culture throughout the firm. In TQM, organisations consist of 'quality chains' in which each person or team treats the receiver of their work as if they were an external customer and adopts a target of 'right first time' or zero defects.

Quality Benchmarking

Benchmarking is a general approach to business improvement based on best practice in the industry, or in another similar industry.

Benchmarking enables a business to identify where it falls short of current best practice and determine what action is needed to either match or exceed best practice.

Done properly, benchmarking can provide a useful **quality improvement target** for a business.

This can be a helpful approach for services as well as for products – for example a fast food business selling fish and chips could decide that it wanted to aim to equal McDonalds' speed of meeting customer orders for takeaway food.

A financial services firm might want its call centre staff to answer 95% of telephone calls within six rings, if this is the practice of the best in the industry.

In some cases, firms can use ***internal benchmarking*** in which best practice may be set with reference to another department, or by a similar factory in a different location.

statistical quality control 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.

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: **$sigma_p$** = square root of (p(1 -p) / n)

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

Control Limits: UCL = u + z $sigma_p$ 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: $UCL_R = D_4(R)$
$LCL_R = D_3(R)$

where is the average of past R values, and D_3 and D_4 are constants based on the sample size

-Chart for Process Average:
UCLR = X bar + $A_2(R)$ **LCL = X bar -** $A_2(R)$
where X bar is the average of several past values, and A_2 is a constant based on the sample size

Other Types of Attribute-Sampling Plans

Double-Sampling Plan:

Specifies two sample sizes (n_1 and n_2) and two acceptance levels (c_1 and c_2)

1. if the first sample passes (actual defects c_1), the lot is accepted

2. if the first sample fails and actual defects > c_2, the lot is rejected

3. if first sample fails but c_1 < actual defects c_2, 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.

Acceptance sampling involves both the producer (or supplier) of materials and the consumer (or buyer). Consumers need acceptance sampling to limit the risk of rejecting good-quality materials or accepting bad-quality materials. Consequently, the consumer, sometimes in con- junction with the producer through contractual agreements, specifies the parameters of the plan. Any company can be both a producer of goods purchased by another company and a consumer of goods or raw materials supplied by another company

Sampling Plans

All sampling plans are devised to provide a specified producer's and consumer's risk. However, it is in the consumer's best interest to keep the average number of items inspected (ANI) to a minimum because that keeps the cost of inspection low. Sampling plans differ with respect to ANI. Three often-used attribute sampling plans are the single-sampling plan, the double-sampling plan, and the sequential-sampling plan. Analogous plans also have been devised for variable measures of quality.

Single-Sampling Plan

The single-sampling plan is a decision rule to accept or reject a lot based on the results of one random sample from the lot. The procedure is to take a random sample of size (n) and inspect each item. If the number of defects does not exceed a specified acceptance number (c), the consumer accepts the entire lot. Any defects found in the sample are either repaired or returned to the producer. If the number of defects in the sample is greater than c, the consumer subjects the entire lot to 100 percent inspection orrejects the entire lot and returns it to the producer. The single-sampling plan is easy to use but usually results in a larger ANI than the other plans. After briefly describing the other sampling plans, we focus our discussion on this plan

Double-Sampling Plan

In a double-sampling plan, management specifies two sample sizes( ) and two acceptance numbers ( ). If the quality of the lot is very good or verybad, the consumer can make a decision to accept or reject the lot on the basis of the first sample,which is smaller than in the single- sampling plan. To use the plan, the consumer takes a random sample of size . If the number of defects is less than or equal to , the consumer accepts thelot. If the number of defects is greater than , the consumer rejects the lot. If the number of defects is between , the consumer takes a second sample of size . If the combined number of defects in the two samples is less than or equal to , the consumer accepts the lot.Otherwise, it is rejected. A double-sampling plan can significantly reduce the costs of inspection relative to a single-sampling plan for lots with a very low or very high proportion defective because a decision can be made after taking the first sample. However, if the decision requires two samples, the sampling costs can be greater than those for the single-sampling plan.

Sequential-Sampling Plan

A further refinement of the double-sampling plan is thesequential-sampling plan

, in which the consumer randomly selects items from the lot and inspects them one by one. Each time an item is inspected, a decision is made to (1) reject the lot (2) accept the lot, or (3) continue sampling, based on the cumulative results so far. The analyst plots the total number of defectives against the cumulative sample size, and if the number ofdefectives is less than a certain acceptance number ( ), the consumer accepts the lot. If the number is greater than another acceptance number ( ), the consumer rejects the lot. If thenumber is somewhere between the two, another item is inspected.

WORK STUDY

Definition: Work study may be defined as the analysis of a job for the purpose of finding the preferred method of doing it and also determining the standard time to perform it by the preferred (or given) method. Work study, therefore, comprises of two areas of study: method study (motion study) and time study (work measurement).

Role of Work Study in Improving Productivity

In order to understand the role of work study, we need to understand the role of method study and that of time study.

Method study (also sometimes called Work Method Design) is mostly used to improve the method of doing work. It is equally applicable to new jobs. When applied to existing jobs and existing jobs, method study aims to find better methods of doing the jobs that are economical and safe, require less human effort, and need shorter make-ready / put-away time. The better method involves the optimum use of best materials and appropriate manpower so that work is performed in well organized manner leading to increased resource utilization, better quality and lower costs.

It can therefore be stated that through method study we have a systematic way of developing human resource effectiveness, providing high machine and equipment utilization, and making economical use of materials.

Time study, on the other hand, provides the standard time, that is the time needed by worker to complete a job by the standard method. Standard times for different jobs are necessary for proper estimation of

- manpower, machinery and equipment requirements
- daily, weekly or monthly requirement of materials
- production cost per unit as an input to better make or buy decision
- labor budgets
- worker's efficiency and make incentive wage payments.

By the application of method study and time study in any organization, we can thus achieve greater output at less cost and of better quality, and hence achieve higher productivity.

Work Study and Ergonomics

The work study and the ergonomics are the two areas of study having the same objective: design the work system so that for the operator it is safe, and the work is less fatiguing and less time taking.

METHOD STUDY

Method study, aims to achieve the better method of doing work, and for this reason method study is sometimes called Work Method Design.

Definition: Method study can be defined as the procedure for systematic recording, analysis and critical examination of existing or proposed method of doing work for the purpose of development and application of easier and more effective method.

Method Study Procedure

The following general steps describe the procedure for making a method study.

1. Select the job – on which method study is to be applied.
2. Obtain information and record.
3. Examine the information critically.
4. Develop the most practical, economical and effective method by considering real limitations of the situation.
5. Install the new method as standard practice.
6. Maintain the standard practice by regular follow up.

Let us consider these steps in some detail.

Selection of Job for Method Study

Practically, any activity or a job is a potential project for improvement but as the work study engineer is to sell his ideas and maintain his existence in the organisation, he should always attempt to select those jobs for improvement which are unpopular among employees or are considered “dirty” by them.

By improving such jobs, he would earn goodwill from the employees as well as the management, and can expect their full cooperation for other studies in the future.

Considerations may be given to the following factors while selecting a job for method study

- Economic Factors

- Technical Factors
- Human Factors

Economic Factors:

If the economic importance of a job is small, it is not wise to start or continue a long study. Priorities should be given to those types of job which offer greater potential for cost reduction. Such jobs are easily identifiable, as they have

- High labour content, i.e. they consume more time
- excessive machine or man idleness
- higher frequency of occurrence, i.e. they have large demand
- bottlenecks in production line
- higher proportion of accidents
- movement of material or men over long distance
- high scrap and reprocessing costs
- high payment of overtime bills.

Technical Factors: The method study engineer must have the necessary technical knowledge about the job to be studied. Only surface knowledge about the subject may not lead to the right solution to the real problem. To illustrate, consider that a particular machine tool in proving bottleneck. The output from this machine is not reaching the assembly line in the required quantity. Through a preliminary study, it is found that it is running at lower speed and feed than that recommended for the pair of work and tool material used. Just increase in speed or feed may not be the solution of this problem. It may be possible that the machine itself is not rigid enough to operate at higher speeds or take a deeper cut. Just increase in speed may increase the output but the quality of job may be seriously affected. Technical expertise in machine tools and metal cutting process would be essential to solve problem of this kind.

Human Factors: Emotional reaction of the workers to the method study and changes in method are important considerations. If the study of a particular job is suspected to cause unrest or ill feeling, it should not be undertaken, however useful it may be from the economic point of view. It is always better to take up first those jobs which are considered ‘dirty', unsafe, unpleasant, boring, or highly fatiguing, and improvements brought about as a result of method study. This would possibly ensure cooperative from the workers for the other jobs as well.

After it is recognized that a problem exists, the first step is to properly formulate it. From the general statements like

“Costs are too high“, “Increase the production”, “Reduce shop floor accidents”, it is necessary to determine just what the real problem is. After it is ascertained that the problem merits consideration, it is decided whether this is the proper time to solve it, and how much time can be spent in solving it. The problem may then be defined broadly giving minimum constraints at this stage, as it will permit the use of imagination and creativity in finding a solution. It may sometimes be desirable to divide the complete problem into a couple of small problems and solve them.

Information Collection And Recording Information Collection Techniques:

The accuracy of data about the method study problem is important for the development of improved method. The following techniques are used for the collection of information / data about the task under consideration. These are not exclusive of each other, and for any particular method study problem, some or all the techniques may be employed.

- Observation. It is a common technique used for collecting information about the present method or the existing problem. The method study person visits the site where the work is currently being done and observes various steps in the method being followed. There are many instances where all the data needed is obtained by only observing the work or work site.

- Discussion. Discussion with those who do or who supervise the work can frequently provide information not obtainable by observation. The discussion technique is commonly used where irregular work is involved or where one is trying to analyze past work in order to improve efficiency of work to be done in future. Even where observation by itself may accomplish the data collection task, discussion may be used for developing good human relations.

- Records. Valuable information can be obtained from past records concerning production, cost, time, inventory and sub-contracts. For certain type of information concerning the past practice, sometimes this is the only way to obtain authentic data.

- Motion Pictures or video Films. Accurate and most detailed information can be obtained by taking motion pictures or video film. Information obtained by this procedure can easily be transmitted / forwarded to all levels in the organization and if needed, can be used directly for training purposes. The film can be used to focus attention at particular point or motion in an operation. For obtaining information concerning those types of work that involve large crew size, it is probably the only procedure.

Information Recording Techniques:

There are three main types of information recording techniques. These are

- Process Charts

- Diagrams

- Templates

A **Process Chart** is a graphic means of representing the activities that occur during a manufacturing or servicing job.

There are several types of process charts. These can be divided into two groups.

(i) Those which are used to record a process sequence (i.e. series of events in the order in which they occur) but do not depict the events to time scale.

Charts falling in this group are

- Operation process chart
- Flow process chart – (man / material / equipment type)
- Operator chart (also called Two Handed Process Chart)

(ii) Those which record events in the sequence in which they occur on a time scale so that the interaction of related events can be more easily studied. Charts falling in this group are

- Multiple activity chart
- Simo chart

Diagrams. A diagram gives pictorial view of the layout of workplace or floor on which locations of different equipment, machines, etc. are indicated. The movement of subject (man or material) is then indicated on the diagram by a line or a string. The diagrams are valuable in highlighting the movement so that analyst can take steps to simplify or reduce it and thus effect saving in time or reduction in collisions / accidents.

Two types of diagrams are common: Flow diagram and string diagram.

Templates and 3-D models:

Two-dimensional cut outs made from thin card sheet representing machinery, furniture, etc. can be used for developing new layouts and methods. The templates may have pieces of permanent magnet attached to them, so that when used on iron board; they remain glued on the board whenever placed.

A scaled 3-D model of a working area helps easy understanding of lighting, ventilation, maintenance and safety aspects that may be important in a method. Such models are often of great value in demonstrating the advantages of the proposed changes to all concerned. However, their use is limited because of higher cost involved. Some computer softwares are available which help in constructing the layout and possibility of visualizing the working of process in a systematic way.

Before taking up descriptions of these charts or diagrams, it is necessary to know the various elements of work.

Elements of Work:

There are five basic elements of work: Operation, Inspection, Transportation, Delay, and storage. Sometimes, more than one element occur simultaneously. It is shown as combined element with combined symbol. Examples are "Operation in combination will inspection", and "Inspection in combination with Transportation".

Operation Process Chart:

An operation process chart provides the chronological sequence of all operations and inspections that occur in a manufacturing or business process. It also shows materials used and the time taken by operator for different elements of work. Generally a process chart is made for full assembly, that is, it shows all the operations and inspections that occur from the arrival of raw material to the packaging of the finished product.

Flow Process Chart:

A flow process chart is used for recording greater detail than is possible in an operation process chart. It is made for each component of an assembly rather than for the whole assembly.
A flow process chart shows a complete process in terms of all the elements of work. There are two main types of flow charts: product or material type , and the operator type . The product type records the details of the events that occur to a product or material, while the operator flow chart details how a person performs an operational sequence.

An important and valuable feature of this chart is its recording of non-productive hidden costs, such as delays, temporary storages, unnecessary inspections, and unnecessary long distances traveled. When the time spent on these non productive activities is highlighted, analyst can take steps to minimize it and thus reduce costs.

Operator Process Chart :

It is also called Left Hand – Right Hand chart and shows the activities of hands of the operator while performing a task. It uses four elements of hand work: Operation, Delay (Wait), Move and Hold. Its main advantage lies in highlighting un-productive elements such as unnecessary delay and hold so that analyst can take measures to eliminate or shorten them.

Multiple Activity Chart:

Worker-Machine process chart and gang process chart fall in the category of multiple activity charts. A worker-machine chart is used for recording and analyzing the working relationship between operator and machine on which he works. It is drawn to time scale. Analysis of the chart can help in better utilization of both worker and machine time. The possibility of one worker attending more than one machine is also sought from the use of this chart.

A gang process chart is similar to worker-machine chart, and is used when several workers operate one machine. The chart helps in exploring the possibility of reducing both the operator time and idle machine time.

Simo Chart:

A Simo chart is another Left-Hand Right-Hand chart with the difference that it is drawn to time scale and in terms of basic motions called therbligs. It is used when the work cycle is highly repetitive and of very short duration.

Work Measurement

Work measurement refers to the estimation of standard time for an activity, that is the time allowed for completing one piece of job by using the prescribed method. Standard time can be defined as the time taken by an average experienced worker for the job with provisions for delays beyond the worker's control.

There are several techniques used for estimation of standard time in industry. These include time study, work sampling, standard data, and predetermined motion time system.

Applications:

Standard times for operations are useful for several applications in industry, like

- Estimating material, machinery, and equipment requirements.
- Estimating production cost per unit as an input to Preparation of budgets
- Determination of selling price
- Make or buy decision
- Estimating manpower requirements.
- Estimating delivery schedules and planning the work
- Balancing the work of operators working in a group.
- Estimating performance of workers and using that as the basis for incentive payment to those direct and indirector labor who show greater productivity.

We will study some of the popular techniques of work measurement.

TIME STUDY.

It is the most versatile and the most widely used technique of work measurement.

Definition:

Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task by using specified method.

This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays.

Time Study Procedure:

The procedure for time study can best be described step-wise, which are self explanatory.

Step 1: Define objective of the study. This involves statement of the use of the result, the precision desired, and the required level of confidence in the estimated time standards.

Step 2: Verify that the standard method and conditions exist for the operation and the operator is properly trained. If need is felt for method study or further training of operator, the same may be completed before starting the time study.

Step 3: Select operator to be studied if there are more than one operator doing the same task.

Step 4: Record information about the standard method, operation, operator, product, equipment, and conditions on the Time Study observation sheet.

Step 5: Divide the operation into reasonably small elements, and record them on the Time Study observation sheet.

Step 6: Time the operator for each of the elements. Record the data for a few number of cycles on the Time Study observation sheet. Use the data to estimate the total number of observations to be taken.

Step 7: Collect and record the data of required number of cycles by timing and rating the operator.

Step 8: Calculate the representative watch time for each element of operation. Multiply it by the rating factor to get normal time.

Normal time = Observed time x Rating factor

Calculate the normal time for the whole operation by adding the normal time of its various elements.

Step 9: Determine allowances for fatigue and various delays.

Step 10: Determine standard time of operation. Standard time =
Normal time + allowances **Selection of job for Time Study**

Time Study is conducted on a job

- which has not been previously time-studied.
- for which method change has taken place recently.
- for which worker(s) might have complained as having tight time standards.

Selection of Worker for Time Study

The selection of worker for time study is a very important factor in the success of the study. If there is only one person on the job, as usually is, then there is no choice. But if more than one person is performing the same operation, the time study man may time one or more of the workers. If all the workers are using the same method for doing the job and there is different in the rate of their doing it, it is necessary to select a suitable worker for the study. The worker on which time study should be conducted must

- have necessary skill for the job.
- have sufficient experience with the given method on the job (that is, he should have crossed the learning stage).
- be an ‘average' worker as regards the speed of working.
- be temperamentally suited to the study (those who can't work in normal fashion when watched, are not suitable for the study).
- have knowledge about the purpose of study.

Time Study Equipment

The following equipment is needed for time study work.

- Timing device
- Time study observation sheet
- Time study observation board
- Other equipment

Timing Device. The stop watch is the most widely used timing device used for time study, although electronic timer is also sometimes used. The two perform the same function with the difference that electronic timer can measure time to the second or third decimal of a second and can keep a large volume of time data in memory.

Time Study Observation Sheet. It is a printed form with spaces provided for noting down the necessary information about the operation being studied, like name of operation, drawing number, and name of the worker, name of time study person, and the date and place of study. Spaces are provided in the form for writing detailed description of the process (element-wise), recorded time or stop-watch readings for each element of the process, performance rating(s) of operator, and computation shows a typical time study observation sheet.

Time Study Board. It is a light -weight board used for holding the observation sheet and stopwatch in position. It is of size slightly larger than that of observation sheet used. The board has a clamp to hold the observation sheet. During the time study, the board is held against the body and the upper left arm by the time study person in such a way that the watch could be operated by the thumb/index finger of the left hand. Watch readings are recorded on the observation sheet by the right hand.

Other Equipment. This includes pencil, eraser, device like tachometer for checking the speed, etc.

Dividing Work into Short Elements

Timing a complete task as one element is generally not satisfactory. For the purpose of time study the task is normally broken into short elements and each element is timed separately, for the following reasons:

(1) To separate unproductive part of task from the productive one.

(2) To improve accuracy in rating. The worker may not work at the same speed throughout the cycle. He may perform some elements faster and some slower. Breaking of task into short elements permits rating of each element separately which is more realistic than just rating once for the complete cycle.

(3) To identify elements causing high fatigue. Breaking of task into short elementspermits giving appropriate rest allowances to different elements.

(4) To have detailed job specifications. This helps in detection of any variation in the method that may occur after the time standard is established.

(5) To prepare standard data for repeatedly occurring elements.

The following guidelines should be kept in mind while dividing a task into elements.

- The elements should be of as short duration as can be accurately timed. (This in turn, depends on the skill of the time study man, method of timing and recording, and many other factors. Generally, with the stop watch, elements of duration less than 0.03 to 0.05 minute are difficult to time accurately. The elements should not normally be longer than 0.40 min.).
- Manually performed elements should be separated from machine paced elements. (Time for machine paced elements

can be determined by calculation). Machine elements are not rated against a normal. This rule also helps in recognition of delays.

- Constant elements should be separated from variable elements. (Constant elements are those elements which are independent of the size, weight, length, or shape of the workpiece. or example, the time to pick screw driver from its place and bring it to the head of a screw is constant, whereas the time to tighten or loosen the screw is a variable, depending upon the length and size of the screw).
- The beginnings and endings of elements should be easily distinguishable. These should preferably be associated with some kind of sound.
- Irregular elements, those not repeated in every cycle, should be separated from regular elements. For example, if the jig is cleaned off after every ten parts produced, "cleaning" is an irregular element, and its time should be spread over ten cycles.
- Unnecessary motions and activities should be separated from those considered essential.
- Foreign or accidental elements should be listed separately. Such elements are generally of non-repetitive type.

Number of cycles to be timed.

The following general principles govern the number of cycles to get the representative average cycle time.

- Greater the accuracy desired in the results, larger should be the number of cycles observed.
- The study should be continued through sufficient number of cycles so that occasional elements such as setting-up machine, cleaning of machine or sharpening of tool are observed for a good number of times.
- Where more than one operator is doing the same job, short study (say 10 to 15 cycles) should be conducted on each of the several operators than one long study on a single operator.

It is important that enough cycles are timed so that reliable average is obtained. Following techniques are used to determine the number of cycles to be timed.

(i) **Use of Tables:** On the consideration of the cost of obtaining the data and the desired accuracy in results, most companies have prepared their own tables for the use of time study people, which indicate the number of cycles to be timed as a function of the cycle time and the frequency of occurrence of the job in the company.

(ii) **(ii) Statistical methods:** On the basis of the requirements of the particular situation involved, *accuracy* and *confidence level* are decided (An accuracy of a confidence level of 95% is considered reasonable in most cases). A preliminary study is conducted in which some (say *N)* cycles are timed. Standard deviation o of these *(N)* observations is calculated as

WORK SAMPLING

Work Sampling (also sometimes called ratio delay study) is a technique of getting facts about utilization of machines or human beings through a large number of instantaneous observations taken at random time intervals. The ratio of observations of a given activity to the total observations approximates the percentage of time that the process is in that state of activity. For example, if 500 instantaneous observations taken at random intervals over a few weeks show that a lathe operator was doing productive work in 365 observations and in the remaining 135 observations he was found 'idle' for miscellaneous reasons, then it can be reliably taken that the operator remains idle (135/500) x 100 = 27 % 0f the time. Obviously, the accuracy of the result depends on the number of observations. However, in most applications there is usually a limit beyond which greater accuracy of data is not economically worthwhile.

Use of Work Sampling for Standard Time Determination

Work sampling can be very useful for establishing time standards on both direct and indirect labor jobs. The procedure for conducting work sampling study for determining standard time of a job can be described step-wise.

Step 1 . Define the problem.

- Describe the job for which the standard time is to be determined.
- Unambiguously state and discriminate between the two classes of activities of operator on the job: what are the activities of job that would entitle him to be in 'working" state.
- This would imply that when operator will be found engaged in any activity other than those would entitle him to be in "Not Working" state.

Step 2. Design the sampling plan.

- Estimate satisfactory number of observations to be made.
- Decide on the period of study, e.g. two days, one week, etc.
- Prepare detailed plan for taking the observations.

This will include observation schedule, exact method of observing, design of observation sheet, route to be followed, particular person to be observed at the observation time, etc.

Step 3. Contact the persons concerned and take them in confidence regarding conduct of the study.

Step 4. Make the observations at the pre-decided random times about the working / not working state of the operator. When operator is in working state, determine his performance rating.
Record both on the observation sheet.

Step 5. Obtain and record other information. This includes operator's starting time and quitting time of the day and total number of parts of acceptable quality produced during the day.

Step 6. Calculate the standard time per piece.

We will now briefly discuss some important issues involved in the procedure.

Number of Observations

As we know, results of study based on larger number of observations are more accurate, but taking more and more observations consumes time and thus is costly. A cost-benefit trade-off has thus to be struck. In practice, the following methods are used for estimation of the number of observations to be made.

- Based on judgment. The study person can decide the necessary number of observations based on his judgment. The correctness of the number may be in doubt but estimate is often quick and in many cases adequate.
- Using cumulative plot of results. As the study progresses the results of the proportion of time devoted to the given state or activity, i.e. Pi from the cumulative number of observations are plotted at the end of each shift or day.. Since the accuracy of the result improves with increasing number of observations, the study can be continued until the cumulative Pi appears to stabilize and collection of further data seems to have negligible effect on the value of Pi.
- Use of statistics. In this method, by considering the importance of the decision to be based on the results of study, a maximum tolerable sampling error in terms of confidence level and desired accuracy in the results is specified. A pilot study is then made in which a few observations are taken to obtain a preliminary estimate of Pi. The number of observations N necessary are then calculated using the following expression.

The number of observations estimated from the above relation using a value of Pi obtained from a preliminary study would be only a first estimate. In actual practice, as the work sampling study proceeds, say at the end of each day, a new calculation should be made by using increasingly reliable value of Pi obtained from the cumulative number of observations made.

Determination of Observation Schedule

The number of instantaneous observations to be made each day mainly depends upon the nature of operation. For example, for non-repetitive operations or for operations in which some elements occur in-frequently, it is advisable to take observations more frequently so that the chance of obtaining all the facts improves. It also depends on the availability of time with the person making the study. In general, about 50 observations per day is a good figure. The actual random schedule of the observations is prepared by using random number table or any other technique.

Design of Observation Sheet

A sample observation sheet for recording the data with respect to whether at the pre-decided time, the specified worker on job is in 'working' state or 'non-working' state. It contains the relevant information about the job, the operators on job, etc. At the end of each day, calculation can be done to estimate the percent of time workers on the job (on an average) spend on activities, which are considered as part of the job.

OC CURVE

A common supplementary plot to standard quality control charts is the so-called *operating characteristic* or *OC* *curve*. One question that comes to mind when using standard variable or attribute charts is how sensitive is the current quality control procedure. Put in more specific terms, how likely is it that you will not find a sample (e.g., a mean in an X-bar chart) outside the control limits (i.e., accept the production process as "in control"), when, in fact, it has shifted by a certain amount? This probability is usually referred to as the b (beta) error probability, that is, the probability of erroneously accepting a process (mean, mean proportion, mean rate defectives, etc.) as being "in control."

Operating characteristic curves are extremely useful for exploring the power of the quality control procedure. The actual decision concerning sample sizes should depend not only on the cost of implementing the plan (e.g., cost per item sampled), but also on the costs resulting from not detecting quality problems. The OC curve allows the engineer to estimate the probabilities of not detecting shifts of certain sizes in the production quality.

ALLOWANCES IN TIME STUDY:

Allowances in Time Study: Definition, Reasons and Types! Definitions:

Allowances in time study can be defined as the extra time figures which are to be added to the basic time of an operation to account for personnel desires, delays, fatigue of operators, any special situation and the policies of the firm or organization. Standard time of a job is obtained by adding various allowances to the basic or normal time of the job.

These allowances are considered or provided to compensate the worker/operator for the production interruptions that may occur due to his personnel legitimate needs or the factors beyond his controls. For example the delay may occur due to operators personnel needs such as drinking water, taking tea, going to toilet etc., unavoidable delays like waiting for tools, materials or equipment, maintenance of machine and periodic inspection of parts/materials.

The fundamental purpose of allowances is to add enough time to the basic time of the production in order to enable the average worker to meet the standard while performing at a normal pace.

The determination of allowances is probably the most controversial part of work study.

Reasons:

Some of the reasons due to which this difficulty is experienced are:

1. ***Individual factors:***

A thin, alert and active worker requires a smaller allowance to recover from fatigue than an inept, dull and obese worker. In the similar manner, every worker conducts his work according to the Learning Curve which is unique for everyone.

2. ***Nature of work:***

Allowances calculated or determined for light or medium work are not acceptable for operation involving very hard work and which is done under very difficult conditions. For example, the work involving more eye movement, more physical work (by hands or by legs) or more mental work needs greater allowances than that of light easy and work involving very less physical work or movements.

Some factors inherent to the job such as gloves or masks to be worn while working, constant danger or risk regarding the surface finish or quality of the work etc. varies from job to job. Thus, the determination of allowances becomes more difficult and controversial.

3. ***Environmental factors:***

While determining the relaxation allowance, certain factors like heat, humidity, vibration, dust, light intensity, noise level etc. have to be taken into account. These are called the environmental factors and these factors are of seasonal nature. These factors are more significant for workers conducting the work under open air or where the environmental factors affect the work such as work in a construction company or in shipyards.

Type of Allowances:

1. Relaxation Allowance:

Relaxation allowance is the most essential part of the time added to the basic time. Other allowances like contingency allowances, policy allowances or other special allowances are applied under certain conditions only. Relaxation allowances are added so as to allow the worker or operator to recover from fatigue.

Fatigue can be defined as mental or physical weariness, existing in a person which adversely affects his efficiency in working. Now, this fatigue can be licensed to come extent by some rest breaks, during which the body part, gets relaxed and recovers from exertion. It can also be lessened by lowering down the rate of working.

Relaxation allowances are added element by element to their basic times so as to obtain the work value of each element separately. After that, the element standard times are added so as to obtain the standard time for the job or operations. Allowances for climatic conditions are applied to the working shift rather than to element or the jobs.

Relaxation allowances itself can be sub-divided into two categories:

1. **Fixed Allowances:**

Fixed allowances consist of the allowances given for personnel needs or desire. These personnel needs includes going for watching getting a drink etc. It is also agreed that women need more personnel time than man. The usual percentage of the personnel allowances is 5% for male workers and 7% for women.

Fixed allowance also includes the allowances for the basic fatigue. This allowances is given to take account of the energy expanded during work and to remove the monotony. Usually, it is taken as 4% a worker who carried out the job while seated, who is engaged in a light work under good working conditions and makes only the normal use of hands, legs and his senses.

2. **Variable Allowances:**

In calculating the relaxation allowance, variable allowances are added to the fixed allowances which are made, depending upon the circumstances of the job. Variable addition is given be improved.

Following factors are to be taken into account:

1. Standing
2. Weightlifting applications.

3. Light conditions.

4. Abnormal posture or position.

5. Visual strains.

6. Air conditions or availability.

7. Aural strenes.

8. Mental stress.

9. Mental monotony.

10. Physical monotony.

2. *Contingency Allowances:*

It is also known as delay allowance. It accounts for some other contingencies such as unexpected work as well. "A contingency allowance is an allowances of time that is to be added in normal time or to be included in standard time to meet the legitimate and unexpected items of work or delays, the precise measurement of which is not economical due to their irregular and infrequent nature of occurrences."

The qualifying statement in the above mentioned definition is 'legitimate.' So, the contingence allowances are given for legitimate contingencies it can be explained with the help of 'delay'. Delays can be avoidable and unavoidable.

3. *Other and Special Allowances:*

There are some other and special allowances which are to be added for certain conditions. These allowances are provided for certain reasons and for come specific period of time. **Some of their allowances are:**

1. Special Allowances:

As the name suggests, these allowances are added for some special conditions. Most of these allowances are temporary and are taken out as soon as conditions normalise.

These include the following:

(a) Start up, shut down, and tooling:

These allowances are given per work period. These allowances compensate for the time loss during cleaning and tooling periods and the shut down at the end of the work period.

(b) Setup and change over:

These types of allowances are provided when a new type of product is started. There include the time taken in set up of machine. Dismantling the previous work piece or tool for new set up is also included in it as the worker is forced to be idle when the new set up is mounted or the previous one is being withdrawn. These allowances are withdrawn as soon as the production starts completely.

(c) Rejection reworks and excess work:

A rejection allowance is provided to compensate for rejection of work. This product rejection is inherent in much process because of come uncontrollable factors. Reworks also present this similar picture. So, these allowances are added for certain conditions when the work is not being done under standard conditions and some excess work results.

(d) Learning, training and implementation:

And the name suggests, these allowances are given to the trainees before they acquire full ability to perform a task within the actual standard time. Some of the workers are engaged in implant training of new operatives and thus some of their production time is lost in this process. Thus, at this stage, training allowances are added.

Third is the implementation allowance, which is given to the workers when they are encouraged to work on some new processes. It is provided to achieve the whole hearted co-operation from the workers to new methods or processes without any fear of loss of their earning. All the above mentioned allowances are temporary in nature.

2. Policy Allowances:

Policy allowance is not a part of time study. It can be permanent or temporary in nature. It is applied according to the policy of the firm in which the time standard is to be applied. Policy allowance is given to honour the wage agreements that are made by the employers with the trade unions.

A policy allowance can be defined as follows:

"It is an increment (other than the bonus increment) applied to the standard time to achieve a satisfactory level of earnings for a particular level of performance under the exceptional circumstances."

A policy allowance can be added as a temporary factor to compensate for any imperfections in the functioning of a firm, But, in this situation, it should be withdrawn as soon as the condition normalises So, the policy allowances should be added with due caution and under well defined circumstances.

UNIT -4

MATERIALS MANAGEMENT: MEANING, IMPORTANCE AND FUNCTIONS

Materials Management: Meaning, Importance and Functions!

The need for materials management was first felt in manufacturing undertakings. The servicing organizations also started feeling the need for this control. And now even non-trading organizations like hospitals, universities etc. have realized the importance of materials management. Every organization uses a number of materials. It is necessary that these materials are properly purchased, stored and used.

Any avoidable amount spent on materials or any loss due to wastage of materials increases the cost of production. The object of materials management is to attack materials cost on all fronts and to optimize the overall end results. Materials management connotes controlling the kind, amount , location and turning of the various commodities used in and produced by the industrial enterprises. It is the control of materials in such a manner that it ensures maximum return on working capital.

L.J. De Rose:

Material management is the planning, directing, controlling and co-ordination of all those activities concerned with material and inventory requirements, from the point of their inception to their introduction into manufacturing process."

As per De Rose all those functions which start with the procurement of materials and end with completion of manufacturing are a part of material management.

Importance of Material Management:

Material management is a service function. It is as important as manufacturing, engineering and finance. The supply of proper quality of materials is essential for manufacturing standard products. The avoidance of material wastage helps in controlling cost of production. Material management is essential for every type of concern.

The importance of material management may be summarized as follows:

1. The material cost content of total cost is kept at a reasonable level. Scientific purchasing helps in acquiring materials at reasonable prices. Proper storing of materials also helps in reducing their wastages. These factors help in controlling cost content of products.

2. The cost of indirect materials is kept under check. Sometimes cost of indirect materials also increases total cost of production because there is no proper control over such materials.

3. The equipment is properly utilized because there are no break downs due to late supply of materials.

4. The loss of direct labour is avoided.

5. The wastages of materials at the stage of storage as well as their movement is kept under control.

6. The supply of materials is prompt and late delivery instances are only few.

7. The investments on materials are kept under control as under and over stocking is avoided.

8. Congestion in the stores and at different stages of manufacturing is avoided.

Functions of Material Management:

Material management covers all aspects of material costs, supply and utilization. The functional areas involved in material management usually include purchasing, production control, shipping, receiving and stores.

The following functions are assigned for material management:

1. ***Production and Material Control:***

Production manager prepares schedules of production to be carried in future. The requirements of parts and materials are determined as per production schedules. Production schedules are prepared on the basis of orders received or anticipated demand for goods. It is ensured that every type or part of material is made available so that production is carried on smoothly.

2. ***Purchasing:***

Purchasing department is authorized to make buying arrangements on the basis of requisitions issued by other departments. This department keeps contracts with suppliers and collects quotations etc. at regular intervals. The effort by this department is to purchase proper quality goods at reasonable prices. Purchasing is a managerial activity that goes beyond the simple act of buying and includes the planning and policy activities covering a wide range of related and complementary activities.

3. ***Non-Production Stores:***

Non-production materials like office supplies, perishable tools and maintenance, repair and operating supplies are maintained as per the needs of the business. These stores may not be required daily but their availability in stores is essential. The non-availability of such stores may lead to stoppage of work.

4. ***Transportation:***

The transporting of materials from suppliers is an important function of materials management. The traffic department is responsible for arranging transportation service. The vehicles may be purchased for the business or these may be chartered from outside. It all depends upon the quantity and frequency of buying materials. The purpose is to arrange cheap and quick transport facilities for incoming materials.

5. ***Materials Handling:***

It is concerned with the movement of materials within a manufacturing establishment and the cost of handling materials is kept under control. It is also seen that there are no wastages or losses of materials during their movement. Special equipment's may be acquired for material handling.

6. ***Receiving:***

The receiving department is responsible for the unloading of materials, counting the units, determining their quality and sending them to stores etc. The purchasing department is also informed about the receipt of various materials.

(MRP) MATERIALS REQUIREMENT PLANNING

The main function of MRP is to guarantee material availability on time.

MRP is required to procure or produce the required quantities on time for in- house purpose or for fulfilling customer demand.

The main objective is to plan the supply based on requirements and considering the current stock in hand and meets the shortages.

MRP Process flow

- With MRP, inventory can be optimized via planning receipts according to the needs so that surplus inventory could be avoided.
- Sales and distribution give concrete customer requirements from the market.
- In Demand Management, sales are planned in advance via a sales forecast. The sales forecast is entered in demand management in the form of Planned Independent Requirement (PIR), i.e., the requirement for the finished product.
- In order to cover these requirements, MRP does net requirement calculation and plans procurement quantities and dates on which the material needs to be procured orproduced.
- If a material is produced in-house, the system explodes the BOM and calculates the dependent requirements, that is, the quantity of components required to produce the finished product.
- If a material shortage exists, planned orders are created at every BOM level to fulfill the requirements and purchase requisitions are generated for externally procured raw materials. You can also create planned orders for externally procured materials which can be converted to purchase requisition.
- MRP does lead time scheduling and calculates planned order dates based on routing times. Basically, it does backward scheduling starting from requirement date minus (GR processing times, in-house production time, float time before production) and calculates the duration of planned orders.
- Production orders or Purchase orders are created after conversion of planned orders and purchase requisition respectively.
- MRP type "PD" in material master MRP 1 view is essential to run the MRP for the materials. If, you don't want to run MRP on the material then MRP type "ND" can be maintained in the material master.

Master Production Schedule (MPS)

It is used specifically for critical materials usually high valued products where you do not want changes in your production plan within planning time fence in next MPS run, and production plan gets firmed automatically as soon as it comes within planning time fence unlike MRP run.

- A separate run occurs for the MPS items; they are not included in the MRP run.
- Basically, it ensures the availability of the critical resources, which should not hamper the production by maintaining the stock.
- Planning time fence (number of days starting from current date) is useful in case of MPS scenario where one can save the procurement proposals (planned orders) fromundergoing any change since the last MRP run.
- No automatic changes happen to the procurement proposals once they enter in the planning time fence (PTF is maintained in material master). So, all planned orders in planning time fence get automatically firmed by the system.
- MRP type " P0" to "P3" in material master should be maintained to run MPS for materials.

MRP Planning Parameters

MRP parameters are required for MRP run in terms of considering the requirements (PIR) in planning horizon, scheduling parameters and about the usage of BOM and routing data.

1. Processing Key

1. Net change (NETCH): In this run, the system considers those materials in the planning run from their last MRP run which have undergone some changes pertaining to receipts and issues or any stock changes.
2. Net Change in Planning Horizon (NETPL): In this run, the system considers those materials in the planning run from their last MRP run which have undergone some changes pertaining to receipts and issues or any stock changes. It considers the requirements in a pre-defined planning horizon, unlike NETCH key which considers the total futuristic requirements.
3. Regenerative Planning (NEUPL): It plans all the materials for the MRP Run irrespective of the changes they undergo. This plan is not so widely used. It takes a long time to obtain the final result.

2. Planning Mode

1. Adapt planning data: It only processes the changed data.
2. Re explodes BOM and Routing: Read BOM and routing data again for theexisting orders.
3. Delete and recreate planning data: It completely deletes the planning data (allreceipts) and creates again.

3. Scheduling

1. Basic Scheduling: MRP calculates only basic dates for the orders and in house production time for the material master is used.
2. Lead Time Scheduling: The production dates are determined by the lead time scheduling for planned orders. The routings are read to schedule and calculate the capacity requirements on work centers.

How to run MRP for all Products

Step 1) From SAP easy access screen, open transaction MD01, we will run MRP at Plant level.

1. Enter your manufacturing Plant for which you want to take MRP run.
2. Enter Processing key as "NETCH" (Net change in total horizon)
3. Input "1" in Create Purchase req. Which means for externally procured materials, MRP will generate purchase requisitions instead of planned orders.
4. Enter "3" for schedule lines which means MRP will generate schedule lines for raw materials having scheduling agreement.
5. Enter "1" in MRP List and system will create MRP list similar to stock /requirement list for later analysis of previous MRP run.
6. Enter Planning mode "3" as we will delete and recreate all planning data for all materials.
7. Enter Scheduling indicator "2" which means MRP will do lead time scheduling and consider routing times to calculate planned order dates.

BREAKING DOWN 'Materials Requirement Planning - MRP'

MRP was the earliest of the integrated information systems dealing with improvements in productivity for businesses with the use of computers and software technology to provide meaningful data to managers. With the advent of such systems, production efficiency could be greatly improved. As the analysis of data and the technology to capture it became more sophisticated, more comprehensive systems were developed to integrate MRP with other aspects of the manufacturing process.

MATERIAL BUDGETING

Direct materials budget is prepared after computing production requirements by preparing a production budget. *Direct materials budget or materials budgeting* details the raw materials that must be purchased to fulfill the production requirements and to provide for adequate inventories. The required purchases of raw materials are computed as follows:

Raw materials needed to meet the production schedule Add desired ending inventory of raw materialsTotal raw materials needs Less beginning inventory of raw materialsRaw materials to be purchased	XX XX XX XX — — _ XX XX XX XX —— _ XX XX === ===

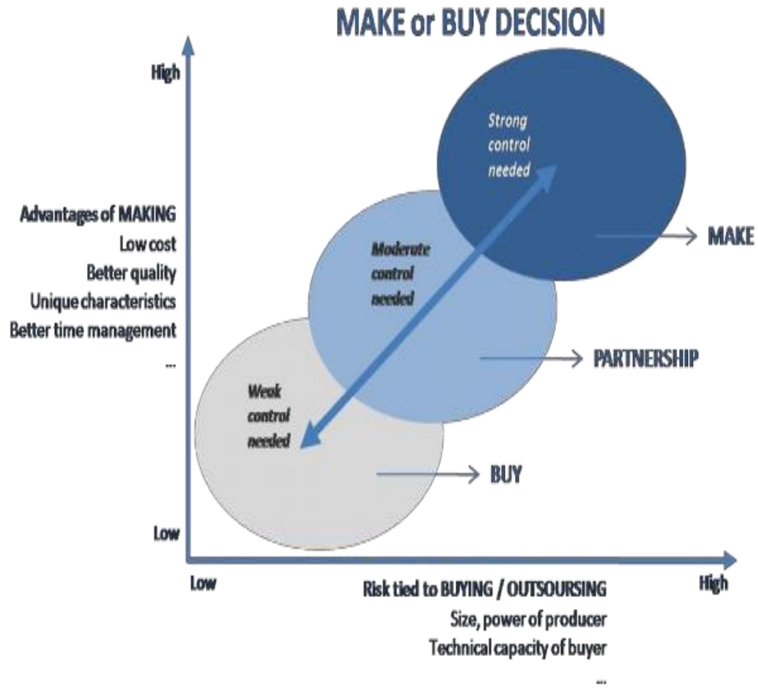
Preparing a budget of this kind is one step in a company's overall material requirements planning (MRP). MRP is an operations management tool that uses a computer to help manage materials and inventories, The objective of material requirements planning (MRP) is to ensure that the right materials are on hand, in the right quantities, and at the right time to support the production budget. The detailed operation of materials requirements planning is covered in most operations management books.

MAKE-OR-BUY DECISION

The make-or-buy decision is the action of deciding between manufacturing an item internally (or in-house) or buying it from an external supplier (also known as outsourcing). Such decisions are typically taken when a firm that has manufactured a part or product, or else considerably modified it, is having issues with current suppliers, or has reducing capacity or varying demand.

Another way to define make-or-buy decision that is closely related to the first definition is this: a decision to perform one of the activities in the value chain in-house, instead of purchasing externally from a supplier. A value chain is the complete range of tasks – such as design, manufacture, marketing and distribution of a product / service that businesses must get done to take a service or product from conception to their customers

Some companies manage all of the tasks in the value chain from manufacturing raw materials all through to the ultimate distribution of the completed goods and provision of after-sales services. Some other companies are happy just to integrate on a smaller scale by buying a lot of the parts and materials that are required for their finished products. When a business is involved in more than one activity in the whole value chain, it is vertically integrated. This kind of integration is quite common.



Vertical integration provides its own set of advantages. An integrated company depends less on its suppliers and so can be certain of a smoother flow of materials and parts for the manufacture than a non-integrated company. In addition, some companies believe they can manage quality better by manufacturing their own parts and materials instead of depending on the quality control standards of external suppliers. What's more, an integrated company realizes revenue from the parts and material that it is "making" rather than "buying" in addition to income from its usual operations.

The benefits of vertical integration are counterbalanced by the benefits of using outside suppliers. By combining demand from different companie, a supplier can enjoy econoies of scale. These economies of scale can cause better quality and lower expenses than would be possible if the business were to endeavor to manufacture the parts or provide a service by itself. At the same time, a business should be careful to retain control over those tasks that are necessary for maintaining its competitive position. Case in point: Hewlett Packard manages the software for laser printers that it manufactures in collaboration with Canon Inc. of Japan.

FACTORS INFLUENCING THE DECISION

To come to a make-or-buy decision, it is essential to thoroughly analyze, all of the expenses associated with product development in addition to expenses associated with buying the product. The assessment should include qualitative and quantitative factors. It should also separate relevant expenses from irrelevant ones and consider only the former. The study should also look at the availability of the product and its quality under each of the two situations.

Introduction to quantitative and qualitative analysis

Quantitative aspects can be calculated and compared whereas qualitative aspects call for subjective judgment and, frequently require multiple opinions. In addition, some of the associated factors can be quantified with sureness while it is necessary to estimate other factors. The make-or-buy decision calls for a thorough assessment from all angles.

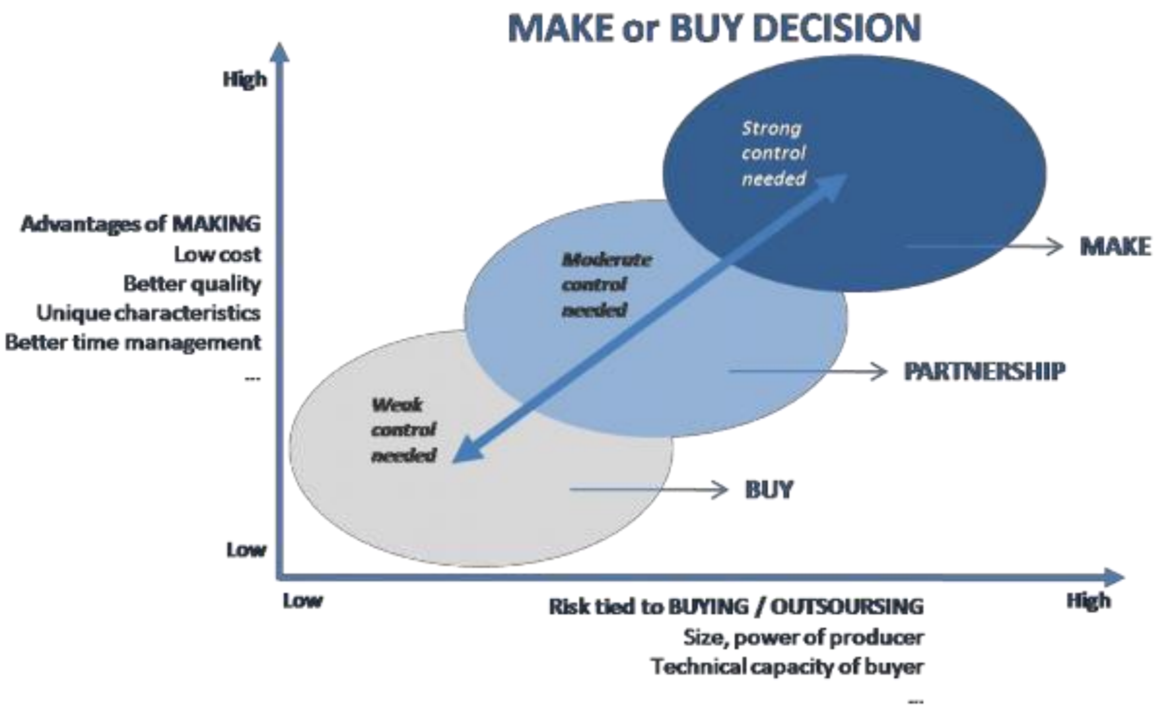
Quantitative aspects are essentially the incremental costs stemming from making or purchasing the component. Factors of this type to look at may incorporate things such as availability of manufacturing facilities, needed resources and manufacturing capacity. This may also incorporate variable and fixed expenses that can be found out either by way of estimation or with certainty. Similarly, quantitative expenses would incorporate the cost of the good under consideration as the price is determined by suppliers offering the product for sale in the marketplace.

Qualitative factors to look at call for more subjective assessment. Examples of such factors include control over component quality, the reliability and reputation of the suppliers, the possibility of modifying the decision in the future, the long-term viewpoint concerning manufacture or purchase of the product, and the impact of the decision on customers and suppliers.

Introduction to relevant and irrelevant expenses

As mentioned earlier, distinguishing between these two kinds of expenses is necessary to come to a make-or-buy decision. Relevant costs for manufacturing the good are all the expenses that could be avoided by not manufacturing the product in addition to the opportunity cost resulting from utilizing production facilities to manufacture the good as against the next best alternative utilization of the manufacturing facilities. Relevant costs for buying the product are all the expenses relating to purchasing a product from suppliers. Irrelevant costs are the expenses involved irrespective of whether the good is produced internally or bought externally.

Manufacturing businesses have to consider cost-lowering decisions on a daily basis. This article will take you through all the basic things you need to know with respect to the vital cost-saving decision known as make-or-buy. You'll learn 1) **what is make-or-buy decision?** 2) **factors influencing the decision**, 3) **how to arrive at a make-or-buy decision**, and an 4) **example**.



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Factors favoring in-house manufacture

- Wish to integrate plant operations
- Need for direct control over manufacturing and/or quality
- Cost considerations (costs less to make the part)
- Improved quality control
- No competent suppliers and/or unreliable suppliers
- Quantity too little to interest a supplier
- Design secrecy is necessary to protect proprietary technology
- Control of transportation, lead time, and warehousing expenses
- Political, environmental, or social reasons
- Productive utilization of excess plant capacity to assist with absorbing fixed overhead (utilizing existing idle capacity)
- Wish to keep up a stable workforce (in times when there are declining sales)
- Greater guarantee of continual supply

Factors favoring purchase from outside

- Suppliers' specialized know-how and research are more than that of the buyer
- Lack of expertise
- Small-volume needs
- Cost aspects (costs less to purchase the item)
- Wish to sustain a multiple source policy
- Item not necessary to the firm's strategy
- Limited facilities for a manufacture or inadequate capacity
- Brand preference
- Inventory and procurement considerations

Costs for the make analysis

- Direct labor expenses
- Incremental inventory-carrying expenses
- Incremental capital expenses

- Incremental purchasing expenses
- Incremental factory operating expenses
- Incremental managerial expenses
- Delivered purchased material expenses
- Any follow-on expenses resulting from quality and associated problems

Cost factors for the buy analysis

- Transportation expenses
- Purchase price of the part
- Incremental purchasing expenses
- Receiving and inspection expenses
- Any follow-on expenses associated with service or quality

Though the cost is rarely the sole criterion utilized to come to a make-or-buy decision, easy break-even analysis can be a useful way to quickly guess the expense implications within a decision.

VENDOR RATING

Vendor rating is the result of a formal vendor evaluation system. Vendors or suppliers are given standing, status, or title according to their attainment of some level of performance, such as delivery, lead time, quality, price, or some combination of variables. The motivation for the establishment of such a rating system is part of the effort of manufacturers and service firms to ensure that the desired characteristics of a purchased product or service is built in and not determined later by some after-the-fact indicator. The vendor rating may take the form of a hierarchical ranking from poor to excellent and whatever rankings the firm chooses to insert in between the two. For some firms, the vendor rating may come in the form of some sort of award system or as some variation of certification. Much of this attention to vender rating is a direct result of the widespread implementation of the just-in-time concept in the United States and its focus on the critical role of the buyer-supplier relationship.

Most firms want vendors that will produce all of the products and services defect-free and deliver them just in time (or as close to this ideal as reasonably possible). Some type of vehicle is needed to determine which supplying firms are capable of coming satisfactorily close to this and thus to be retained as current suppliers. One such vehicle is the vendor rating.
In order to accomplish the rating of vendors, some sort of review process must take place. The process begins with the identification of vendors who not only can supply the needed product or service but is a strategic match for the buying firm. Then important factors to be used as criteria for vendor evaluation are determined. These are usually variables that add value to the process through increased service or decreased cost. After determining which factors are critical, a method is devised that allows the vendor to be judged or rated on each individual factor.

It could be numeric rating or a Likert-scale ranking. The individual ratings can then be weighted according to importance, and pooled to arrive at an overall vendor rating. The process can be somewhat complex in that many factors can be complementary or conflicting. The process is further complicated by fact that some factors are quantitatively measured and others subjectively.

Once established, the rating system must be introduced to the supplying firm through some sort of formal education process. Once the buying firm is assured that the vendor understands what is expected and is able and willing to participate, the evaluation process can begin. The evaluation could be an ongoing process or it could occur within a predetermined time frame, such as quarterly. Of course the rating must be conveyed to the participating vendor with some firms actually publishing overall vendor standings. If problems are exposed, the vendor should formally present an action plan designed to overcome any problems that may have surfaced.

Many buying firms require the vendor to show continuing improvement in predetermined critical areas.

CRITERIA FOR EVALUATION

Vendor performance is usually evaluated in the areas of pricing, quality, delivery, and service. Each area has a number of factors that some firms deem critical to successful vendor performance.

Pricing factors include the following:

- Competitive pricing. The prices paid should be comparable to those of vendors providing similar product and services. Quote requests should compare favorably to other vendors.
- Price stability. Prices should be reasonably stable over time.
- Price accuracy. There should be a low number of variances from purchase-order prices on invoiced received.
- Advance notice of price changes. The vendor should provide adequate advance notice of price changes.
- Sensitive to costs. The vendor should demonstrate respect for the customer firm's bottom line and show an understanding of its needs. Possible cost savings could be suggested. The vendor should also exhibit knowledge of the market and share this insight with the buying firm.
- Billing. Are vendor invoices are accurate? The average length of time to receive credit memos should be reasonable. Estimates should not vary significantly from the final invoice. Effective vendor bills are timely and easy to read and understand.

Quality factors include:

- Compliance with purchase order. The vendor should comply with terms and conditions as stated in the purchase order. Does the vendor show an understanding of the customer firm's expectations?
- Conformity to specifications. The product or service must conform to the specifications identified in the request for proposal and purchase order. Does the product perform as expected?
- Reliability. Is the rate of product failure within reasonable limits?
- Reliability of repairs. Is all repair and rework acceptable?
- Durability. Is the time until replacement is necessary reasonable?
- Support. Is quality support available from the vendor? Immediate response to and resolution of the problem is desirable.
- Warranty. The length and provisions of warranty protection offered should be reasonable. Are warranty problems resolved in a timely manner?
- State-of-the-art product/service. Does the vendor offer products and services that are consistent with the industry

state-of-the-art? The vendor should consistently refresh product life by adding enhancements. It should also work with the buying firm in new product development.

Delivery factors include the following:

- Time. Does the vendor deliver products and services on time; is the actual receipt date on or close to the promised date? Does the promised date correspond to the vendor's published lead times? Also, are requests for information, proposals, and quotes swiftly answered?
- Quantity. Does the vendor deliver the correct items or services in the contracted quantity?
- Lead time. Is the average time for delivery comparable to that of other vendors forsimilar products and services?
- Packaging. Packaging should be sturdy, suitable, properly marked, and undamaged. Pallets should be the proper size with no overhang.
- Documentation. Does the vendor furnish proper documents (packing slips, invoices, technical manual, etc.) with correct material codes and proper purchase order numbers?
- Emergency delivery. Does the vendor demonstrate extra effort to meet requirements when an emergency delivery is requested?

Finally, these are service factors to consider:

- Good vendor representatives have sincere desire to serve. Vendor reps display courteous and professional approach, and handle complaints effectively. The vendor should also provide up-to-date catalogs, price information, and technical information. Does the vendor act as the buying firm's advocate within the supplying firm?
- Inside sales. Inside sales should display knowledge of buying firms needs. It should also be helpful with customer inquiries involving order confirmation, shipping schedules, shipping discrepancies, and invoice errors.
- Technical support. Does the vendor provide technical support for maintenance, repair, and installation situations? Does it provide technical instructions, documentation, general information? Are support personnel courteous, professional, and knowledgeable? The vendor should provide training on the effective use of its products or services.
- Emergency support. Does the vendor provide emergency support for repair or replacement of a failed product.
- Problem resolution. The vendor should respond in a timely manner to resolve problems. An excellent vendor provides follow-up on status of problem correction.

A 2001 article in *Supply Management* notes that while pricing, quality, delivery, and service are suitable for supplies that are not essential to the continued success of the buying firm, a more comprehensive approach is needed for suppliers that are critical to the success of the firm's strategy or competitive advantage. For firms that fall into the latter category performance may need to be measured by the following 7 C's.

1. Competency—managerial, technical, administrative, and professional competence ofthe supplying firm.
2. Capacity—supplier's ability to meet physical, intellectual and financial requirements.
3. Commitment—supplier's willingness to commit physical, intellectual and financial resources.
4. Control—effective management control and information systems.

5. Cash resources—financial resources and stability of the supplier. Profit, ROI, ROE, asset-turnover ratio.
6. Cost—total acquisition cost, not just price.
7. Consistency—supplier's ability to exhibit quality and reliability over time.

If two or more firms supply the same or similar products or services, a standard set of criteria can apply to the vendor's performance evaluation. However, for different types of firms or firms supplying different products or services, standardized evaluation criteria may not be valid. In this case, the buying firm will have to adjust its criteria for the individual vendor. For example, Honda of America adjusts its performance criteria to account for the impact of supplier problems on consumer satisfaction or safety. A supplier of brakes would be held to a stricter standard than a supplier of radio knobs.

BENEFITS

Benefits of vendor rating systems include:

- Helping minimize subjectivity in judgment and make it possible to consider all relevant criteria in assessing suppliers.
- Providing feedback from all areas in one package.
- Facilitating better communication with vendors.
- Providing overall control of the vendor base.
- Requiring specific action to correct identified performance weaknesses.
- Establishing continuous review standards for vendors, thus ensuring continuous improvement of vendor performance.
- Building vendor partnerships, especially with suppliers having strategic links.
- Developing a performance-based culture.

Vendor ratings systems provide a process for measuring those factors that add value to the buying firm through value addition or decreased cost. The process will continually evolve and the criteria will change to meet current issues and concerns.

WASTE MANAGEMENT

Waste management is collection, transportation, and disposal of garbage, sewage and other waste products.

Waste management is the process of treating solid wastes and offers variety of solutions for recycling items that don’t belong to trash. It is about how garbage can be used as a valuable resource. Waste management is something that each and every household and business owner in the world needs. Waste management disposes of the products and substances that you have use in a safe and efficient manner.

According to Wikipedia,

"*Waste management or Waste disposal is all the activities and actions required to manage waste from its inception to its final disposal. This includes amongst other things, collection, transport, treatment and disposal of waste together with monitoring and regulation. It also encompasses the legal and regulatory framework that relates to waste management encompassing guidance on recycling etc.*"

You will find there are eight major groups of waste management methods, each of them divided into numerous categories. Those groups include source reduction and reuse, animal feeding, recycling, composting, fermentation, landfills, incineration and land application. You can start using many techniques right at home, like reduction and reuse, which works to reduce the amount of disposable material used.

Various Methods of Waste Disposal

Although there are many methods available to dispose off waste. Let's take a look at some of the most commonly used methods that you should know about waste management.

Landfills

Throwing daily waste/garbage in the landfills is the most popularly used method of waste disposal used today. This process of waste disposal focuses attention on burying the waste in the land. Landfills are commonly found in developing countries. There is a process used that eliminates the odors and dangers of waste before it is placed into the ground. While it is true this is the most popular form of waste disposal, it is certainly far from the only procedure and one that may also bring with it an assortment of space.

This method is becoming less these days although, thanks to the lack of space available and the strong presence of methane and other landfill gases, both of which can cause numerous contamination problems. Landfills give rise to air and water pollution which severely affects the environment and can prove fatal to the lives of humans and animals. Many areas are reconsidering the use of landfills.

Incineration/Combustion

Incineration or combustion is a type disposal method in which municipal solid wastes are burned at high temperatures so as as to convert them into residue and gaseous products. The biggest advantage of this type of method is that it can reduce the volume of solid waste to 20 to 30 percent of the original volume, decreases the space they take up and reduce the stress on landfills.

This process is also known as thermal treatment where solid waste materials are converted by Incinerators into heat, gas, steam and ash. Incineration is something that is very in countries where landfill space is no longer available, which includes Japan.

Recovery and Recycling

Resource recovery is the process of taking useful discarded items for a specific next use. These discarded items are then processed to extract or recover materials and resources or convert them to energy in the form of useable heat, electricity or fuel.

Recycling is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component of Reduce, Reuse and Recycle waste hierarchy. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use.

Plasma gasification

Plasma gasification is another form of waste management. Plasma is a primarily an electrically charged or a highly ionized gas. Lighting is one type of plasma which produces temperatures that exceed 12,600 °F . With this method of waste disposal, a vessel uses characteristic plasma torches operating at +10,000 °F which is creating a gasification zone till 3,000 °F for the conversion of solid or liquid wastes into a syngas.

During the treatment solid waste by plasma gasification, the waste's molecular bonds are broken down as result of the intense heat in the vessels and the elemental components. Thanks to this process, destruction of waste and dangerous materials is found. This form of waste disposal provides renewable energy and an assortment of other fantastic benefits.

Composting

Composting is a easy and natural bio-degradation process that takes organic wastes i.e. remains of plants and garden and kitchen waste and turns into nutrient rich food for your plants. Composting, normally used for organic farming, occurs by allowing organic materials to sit in one place for months until microbes decompose it. Composting is one of the best method of waste disposal as it can turn unsafe organic products into safe compost. On the other side, it is slow process and takes lot of space.and turns it to

Waste to Energy (Recover Energy)

Waste to energy(WtE) process involves converting of non-recyclable waste items into useable heat, electricity, or fuel through a variety of processes. This type of source of energy is a renewable energy source as non-recyclable waste can be used over and over again to

create energy. It can also help to reduce carbon emissions by offsetting the need for energy from fossil sources. Waste-to-Energy, also widely recognized by its acronym WtE is the generation of energy in the form of heat or electricity from waste.

Avoidance/Waste Minimization

The most easier method of waste management is to reduce creation of waste materials thereby reducing the amount of waste going to landfills. Waste reduction can be done through recycling old materials like jar, bags, repairing broken items instead of buying new one, avoiding use of disposable products like plastic bags, reusing second hand items, and buying items that uses less designing.

Recycling and composting are a couple of the best methods of waste management. Composting is so far only possible on a small scale, either by private individuals or in areas where waste can be mixed with farming soil or used for landscaping purposes. Recycling is widely used around the world, with plastic, paper and metal leading the list of the most recyclable items. Most material recycled is reused for its original purpose.

The Bottom Line

There are certain waste types that are considered as hazardous and cannot be disposed of without special handling which will prevent contamination from occurring. Biomedical waste is one example of such. This is found in health care facilities and similar institutions. The special waste disposal system for this unit in place to dispose of this type of waste.

UNIT –V

STORES MANAGEMENT

A professionally managed Stores has a process and a space within, to receive the incoming materials (Receiving Bay), keep them for as long as they are not required for use (Custody) and then to move them out of stores for use (Issue).

In a manufacturing firm this process forms a cycle to maintain and run the activities of Stores. **The basic responsibilities** of stores are to act as custodian and controlling agent for parts, supplies, and materials, and to provide service to users of those goods.

Typically and at times essentially, a Stores has to follow certain activities that are managed through use of various resources and are thus called Stores Management.

The task of storekeeping relates to safe custody and preservation of the materials stocked, to their receipts, issue and accounting.

The objective is to efficiently and economically provide the right materials at the time when it is required and in the condition in which it is required.

The basic job of the Stores Manager hence is to receive the goods and act as a caretaker of the materials and issue them as and when Production demands it. Needless to say storekeeping activity does not add any value to the product. In fact it only adds to the cost. The organization has to spend money on space ie. expenditure on land, building and roads, equipment, machinery and other facilities provided such as electricity, people i.e. salaries and wages, insurance, maintenance costs, stationary, communication expenses and the cost to maintain the inventory etc. All of these get added to the organisational overheads and finally get reflected in the costing of the finished product. However, it is an essential function in any manufacturing or marketing organization. This basic reason has propelled the evolution of philisophies such as JIT, JIT II etc.

Thus , the basic functions , to manage a stores, carried out are:

- Receiving of incoming consignments (goods)
- Safe keeping of goods (Custody)
- Disposal of undesirable goods
- Inventory Management

House keeping and record maintenance

It all starts with a suitable Lay out design of stores. Depending upon the nature of items used for processing by the organisation the lay out and type of stores are selected. For example , a process that requires use of raw materials , not costly enough, an open and nearby stores with truck / rail inside movement possibility can be adequate. Similarly, for storing costly material, a closed and restricted type of stores shall be needed.

However, irrespective of the type and lay out , any Stores would have , as its starting activity , receiving and accounting of the incoming goods. This part of Stores is known as **Receiving Bay.**

Once the material has been received and cleared through inspection and accepted for use, it needs safe custody till it's actually used. It calls for a separate physical storage space , open or closed, as per need. It maintains all documents that are able to trace an item , show all its details and preserve it up to its shelf life in the manner prescribed or till it is issued for use.

This part of Stores is called **Custody**. Thus the role of Custody is to receive and preserve the material and then to issue it to the user, as and when needed. A stage comes when the material is needed for use. Stores thus releases the material from its custody to the user department and the process is called 'issue of goods. It might also happen that after partial use , some materials having useable value in future are returned to the stores and thus they also become part of the custody again.

In the long drawn process of preserving the materials till its use ,some materials might get obsolete and unserviceable and may require removal from stores , in order to clear space for other incoming goods. This activity is known as Disposal of goods for which auction etc is done. A store refers to raw materials, work-in-progress and finished goods remaining in stock. Store- keeping means the activities relating to purchasing, issuing, protecting, storing and recording of the materials. Store-keeping includes the receipts and issues of materials, their recording, movements in and out of the store and safeguarding of materials. The store is a service department headed by a store-keeper who is responsible for a proper storage, protection and issue of all kinds of materials.

Objectives Of Store-keeping

The following are the main objectives of store-keeping

* To avoid over and under-stocking of materials.
* To maintain systematic records of materials.
* To protect materials from losses and damages.
* To minimize the storage costs of materials

Types Of Stores

Generally, there are three types of stores

1. Centralized Stores
2. Decentralized Stores
3. Centralized Stores With Sub-stores

SAFETY STOCK

Safety stock (also called **buffer stock**) is a term used by logisticians to describe a level of extra stock that is maintained to mitigate risk of stockouts (shortfall in raw material or packaging) due to uncertainties in supply and demand. Adequate safety stock levels permit business operations to proceed according to their plans.[1] Safety stock is held when there is uncertainty in demand, supply, or manufacturing yield; it serves as an insurance against stockouts.

Safety stock is an additional quantity of an item held in the inventory in order to reduce the risk that the item will be out of stock, safety stock act as a buffer stock in case the sales are greater than planned and or the supplier is unable to deliver the additional units at the expected time.

With a new product, safety stock can be utilized as a strategic tool until the company can judge how accurate their forecast is after the first few years, especially when used with a material requirements planning worksheet. The less accurate the forecast, the more safety stock is required to ensure a given level of service. With a material requirements planning (MRP) worksheet a company can judge how much they will need to produce to meet their forecasted sales demand without relying on safety stock. However, a common strategy is to try and reduce the level of safety stock to help keep inventory costs low once the product demand becomes more predictable. This can be extremely important for companies with a smaller financial cushion or those trying to run on lean manufacturing, which is aimed towards eliminating waste throughout the production process.

The amount of safety stock an organization chooses to keep on hand can dramatically affect their business. Too much safety stock can result in high holding costs of inventory. In addition, products which are stored for too long a time can spoil, expire, or break during the warehousing process. Too little safety stock can result in lost sales and, thus, a higher rate of customer turnover. As a result, finding the right balance between too much and too little safety stock is essential.

Reasons for keeping safety stock

Safety stocks are mainly used in a “Make To Stock” manufacturing strategy. This strategy is employed when the lead time of manufacturing is too long to satisfy the customer demand at the right cost/quality/waiting time.

The main goal of safety stocks is to absorb the variability of the customer demand. Indeed, the Production Planning is based on a forecast, which is (by definition) different from the real demand. By absorbing these variations, safety stock improves the customer service level.

Creating a safety stock will also prevent stock-outs from other variations, like an upward trend in customer demand.

Safety stock is used as a buffer to protect organization from stockouts caused by inaccurate planning or poor schedule adherence by suppliers. As such, its cost (in both material and management) is often seen as a drain on financial resources that results in reduction initiatives. In addition, time sensitive goods such as food, drink, and other perishable items could spoil and go to waste if held as safety stock for too long.[1] Various methods exist to reduce safety stock, these include better use of technology, increased collaboration with suppliers, and more accurate forecasting [2][3] In a lean supply environment, lead times are reduced, which can help minimize safety stock levels thus reducing the likelihood and impact of stockouts.[4] Due to the cost of safety stock, many organizations opt for a service level led safety stock calculation; for example, a 95% service level could result in stockouts, but is at a level that is satisfactory to the company. The lower the service level, the lower the requirement for safety stock.

An Enterprise Resource Planning system (ERP system) can also help an organization reduce its level of safety stock. Most ERP systems provide a type of Production Planning module. An ERP module such as this can help a company develop highly accurate and dynamic sales forecasts and sales and operations plans. By creating more accurate and dynamic forecasts, a company reduces their chance of producing insufficient inventory for a given period and, thus, should be able to reduce the amount of safety stock that they require.[1] In addition, ERP systems use established formulas to help calculate appropriate levels of safety stock based on the previously developed production plans. While an ERP system aids an organization in estimating a reasonable amount of safety stock, the ERP module must be set up to plan requirements effectively.[5]

Inventory policy

The size of the safety stock depends on the type of inventory policy that is in effect. An inventory node is supplied from a "source" which fulfills orders for the considered product after a certain replenishment lead time. In a **periodic** inventory policy the inventory level is checked periodically (such as once a month) and an order is placed at that time as to meet the expected demand until next order. In this case, the safety stock is calculated considering the demand and supply variability risks during this period plus the replenishment lead time. If the inventory policy is **continuous** policy (such as an Order point-Order Quantity policy or an Order Point- Order Up To policy) the inventory level is continuously monitored and orders are placed with freedom of time. In this case, safety stock is calculated considering the risk of only the replenishment lead time. If applied correctly, continuous inventory policies can lead to smaller safety stock whilst ensuring higher service levels, in line with lean processes and more efficient overall business management.

Methods for calculating safety stocks

Reorder Point Method with Demand and Lead Time Uncertainty for Type I Service

A commonly used approach calculates[6][7] the safety stock based on the following factors:

- Demand: the amount of items consumed by customers, usually a random variable.
- Lead time: the delay between the time the reorder point (inventory level which initiates an order is reached and renewed availability.
- Service level: the desired probability of meeting demand during lead time without a stockout. Naturally, when the desired service level is increased, the required safety stock increases as well.
- Forecast error: an estimate of how far actual demand may be from forecast demand.

INVENTORY CONTROL

Inventory control is the processes employed to maximize a company's use of inventory. The goal of inventory control is to generate the maximum profit from the least amount of inventory investment without intruding upon customer satisfaction levels. Given the impact on customers and profits, inventory control is one of the chief concerns of businesses that have large inventory investments, such as retailers and distributors.

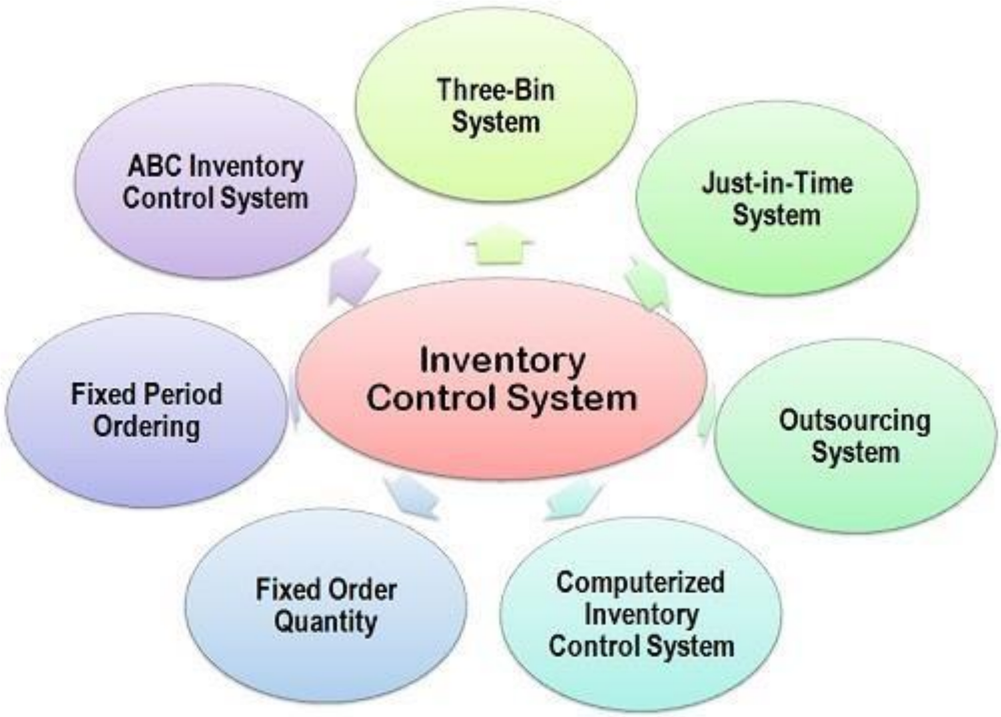
Some of the more common areas in which to exercise inventory control are:

- ***Raw materials availability***. There must be enough raw materials inventory on hand to ensure that new jobs are launched in the production process in a timely manner, but not so much that the company is investing in an inordinate amount of inventory. The key control designed to address this balance is ordering frequently in small lot sizes from suppliers. Few suppliers are willing to do this, given the cost of frequent deliveries, so a company may have to engage in sole sourcing of goods in order to entice suppliers into engaging in just-in-time deliveries.
- ***Finished goods availability***. A company may be able to charge a higher price for its products if it can reliably ship them to customers at once. Thus, there may be a pricing premium associated with having high levels of finished goods on hand. However, the cost of investing in so much inventory may exceed the profits to be gained from doing so, so inventory control involves balancing the proportion of allowable backorders with a reduced level of on-hand finished goods. This may also lead to the use of a just-in-time manufacturing system, which only produces goods to specific customer orders (which nearly eliminates inventory levels).
- ***Work in process.*** It is possible to reduce the amount of inventory that is being worked on in the production process, which further reduces the inventory investment. This can involve a broad array of actions, such as using production cells to work on subassemblies, shifting the work area into a smaller space to reduce the amount of inventory travel time, reducing machine setup times to switch to new jobs, and minimizing job sizes.
- ***Reorder point.*** A key part of inventory control is deciding upon the best inventory level at which to reorder additional inventory. If the reorder level is set very low, this keeps the investment in inventory low, but also increases the risk of a stockout, which may interfere with the production process or sales to customers. The reverse problems arise if the reorder point is set too high. There can be a considerable amount of ongoing adjustment to reorder levels to fine tune these issues. An alternative method is to use a material requirements planning system to order only enough inventory for expected production levels.
- ***Bottleneck enhancement.*** There is nearly always a bottleneck somewhere in the production process that interferes with the ability of the entire operation to increase its output. Inventory control can involve placing an inventory buffer immediately in front of the bottleneck operation, so that the bottleneck can keep running even if there are production failures upstream from it that would otherwise interfere with any inputs that it requires.
- ***Outsourcing***. Inventory control can also involve decisions to outsource some activities to suppliers, thereby shifting the inventory control burden to the suppliers (though usuallyin exchange for a reduced level of profitability).

The issues noted here highlight how difficult it can be to manage the inventory control function. Your operating boundaries are to either invest too much in inventory, or to have too little inventory on hand to satisfy the production manager or customers.

INVENTORY CONTROL SYSTEM

Definition: The **Inventory control system** is maintained by every firm to manage its inventories efficiently. Inventory is the stock of products that a company manufactures for sale and the components or raw materials that make up the product. Hence, an inventory comprises of the buffer of raw material, work-in-process inventories and finished goods.



Following are the popular Inventory Control Systems that are being used by big manufacturers and the retail units:

1. ABC Inventory Control System
2. Three-Bin System
3. Just-in-Time (JIT) System
4. Outsourcing Inventory System
5. Computerized Inventory Control System
6. Fixed Order Quantity
7. Fixed Period Ordering

There are several inventory control systems that are in practice, and these range from simple system to a complex one depending upon nature and the size of the business operations. Talking about the simple system, several small manufacturing firms operate a Two-Bin System; wherein inventory is stored in two bins. Once the inventory in one bin is used, and the order is placed, meanwhile, the inventory from the other bin is used by the firm.

This system is quite inadequate for the larger firms that deal in several product lines and maintain a heavy sales counter. Thus, self –operating or an automatic computer system is to be employed to keep track on the inventory stock and place the order in case of a shortage.

Important Techniques of Inventory Control System

Some of the most important techniques of inventory control system are: 1. Setting up of various stock levels. 2. Preparations of inventory budgets. 3. Maintaining perpetual inventory system. 4. Establishing proper purchase procedures. 5. Inventory turnover ratios. and 6. ABC analysis.

1. Setting up of various stock levels:

To avoid over-stocking and under stocking of materials, the management has to decide about the maximum level, minimum level, re-order level, danger level and average level of materials to be kept in the store.

These terms are explained below:

(a) *Re-ordering level:*

It is also known as 'ordering level' or 'ordering point' or 'ordering limit'. It is a point at which order for supply of material should be made.

This level is fixed somewhere between the maximum level and the minimum level in such a way that the quantity of materials represented by the difference between the re-ordering level and the minimum level will be sufficient to meet the demands of production till such time as the materials are replenished. Reorder level depends mainly on the maximum rate of consumption and order lead time. When this level is reached, the store keeper will initiate the purchase requisition.

Reordering level is calculated with the following formula:

Re-order level =Maximum Rate of consumption x maximum lead time

(b) *Maximum Level:*

Maximum level is the level above which stock should never reach. It is also known as 'maximum limit' or 'maximum stock'. The function of maximum level is essential to avoid unnecessary blocking up of capital in inventories, losses on account of deterioration and obsolescence of materials, extra overheads and temptation to thefts etc. This level can be determined with the following formula. Maximum Stock level = Reordering level + Reordering quantity —(Minimum Consumption x Minimum re-ordering period)

(c) *Minimum Level:*

It represents the lowest quantity of a particular material below which stock should not be allowed to fall. This level must be maintained at every time so that production is not held up due to shortage of any material.

It is that level of inventories of which a fresh order must be placed to replenish the stock. This level is usually determined through the following formula:

Minimum Level = Re-ordering level — (Normal rate of consumption x Normal delivery period)

(d) *Average Stock Level:*

Average stock level is determined by averaging the minimum and maximum level of stock.

The formula for determination of the level is as follows:

Average level =1/2 (Minimum stock level + Maximum stock level)

This may also be expressed by minimum level + 1/2 of Re-ordering Quantity.

(e) ***Danger Level:***

Danger level is that level below which the stock should under no circumstances be allowed to fall. Danger level is slightly below the minimum level and therefore the purchases manager should make special efforts to acquire required materials and stores.

This level can be calculated with the help of following formula:

Danger Level =Average rate of consumption x Emergency supply time.

(f) ***Economic Order Quantity (E.O.Q.):***

One of the most important problems faced by the purchasing department is how much to order at a time. Purchasing in large quantities involve lesser purchasing cost. But cost of carrying them tends to be higher. Likewise if purchases are made in smaller quantities, holding costs are lower while purchasing costs tend to be higher.

Hence, the most economic buying quantity or the optimum quantity should be determined by the purchase department by considering the factors such as cost of ordering, holding or carrying.

This can be calculated by the following formula:

$Q = \sqrt{2AS/I}$

where Q stands for quantity per order ;

A stands for annual requirements of an item in terms of rupees; S stands for
cost of placement of an order in rupees; and
I stand for inventory carrying cost per unit per year in rupees.

2. **Preparation of Inventory Budgets:**

Organisations having huge material requirement normally prepare purchase budgets. The purchase budget should be prepared well in advance. The budget for production and consumable material and for capital and maintenance material should be separately prepared.

Sales budget generally provide the basis for preparation of production plans. Therefore, the first step in the preparation of a purchase budget is the establishment of sales budget.

As per the production plan, material schedule is prepared depending upon the amount and return contained in the plan. To determine the net quantities to be procured, necessary adjustments for the stock already held is to be made.

They are valued as standard rate or current market. In this way, material procurement budget is prepared. The budget so prepared should be communicated to all departments concerned so that the actual purchase commitments can be regulated as per budgets.

At periodical intervals actuals are compared with the budgeted figures and reported to management which provide a suitable basis for controlling the purchase of materials,

3. **Maintaining Perpetual Inventory System:**

This is another technique to exercise control over inventory. It is also known as automatic inventory system. The basic objective of this system is to make available details about the quantity and value of stock of each item at all times. Thus, this system provides a rigid control over stock of materials as physical stock can be regularly verified with the stock records kept in the stores and the cost office.

4. **Establishing Proper Purchase Procedures:**

A proper purchase procedure has to be established and adopted to ensure necessary inventory control. The following steps are involved.

(a) ***Purchase Requisition:***

It is the requisition made by the various departmental heads or storekeeper for their various material requirements. The initiation of purchase begins with the receipts of a purchase requisition by the purchase department.

(b) ***Inviting Quotations:***

The purchase department will invite quotations for supply of goods on the receipt of purchase requisition.

(c) ***Schedule of Quotations:***

The schedule of quotations will be prepared by the purchase department on the basis of quotations received.

(d) ***Approving the supplier:***

The schedule of quotations is put before the purchase committee who selects the supplier by considering factors like price, quality of materials, terms of payment, delivery schedule etc.

(e) ***Purchase Order:***

It is the last step and the purchase order is prepared by the purchase department. It is a written authorisation to the supplier to supply a specified quality and quantity of material at the specified time and place mentioned at the stipulated terms.

5. **Inventory Turnover Ratio:**

These are calculated to minimise the inventory by the use of the following formula:

Inventory Turnover Ratio

= Cost of goods consumed/sold during the period/Average inventory held during the period

The ratio indicates how quickly the inventory is used for production. Higher the ratio, shorter will be the duration of inventory at the factory. It is the index of efficiency of material management.

The comparison of various inventory turnover ratios at different items with those of previous years may reveal the following four types of inventories:

(a) ***Slow moving Inventories:***

These inventories have a very low turnover ratio. Management should take all possible steps to keep such inventories at the lowest levels.

(b) ***Dormant Inventories:***

These inventories have no demand. The finance manager has to take a decision whether such inventories should be retained or scrapped based upon the current market price, conditions etc.

(c) ***Obsolete Inventories:***

These inventories are no longer in demand due to their becoming out of demand. Such inventories should be immediately scrapped.

(d) ***Fast moving inventories:***

These inventories are in hot demand. Proper and special care should be taken in respect of these inventories so that the manufacturing process does not suffer due to shortage of such inventories.

Perpetual inventory control system:

In a large b essential to have information about continuous availability of different types of materials and stores purchased, issued and their balance in hand. The perpetual inventory control system enables the manufacturer to know about the availability of these materials and stores without undergoing the cumbersome process of physical stock taking.

Under this method, proper information relating to receipt, issue and materials in hand is kept. The main objective of this system is to have accurate information about the stock level of every item at any time.

Perpetual inventory control system cannot-be successful unless and until it is accompanied by a system of continuous stock taking i.e., checking the total stock of the concern 3/4 times a year by picking 10/15 items daily (as against physical stock taking which takes place once a year).

The items are taken in rotation. In order to have more effective control, the process of continuous stock taking is usually undertaken by a person other than the storekeeper. This will check the functioning of storekeeper also. The items may be selected at random to have a surprise check.
The success of the system of perpetual inventory control depends upon the proper implementation of the system of continuous stock taking.

6. ABC analysis:

In order to exercise effective control over materials, A.B.C. (Always Better Control) method is of immense use. Under this method materials are classified into three categories in accordance with their respective values. Group ‘A’ constitutes costly items which may be only 10 to 20% of the total items but account for about 50% of the total value of the stores.

A greater degree of control is exercised to preserve these items. Group ‘B’ consists of items which constitutes 20 to 30% of the store items and represent about 30% of the total value of stores.

A reasonable degree of care may be taken in order to control these items. In the last category i.e. group ‘Q’ about 70 to 80% of the items is covered costing about 20% of the total value. This can be referred to as residuary category. A routine type of care may be taken in the case of third category.

This method is also known as ‘stock control according to value method’, ‘selective value approach’ and ‘proportional parts value approach’.

If this method is applied with care, it ensures considerable reduction in the storage expenses and it is also greatly helpful in preserving costly items.

. COSTS SYSTEMS OF INVENTORY CONTROL

In business, an inventory control system is a system that integrates all aspects of administering a company’s inventories including shipping, purchasing, receiving, warehouse storage, turnover, tracking, and re-ordering. These systems often differ based on the type of business being run.

From stretch film packaging to warehouses to manufacturing, and even small businesses, inventory control systems are unique tools that help you measure and balance your operations.

Today, there are various types of inventory control systems to help you track and keep your inventory at hand. Here are the two main types of inventory control systems that you could consider using. The main difference between the two is how often inventory data is updated.

Perpetual Inventory System

The perpetual inventory system is by far the most favored method of tracking inventory in stretch film packaging. In this system, inventory data is entered perpetually or continuously. Once an order is placed or received, the data is updated into the system right away. Compared to the periodic inventory system, a perpetual inventory system is superior because it allows real- time tracking of sales in addition to monitoring individual inventory levels for each item.

However, the calculated inventory levels obtained from a perpetual inventory system may steadily deviate from the actual inventory levels due to theft or unrecorded transactions. It is therefore vital to periodically compare the physical inventories to the actual on-hand quantities and adjust accordingly.

Periodic Inventory System

In this system, inventory data is not kept consistently up to date. Instead, inventory information is updated after a particular interval of time (usually once a year). Although this method is not as efficient as the perpetual system, it appeals to many people because you do not have to expend as much cash upfront to set up the technology and software needed to keep track of data.

One major shortcoming with this system is that for the entire year, you do not have access to inventory data. For stretch film packaging business, this system can prove humongous especially when there is an increase in sales

Valuation Methods

After selecting between one of the two methods, value your inventory. The following inventory three methods are used to compute the cost of goods sold and the cost of ending inventory.

First-in-First-Out Method (FIFO)

Under FIFO, it is assumed that the oldest inventory items are recorded as sold first, and newer inventory remains unsold. This implies that the cost of older inventory/stock is allocated to cost of goods sold, and that of fresh inventory is allocated to ending inventory.

Last-in-First-Out Method (LIFO)

This method is almost the exact opposite of FIFO. Under LIFO, it is assumed that the last items recorded in the inventory are the first to be sold. However, the inventory is valued according to the cost of items purchased earlier in the year. When inflation occurs, LIFO can result in the highest estimate of cost of goods sold and the lowest net income.

Average Cost Method (AVCO)

Under this method, the average cost of all items available for sale during that particular period is taken to determine the cost of goods sold and ending inventory. If there is a rapid inventory turnover, AVCO can more closely be similar to FIFO than LIFO.

ABC analysis

The ABC classification process is an analysis of a range of objects, such as finished products

,items lying in inventory or customers into three categories. It's a system of categorization, with similarities to Pareto analysis, and the method usually categorizes inventory into three classes with each class having a different management control associated.

A - outstandingly important; B - of average importance; C - relatively unimportant as a basis for a control scheme. Each category can and sometimes should be handled in a different way, with more attention being devoted to category A, less to B, and still less to C. Popularly known as the "80/20" rule ABC concept is applied to inventory management as a rule- of-thumb. It says that about 80% of the Rupee value, consumption wise, of an inventory remains in about 20% of the items

This rule , in general , applies well and is frequently used by inventory managers to put their efforts where greatest benefits , in terms of cost reduction as well as maintaining a smooth availability of stock, are attained.

The ABC concept is derived from the Pareto's 80/20 rule curve. It is also known as the 80-20 concept. Here, Rupee / Dollar value of each individual inventory item is calculated on annual consumption basis.

Thus, applied in the context of inventory, it's a determination of the relative ratios between the number of items and the currency value of the items purchased / consumed on a repetitive basis :

- 10-20% of the items (**'A' class**) account for 70-80% of the consumption
- the next 15-25% (**'B' class**) account for 10-20% of the consumption and

the balance 65-75% (**'C' class**) account for 5-10% of the consumption

High value (A), Low value (C) , intermediary value (B)

- 20% of the items account for 80% of total inventory consumption value (Qty consumed X unit rate)
- Specific items on which efforts can be concentrated profitably
- Provides a sound basis on which to allocate funds and time

A,B & C , all have a purchasing / storage policy - "A", most critically reviewed , "B" little less while "C" still less with greater results ABC Analysis is the basis for material management processes and helps define how stock is managed. It can form the basis of various activity including leading plans on alternative stocking arrangements (consignment stock), reorder calculations and can help determine at what intervals inventory checks are carried out (for example A class items may be required to be checked more frequently than c class stores

Inventory Control Application: The ABC classification system is to grouping items according to annual issue value, (in terms of money), in an attempt to identify the small number of items that will account for most of the issue value and that are the most important ones to control for effective inventory management. The emphasis is on putting effort where it will have the most effect.

All the items of inventories are put in three categories, as below :

A Items : These Items are seen to be of high Rupee consumption volume. "A" items usually include 10-20% of all inventory items, and account for 50-60% of the total Rupee consumption volume.

B Items : "B" items are those that are 30-40% of all inventory items, and account for 30-40% of the total Rupee consumption volume of the inventory. These are important, but not critical, and don't pose sourcing difficulties.

C Items : "C" items account for 40-50% of all inventory items, but only 5-10% of the total

Rupee consumption volume. Characteristically, these are standard, low-cost and readily available items. ABC classifications allow the inventory manager to assign priorities for inventory control. Strict control needs to be kept on A and B items, with preferably low safety stock level. Taking a lenient view, the C class items can be maintained with looser control and with high safety stock level. The ABC concept puts emphasis on the fact that every item of inventory is critical and has the potential of affecting ,adversely, production, or sales to a customer or operations. The categorization helps in better control on A and B items.

In addition to other management procedures, ABC classifications can be used to design cycle counting schemes. For example, A items may be counted 3 times per year, B items 1 to 2 times, and C items only once, or not at all.

VED stands for vital, essential and desirable. This analysis relates to the classification of maintenance spare parts and denotes the essentiality of stocking spares.

The spares are split into three categories in order of importance. From the view-points of functional utility, the effects of non-availability at the time of requirement or the operation, process, production, plant or equipment and the urgency of replacement in case of breakdown.

Some spares are so important that their non-availability renders the equipment or a number of equipment in a process line completely inoperative, or even causes extreme damage to plant, equipment or human life.

VED Analysis:

In this analysis, the items are classified on the basis of their criticality to the production process or other services. In the VED classification of materials:

V = Vital items

E = Essential items

D = Desirable items

Vital items are stocked in adequate number to ensure smooth and risk free operation of plant. In other words, without such items the production process would come to a standstill.

Essential items are those whose stock-out would adversely affect the efficiency of the production system. Although the production system would not stop for want to these items, yet their non- availability might cause temporary losses in, or dislocation of production.

The D or desirable class of items are those which are required but do not immediately cause a loss of production.

The VED analysis is done in respect of spare parts. However, this VED classification can also be done in the case of critical raw materials, which are difficult to obtain.

VED analysis

On the other hand some spares are non-functional, serving relatively unimportant purposes and their replacement can be postponed or alternative methods of repair found. All these factors will have direct effects on the stocks of spares to be maintained.

Therefore, it is necessary to classify the spares in the following categories: V:

Vital items which render the equipment or the whole line operation in a process totally and immediately inoperative or unsafe; and if these items go out of stock or are not readily available, there is loss of production for the whole period.

E:

Essential items which reduce the equipment's performance but do not render it inoperative or unsafe; non-availability of these items may result in temporary loss of production or dislocation of production work; replacement can be delayed without affecting the equipment's performance seriously; temporary repairs are sometimes possible.

D:

Desirable items which are mostly non-functional and do not affect the performance of the equipment.

As the common saying goes “Vital Few — trivial many”, the number of vital spares in a plant or a particular equipment will only be a few while most of the spares will fall in ‘the desirable and essential’ category.

However, the decision regarding the stock of spares to be maintained will depend not only on how critical the spares are from the functional point of view (VED analysis) but also on the annual consumption (user) cost of spares (ABC — analysis) and, therefore, for control of spare parts both VED and ABC analyses are to be combined.

Short Notes # SDE Analysis:

The criterion for this analysis is the availability of the materials in the market. In industrial situations where certain materials are scarce (specially in a developing country like India) this analysis is very useful and gives proper guideline for deciding the inventory policies.

The characteristics of the three categories – SD and E – are: S:
Refers to scarce items, items which are in short supply. Usually these are raw materials, spare parts and imported items.

D:

Stands for difficult items, items which are not readily available in local markets and have to be procured from faraway places, or items for which there are a limited number of suppliers; or items for which quality suppliers are difficult to get.

E:

Refer to items which are easily available in the local markets.

FNSD CLASSIFICATION:

Based on the consumption pattern of the items, the FNSD classification calls for classification of items as

F = Fast moving items

N = Normal moving items S =
Slow moving items
D = Dead items or non-moving items.

Cut off points of these classes are usually in terms of number of items issued during the last few years. This helps in preventing obsolescence and ensures disposal of dead stock. Some authors classify the items as FSN where ‘F stands for fast, ‘S’ stand for slow moving, ‘N’ stand for non- moving materials & parts. This will automatically reduce inventory costs.

VALUE ANALYSIS

All organizations strive to create value for their customers. This value creates mind space for product and services. Value analysis, therefore, is a scientific method to increase this value.

Value is a perception hence every customer will have their own perceptions on how they define value. However, overall at the highest level, value is quality, performance, style, design relative to product cost. Increasing value necessarily does not mean decrease in all-inclusive cost of production but providing something extra for which a premium can be charged.

The objective and benefits of value analysis can be summarized as below:

- Value analysis aims to simplify products and process. There by increasing efficiency in managing projects, resolve problems, encourage innovation and improve communication across organization.
- Value analysis enables people to contribute in the value addition process by continuous focus on product design and services.
- Value analysis provides a structure through cost saving initiatives, risk reduction and continuous improvement.

Activities for Value Analysis

Activities for value analysis are separated into following activities:

Product/Service - The 1st step is to identify the product or service which is based on usage/demand, complexity in development and future potential.

Cost Analysis: The next step understands in detail cost structure in developing and manufacturing the product.

Define product and function: The next step is to define all the primary function of the product and service through satisfying the basic need and then taking next step in delighting the customer. For this better understanding of product components and characteristics is required.

Evaluation of alternatives: Through brainstorming possible alternatives can short listed which can provide value to the primary function of the product. Cost evaluation at high level needs to be done for all the alternatives, and the cheapest alternative is short listed.

Secondary Function evaluation: Secondary functions of the product and services are studied and evaluated.

Recommendation: Value Analysis done has to communicate to the various level of the management team as to get acceptance.

Value Analysis Team

The process of value analysis is carried out by value analysis team. So it becomes paramount that team selection for value analysis also follows a structured process. Value analysis team consists of trained and qualified team members who have background and knowledge about the project.

Team leader is selected by the project manager. Team size for value analysis is 5 to 8.

Value Analysis Process

Value analysis process can be divided into three phases of mainly pre-analysis, analysis and post analysis. Pre-analysis contains activities of project selection and team selection. Analysis phase as the name suggests consists of activities like investigation, speculation, evaluation, development and presentation of the report. Post analysis consists of activities' implementation of the report and regular audit.

Functional Analysis part of Value Analysis

Function analysis is required to transform the project elements from design of product towards function of product. The main categories are Basic, Secondary, Required Secondary Aesthetic, Unwanted, Higher Order and Assumed.

Concept And Meaning Of Cost Reduction

Cost reduction means conducting some innovations in the way of working in a new style, so that the excess costs of production and operation could be eliminated. Cost reduction programs are directed toward specific efforts to reduce costs by improving methods work arrangements and products. Cost reduction can be made in different areas and stages of production, storing and distribution process by applying more advanced and scientific techniques of operation. So, a cost reduction program needs a research and development activity.

Cost reduction programs may require a bulk amount of research and development budget, but once a new technique is introduced, it gives competitive advantages for the long period.

The aim of cost reduction is to see whether there is any possibility of bringing about a saving in the costs incurred on materials, labor, overheads etc.

Cost reduction is possible through the following improvements:

* Obtaining more outputs from the same inputs and facilities.

* Using a lesser quantity of inputs to obtain the same output .

* Simplifying the methods of distribution.

* Improving the location and layout of plant, warehouse and other resources.

Meaning of Cost Reduction:

Cost reduction is a planned positive approach to reduce expenditure. It is a corrective function by continuous process of analysis of costs, functions, etc. for further economy in application of factors of production.

The Chartered Institute of Management Accountants, London defines cost reduction as follows:

"Cost reduction is to be understood as the achievement of real and permanent reduction in the unit cost of goods manufactured or services rendered without impairing their suitability for the use intended or diminution in the quality of the product."

The definition given above brings to light the following characteristics of cost reduction:

1. The reduction must be a real one in the course of manufacture or services rendered. Real cost reduction comes through greater productivity. Greater productivity may be through (1) obtaining a large quantity of production from the same facilities; (2) using materials of lower price and of different quality without, however, sacrificing the quality of the finished product, i.e., reducing cost through the process of substitution; (3) simplifying the process of manufacture without sacrificing the quality of the finished product; (4) changing features of the product suitably without sacrificing the quality of the product etc.

2. The reduction must be a permanent one. It is short-lived if it comes through reduction in the prices of inputs, such as materials, labour etc. The reduction should be through improvements in methods of production from research work.

3. The reduction should not be at the cost of essential characteristics, such as quality of the products or services rendered.

Thus, cost reduction must be a genuine one and should aim at the elimination of wasteful elements in methods of doing things. It should not be at the cost of quality. Cost reduction is a continuous process of critically examining various elements of cost and each aspect of the business (i.e. procedures, methods, products, management including market and finance etc.) is critically examined with a view to improving the efficiency for reducing costs.

Every plan of cost reduction proceeds with this assumption that there is always scope for cost reduction. A continuous research is made into various areas for finding out the best possible methods of performance for ensuring minimum possible costs.

The reduction in costs should be real and permanent. Reduction due to wind falls, changes in government policy like a reduction in taxes (or duties or due to temporary) and measures taken for tiding over financial difficulties do not strictly come under the purview of cost reduction.

Broadly speaking reduction in cost per unit of production may be effected in two ways:

1. By reducing expenditure but the volume of output remains constant.
2. By increasing production viz. increasing the out turn, but the level of expenditureremains unchanged.

Tools and Techniques of Cost Reduction:

The various techniques and tools used for achieving cost reduction are practically the same which have been suggested for cost control.

Some of these are:

(i) Budgetary control,

(ii) Standard costing,

(iii) Standardisation of products and tools and equipment's,

(iv) Simplification and variety reduction,

(v) Improvement in design,

(vi) Material control,

(vii) Labour control,

(viii) Overhead control,

(ix) Production planning and control,

(x) Automation,

(xi) Operation research,

(xii) Market research,

(xiii) Planning and control of finance,

(xiv) Value analysis,

(xv) Quality measurement and research,

(xvi) Cost benefit analysis.

(xvii) Contribution Analysis

(xviii) PERT

(xix) Job Evaluation and Merit Rating.

Advantages of Cost Reduction:

Cost reduction causes a definite increase in margins. The saving in cost may also be passed to consumers in the form of lower prices or more quantity in the same price. This will create more demand for the products, economies of large scale production, more employment through industrialisation and all-round improvement in the standard of living. Government may also stand to gain by way of higher tax revenues.

Increased competitive strength to the industry stimulates more exports. Thus, profit is increased by reducing the costs, it can be utilised for expansion of the organisation which will create more employment and overall industrial prosperity.

Cost reduction is essential of a product has to withstand its global market. Brand loyalty is fading away fast. Nowadays consumers have become price and quality conscious. Hence cost reduction is the key for global competitiveness.

There are many advantages of cost reduction.

Some of these are:

1. **Cost reduction increases profit:**

It provides a basis for more dividends to the shareholders, more bonus to the staff and more retention of profit for expansion of the business which will create more employment and overall industrial prospects.

2. Cost reduction will provide more money for labour welfare schemes and thus improve men- management relationship.

3. Cost reduction will help in making goods available to the consumers at cheaper rates. This will create more demand for the products, economies of large scale production, more employment through industrialisation and all-round improvement in the standard of living.

4. Cost reduction will be helpful in meeting competition effectively.

5. Higher profit will provide more revenue to the government by way of taxation.

6. As a result of reduction in cost, export price may be lowered which may increase total exports.

7. Cost reduction is obtained by increasing productivity. Therefore, a developing country, like India, which suffers from shortage of resources can develop faster if it makes the best use of resources by increasing productivity.

8. Cost reduction lays emphasis on a continuous search for improvement which will improve the image of the firm for long-term benefits.

According to G. Kantharaj, "In the particular context of a developing economy, it becomes predominantly important to emphasize on Cost Reduction in agriculture, industry, public administration, etc. Cost Reduction cannot be ushered in by a magic wand. Cost reduction is everybody's concern. …..The motto of every industry and every organisation should be to produce more goods and to render efficient services. Spiralling up of prices and inflationary trends seem to have reached a Point of No Return in the country. The situation cannot be salvaged, unless every responsible individual wages a war vehemently to curtail the wastages and delays in his own jurisdiction."

Dangers of Cost Reduction:

The possible dangers of any cost reduction plan may be as follows:

1. Quality may be sacrificed at the cost of reduction in cost: To reduce cost, quality may be reduced gradually and it may not be detected till it has assumed alarming proportion. Quality may be reduced to such an extent that it may not be accepted in the market and the business may be lost to the competitors.

2. In the beginning cost reduction programme may not be liked by the employees and danger may be posed to the programme because success of any cost reduction plan depends upon the willing cooperation and active participation of the employees.

3. It is possible that reduction in cost may not be real and permanent. It may not be based on sound reasons and may be short lived and cost may come back to the original cost level when temporary conditions (i.e. fall in prices of materials) due to which cost has reduced disappear.

4. There may be a conflict between individual objective and organisational objective. It is possible that a head of a particular department may follow activities which may reduce the cost of his department but may lead to increase in cost for the organisation as a whole.