UNIT 1 OPERATIONS MANAGEMENT – AN OVERVIEW

Objectives

Upon completion of this unit, you should be able to:

- know the production/operation function as process of value addition
- recognise the distinction between products and services
- comprehend all organisations as conversion systems whether in manufacturing or service sectors
- understand the systems concepts in operations management
- appreciate the purpose and objectives in operations management
- identify various problems of decision-making in operations management
- distinguish various structures of production systems and their associated problems
- appreciate the role of materials management
- know the concepts in systems life-cycle
- appreciate the role of scientific approach of industrial engineering/operations research in the. management of production/service systems
- understand the basic theme of the subject and be familiar with the conceptual scheme we will follow in this text
- have a brief idea of the historical profile of the development of operations management

Structure

1.1.1 INTRODUCTION

In this unit you will learn about the aspects of management of production and service organisations. For long the term `production' has been associated only with a factory like situation where goods are produced in the physical sense. Factory has been defined as "……any premises in which persons are employed for the purpose of making, altering, repairing, ornamenting, finishing, cleaning, washing, breaking. demolishing or adopting for sale, any article".

However, by generalising the concept of production as the "process through which goods and services are created" we can include both manufacturing and service organisations within the purview of production management. Thus the essential features of the production function are to bring together people, machines any' materials to provide goods or services thereby satisfying the wants of the people.

Inclusion of services within the scope of production enables us to look at the problem of production management in a much wider perspective. This brings a number of seemingly non-manufacturing sectors of economy such as transport, energy. health, agriculture, warehousing, banking etc. within the scope of production systems. That is why the terms production and operations management or operations management have been suggested by many to indicate the general applications of the techniques of management of machines and materials.

This broad concept of production is kept in mind throughout this book although the apparent emphasis may be on techniques used in the context of manufacturing organisation but you should always be able to extend and apply these management techniques to all types of service organisations as well.

The Value Added Process

Perhaps a more general concept of `operations' instead of `production' will better include both manufacturing as well as service organisations. Operations-either in manufacturing or in service-are purposeful activities of an organisation. Operations function is the heart of and indeed the very reason for an organisation to come into being. All operations can be said to add value to some object thereby enhancing its usefulness. We may formally define an operation as "the process of changing inputs into outputs and thereby adding value to some entity; this constitutes the primary function of virtually every organisation"

Now let us consider how value can be added to an entity by performing an `operation' function. There are four major ways:

a) Alter: This refers to change in the form or state of the inputs. This change may be physical as in manufacturing, or sensual or psychological such as the feeling of comfort or satisfaction after getting cured from an illness.

b) Transport: The entity gets value added through transport because it may have more value if located somewhere other than where it currently is. Entity may include people, goods or garbage.

c) Store: The value is enhanced if the entity is kept in a protected environment for some period of time, such as potatoes in cold storage or foodgrains in warehouses.

d) Inspect: The value of an entity may be enriched through an inspection as we better understand its properties and can therefore take more informed decisions regarding their purchase, use, repair etc.

Thus we see that the value may be added to an entity through a number of different-means. It may directly change in space, in time or even just in our mental image of it. All these processes can be called `operations'. Thus almost every organisation-manufacturing, transportation, warehousing, health-care, education etc. come within the purview of operations management.

Products and Services

The output of an operations (or production) system may be in terms of end-product-physical goods such as automobiles or rendering a service such as in transportation, hospitals, educational institutions, cinema-halls etc. Rendering a service may involve physical goods (or facilitating goods) such as dentist making a set of false teeth while rendering dental care. Thus services can be considered as bundles of benefits, some may be tangible and others intangible (such as reduced waiting, courteous calls, convenient location etc.) and these may or may not be accompanied by facilitating goods. Based on this grouping it is possible to segregate organisations producing goods or services or both.

The Conversion Process

From the foregoing description, it should now be clear that all production or operation functions are essentially a part of the conversion process which transforms entities in shape, size, form, location, space, time and state. Hence every organisation can be considered essentially as a conversion system which converts inputs into outputs through the conversion process (or operations). This aspect is further highlighted in the next section.

1.2 SYSTEMS CONCEPTS IN OPERATIONS MANAGEMENT

A system may be defined as "a purposeful collection of people, objects and procedures for operating within an environment". Thus every organisation can be represented as a system consisting of interacting sub-systems. The features of a system are that these have inputs and outputs. The basic process of the system convert.; the resource inputs into some useful form of outputs. Of course, depending upon the efficiency of the conversion process we may have undesirable outputs too-such as pollution, scrap or wastage, rejections, loss of human life (in a hospital) etc. Using the generalised concept of production (which includes services) we can call such systems as production systems.

Figure I: Conceptual Model of A Production/Operation System

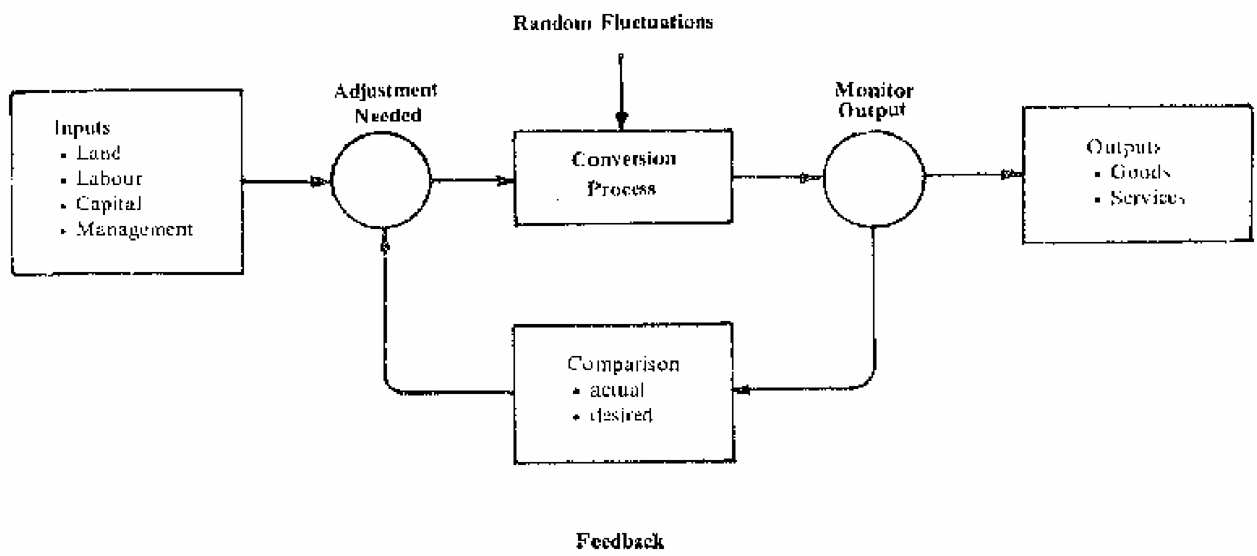


Figure I describe a generalised concept of production system. It takes resource inputs and processes them to produce useful outputs in the form of goods or services.

Inputs and Outputs

Inputs to the system may be labour, material, equipment (machines), facilities, energy, information and technology. Thus machines and materials, which constitute the main focus of this book are the resource inputs required by the production system Other inputs to operating system can be-customers in a bank, patients in a hospital commuters to a public transport system, files and papers to an office situation, and programmes to be run in a computer centre etc.

Similarly outputs from a system may be in terms of finished products, transported goods, delivered messages, cured patients, serviced customers etc.

Productivity of Conversion Process

Now we come to the main question of how we know that we are managing our system operations well. This concerns the efficiency with which we are.converting the inputs into outputs. This conversion efficiency can be roughly gauged by the ratio of output/input; a term which is generally known as `productivity' of the system. It is obvious that productivity can be improved by maximising the desirable form of outputs from the system for a given level of resource inputs or alternatively by requiring a minimum amount of resource inputs for a given level of output from the system.

Thus

$$\text{Productivity (P)} = \frac{\text{Output(O)}}{\text{Inputs(I)}}$$

Management of production systems is essentially concerned with the management for productivity. An alternate way of looking at the concept of productivity is to look at the amount of waste generated in the system. If waste is unnecessary input' and `undesirable output' from a system, then productivity can be improved by reducing wastefulness (or wastivity) of the system.

Thus a simple way to look at the productivity improvement is to attack wastes of all types of resources-materials, labour, capacity of machines, time, space, capital etc.

If you look a bit deeper into what is happening inside the conversion system-you could find only two mutually exclusive things happening. Either, the resources are being processed (operation) taking it nearer to the completion stage or nothing useful is happening to the resource inputs. For example materials may be waiting in the form of inventory in stores, waiting to be loaded on the machine. Job orders may be waiting to be processed. In a hospital a patient may be waiting to be attended to etc. All these forms of waiting, delays in inventories are non-productive events and any drive to improve productivity must aim at eliminating or at least reducing such idle time, waiting etc. Thus if you wish to improve your system operations, try to attack such non-productive elements in the total throughput time of the entity in the system.

Manufacturing and Service Systems

As stated earlier, the generalised model of production system includes both manufacturing systems as well as service systems. Examples of manufacturing systems are: Manufacturing of fertilisers, cement, coal, textile, steel, automobiles, machine tools, blades, televisions, furnitures etc. Examples of service systems include a post office, bank, hospital, municipal corporation, transport organisation, university, supply office, telephone exchange etc.

Although basic structure of service systems is amenable to same analysis as manufacturing systems, service systems do have some salient features making the management of such systems slightly more difficult. Some of these characteristics are:

a) Output from the system is non-inventoriable. You cannot generally produce to stock.

b) Demand for the service is variable.

c) Operations may be labour-intensive.

d) Location of service operation is dictated by location of users.

1.3 OBJECTIVES IN OPERATIONS MANAGEMENT

Every system (or organisation) has a purpose, certain objectives and goals to achieve. Since the objectives of an organisation have hierarchical structure, sub-goals lead to accomplishment of goals which contribute to the achievement of objectives and eventually the purpose or mission of an organisation. It is very important that these objectives should be unambiguously identified, properly structured and explicitly stated.

In general terms, the objectives of an organisation may be to produce the goods/or services in required quantities and of quality as per schedule and at a **minimum cost**. Thus quantity, quality and time schedule are the objectives that determine the extent of customer satisfaction. If an organisation can provide for these at a minimum cost then the `value' of goods created or services rendered enhances and that is the only way to remain competitive. Thus various objectives can be grouped as-performance objectives and cost objectives.

Performance Objectives

The performance objectives rimy include:

a) **Efficiency** or productivity as output per unit of input.

b) **Effectiveness:** It concerns whether a right set of outputs is being produced. Where efficiency may refer to 'doing things right' ,effectiveness may mean 'doing the right things'.

c) **Quality:** Quality is the extent to which a product or service satisfies the customer needs. The output has to conform to quality specifications laid down before it can be accepted.

d) **Lead times:** Manufacturing lead time or throughput time is the time elapsed in the conversion process. Minimisation of idle time, delays, waiting etc. will reduce throughput time.

e) **Capacity utilisation:** Percentage utilisation of manpower, machines etc.

f) **Flexibility:** If the conversion process has the flexibility of producing a combination of outputs, it is possible to satisfy a variety of customer needs.

Cost Objectives

Attaining high degree of customer satisfaction on performance front must be coupled with lower cost of producing the goods or rendering a service. Thus cost minimisation is an important systems objective. Costs can be explicit (visible) or implicit (hidden or invisible). These could be tangible in economic terms or intangible in social cost terms - such as delayed supplies, customer complaints etc. While managing production systems we must consider both the visible and invisible, tangible and intangible costs. Some example of these costs are:

a) Explicit (visible) costs:

- Material cost
- Direct and indirect labour cost
- Scrap/rework cost
- Maintenance cost

b) Implicit (invisible/hidden) costs:

- Cost of carrying inventory
- Cost of stockouts, shortages, back-logging, lost sales
- Cost of delayed deliveries
- Cost of material handling
- Cost of inspection
- Cost of grievances, dissatisfaction
- Downtime costs
- Opportunity costs

For the purpose of managerial decision-making, we should consider the total relevant systems costs including visible and invisible. A longer term cost implications rather than only short-term will help in arriving at better decisions.

1.4 OPERATIONS MANAGEMENT DECISIONS

Operations Management is essentially a function concerning decision-making with Operations respect to a production/operation system so as to render the necessary customer satisfaction at lowest cost.

The Process of Management

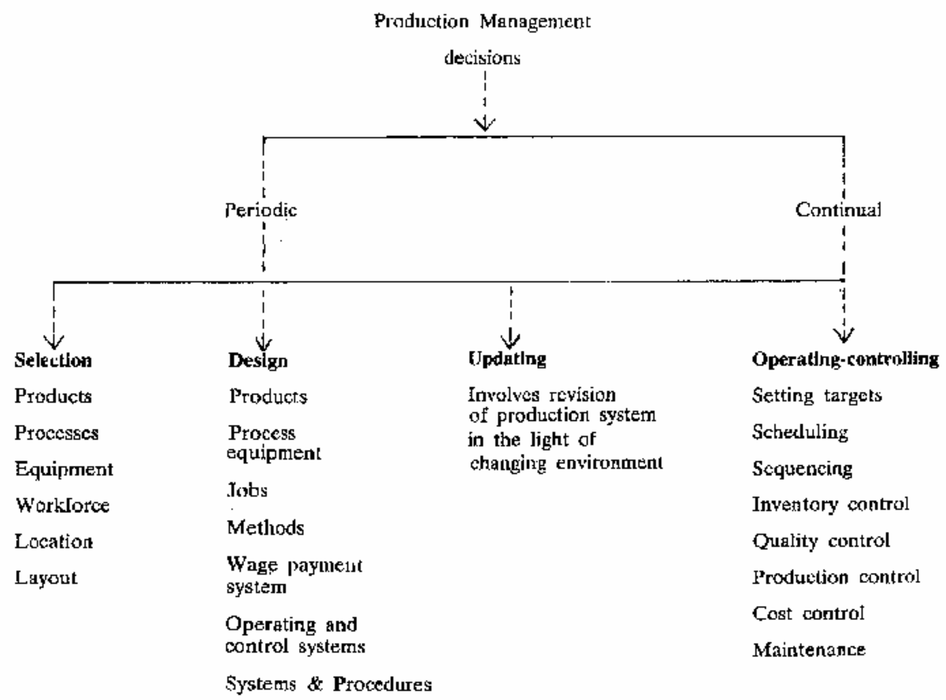
Essentially management can be considered as a process of planning, organising, coordinating and control.

There are different ways in which the production management functions can be grouped for the sake of discussion. For instance, all the decisions concerning the production system could be divided as:-

a) Periodic decisions which include selection, design and updating of resources, structures, systems and procedures.

b) Continual decisions which are required in day-to-day operation and control of production systems.

Figure II: A classification of Production Management Decisions



Source: Chase, R.B. and N.J. Aquilano, 1973. Production and Operations Management: A Life-cycle Approach. Richard D. Irwin: Homewood.

Figure II shows a listing of some of the decisions according to this scheme of functional classification. It may be seen that decisions in (a) above are generally strategic decisions having long-term implications while in (b) we have operational (short-term) decisions.

And yet another way of looking at these decisions may be:

i) Planning and Design of Production Systems.

ii) Operations and Control of Production Systems.

The major topics covered in this book will he grouped according to the above mentioned classification.

A third way to group these decisions could be:

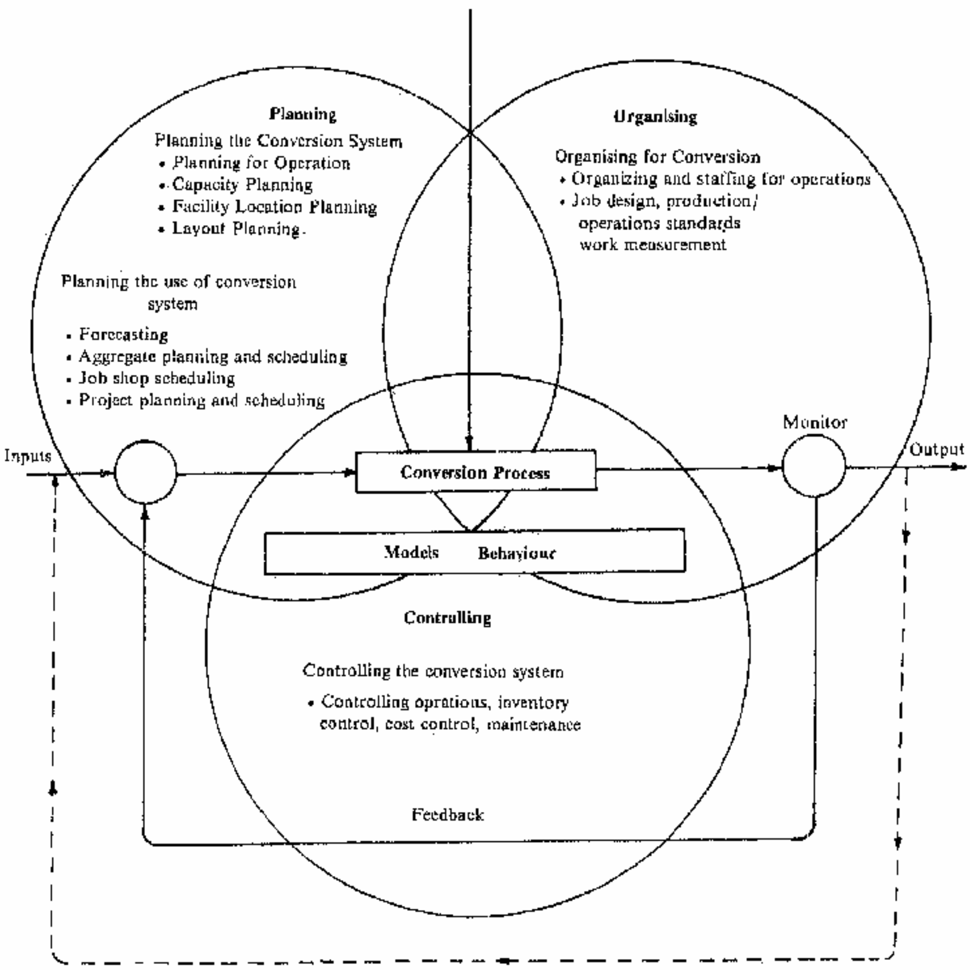
I	Planning Decisions	Planning the conversion systems Planning the use of the conversion systems
II	Organising Decisions	• Organising for conversion • Structuring of operations • Staffing • Job and work-design • Production/operation standards • Payment systems etc.

III Controlling Decisions - Monitoring and control of conversion systems on aspects of

- Quantity
- Quality
- Time
- Inventory
- Cost
- Maintenance

Figure III shows schematically a listing of production management decisions according to this classification.

Figure III: A Framework of Planning, Organizing and Control Decisions in Production Systems



Source: Adam Jr., E.E. and R.J. Ebert, 1978. Production and Operations Managerial Concepts: Model and Behaviour, Prentice-Hall-Inc., Englewood-Cliffs.

Strategic (long-term) Decisions

A decision is said to be strategic if it has a long-term impact; influences a larger part of the system and is difficult to undo once implemented. These decisions in the context of production systems are essentially those which deal with the Design and Planning (long-range or intermediate range) aspects. Some examples of these decisions are:

a) Product selection and. design: What products or services are to be offered constitute a crucial decision. A wrong choice of product or poor design of the product may render our systems' operations ineffective and non-competitive. A careful evaluation of product/service alternatives on the multiple objective basis can help in choosing right product(s). Techniques of value engineering can be useful in creating a good design which does not incorporate unnecessary features and can attain the intended functions at lowest costs.

b) Process selection and planning: Choosing optimal (best under the circumstances and for the purpose) process of conversion systems is an important decision concerning choice of technology, equipment and machines. Process planning pertains to careful detailing of processes of resource conversion required and their sequence. Included in such decisions are the aspects of mechanisation and automation. **c) Facilities location:** It concerns decision regarding location of production system or its facilities. A poor location may spell operating disadvantages for all times to come. Therefore it is important to choose a right location which will minimise total 'delivered-to-customer'cost (production and distribution cost) by virtue of location. Evidently such a decision calls for evaluation of location alternatives against multiplicity of relevant factors considering their relative importance for the system under consideration.

d) Facilities layout and materials handling: Facilities layout planning problems are concerned with relative location of one department (activity centre) with another in order to facilitate material flow, reduce handling cost, delays and congestion, provide good house-keeping, facilitate coordination etc. A detailed layout plan gives x blueprint of how actual factors of production are to be integrated. The types of layout will depend upon tile nature of production systems. Most of the concepts used in layout planning models are based on the importance of locating departments close to each other in order to minimise the cost of Materials handling. Proper choice of the material handling equipment such as fork-lift truck, conveyors etc. is a related decision in layout planning. There are large number of computer packages developed such as CRAFT (Computerised Relative Allocation of Facilities Techniques), CORELAP (Computerised Relationship Layout Planning) etc. to help in layout planning for process based layouts. Balancing the production or assembly line and line-design including provision of inter-stage storage capacity are some relevant issues in the product-based layouts.

Newer technologies, particularly computer-based, are significantly altering the traditional concepts in layout planning. More recently the concepts in Group Technology (GT), Cellular Manufacturing Systems (CMS) and Flexible Manufacturing Systems (FMS) have influenced the layout planning and material handling policies significantly.

e) Capacity planning: It Concerns the acquisition of productive resources. Capacity may be considered as the maximum available amount of output of the conversion process over some specified time span. Capacity planning may be over short-term as well as on a long-term basis. In service systems the concept of capacity and hence capacity planning is a bit more difficult problem, Long-term capacity planning includes expansion and contraction of major facilities required in conversion process, determination of economics of multiple shift operation etc. Break even analysis is a valuable tool for capacity planning. Other techniques like learning curves, linear programming and decision tree arc also useful tools in capacity planning.

The above mentioned five decision areas will be described in detail in the units immediately following this one.

Operational (short-term) Decisions

Operational level decisions deal with short-term planning and control problem. Some of these are

a) Production planning scheduling and control: In operation scheduling we wish to determine the optimal schedule and sequence of operations, economic batch quantity, machine assignment and despatching priorities for sequencing Production control is a complementary activity to production planning and involves follow up of the production plans.

b) Inventory planning and control: This problem deals with determination of optimal inventory levels at raw material in process and finished goods stages of a production tYa[t]eno.8nw much to order, when o order are two typical decisions involving inventories. Materials requirement planning (MRP) is an important upcoming concept in such a situation.

c) **Quality assurance:** Quality is an important aspect of production systems and we must ensure that whatever product or service is produced it satisfies the quality requirements of the customer at lowest cost. This may be termed as quality assurance. Setting standards of quality, control of quality of products, processes are some of the aspects of quality assurance. Value engineering considerations are related issues in quality assurance.

d) **Work and job design:** These are problems concerning design of work methods, systems and procedures, methods improvement, elimination of avoidable delays, work measurement, work place layout, ergonomic considerations in job design, work and job restructuring, job enlargement etc. Design and operation of wage incentives is an associated problem area.

e) **Maintenance and replacement:** These include decisions regarding optimal policies for preventive, scheduled and breakdown maintenance of the machines. repair policies and replacement decisions. Maintenance of manpower scheduling and sequencing of repair jobs; preventive replacement and condition monitoring of the equipment and machines are some other important decisions involving equipment maintenance. Maintenance is extremely crucial problem area particularly for a developing economy such as ours because it is only through a very effective maintenance management that we can improve capacity utilisation and keep our plant and machinery productive and available for use.

f) **Cost reduction and control:** For an on-going production system the role of cost reduction is prominent because through effective control of total cost of production, we can offer more competitive products and services. Cost avoidance and cost reduction can be achieved through various productivity techniques. Value engineering is a prominent technique available for cost reduction. Concepts like standard costing and budgetary control help in monitoring and controlling the costs of labour, material etc. and suggest appropriate follow up action to keep these costs within limits.

Monitoring and Feedback Control

In every system, the actual accomplishment of objectives may not be as planned for various reasons. It is therefore very important to monitor the actual performance by measuring the actual output or some performance indicators. Basic elements of monitoring and feedback control-be it control of quantity, quality, time, inventory or cost-are:

1 Establish standards of performance or outputs.
2 Measure actual performance.
3 Compare the difference between the actual and planned.
4 Take appropriate remedial actions by changing inputs revising plans, changing priorities, expediting the progress etc.

Design of an appropriate feedback control system is therefore vital for all production/operations management problems. Control is complementary to planning. Without monitoring and control, planning.may not be effective; without planning, control may not be effective. Thus planning and control are two sides of the same coin.

In the design of control systems, we should consider cost-benefit aspect of control in mind. If cost of control exceeds its benefits, it becomes counter-productive. Thus selective controls must be exercised employing the exception principle or Pareto's Law. A more effective control could be self-control or cybernetic or steering control but it may he difficult to design such controls in a large and complex organisation.

Need for Updating and Review of Decisions

When we plan or design our production system, the process of planning assumes certain external and internal environment or work. In a dynamic system there may be changes in the environmental parameters which make our previous decisions out of date and irrelevant. In such a situation, we need to review, revise and update our decisions. For example, we may switch over to group technology layout from existing process type; we may add or delete oar product lines; we may revise the product design in the light of newer types of materials that have developed or on the basis of feedback from customers etc.

It is a good practice to incorporate periodic reviews and updating as a part of our system so that our decisions are relevant to the prevailing circumstances and are. compatible with the external environment. Thus, we should be able to revise all the previously stated decisions should the contingency of the situation so demand.

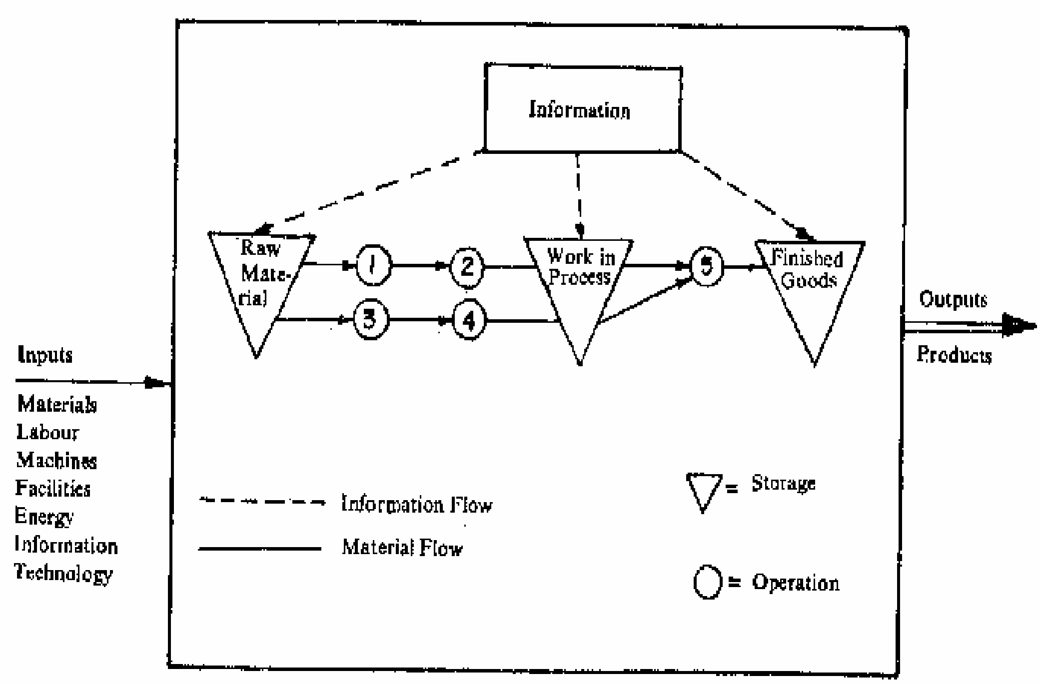
1.5 TYPES OF PRODUCTION SYSTEMS

Looking from a different. point of view, the entire problem of production/operations management can be visualised as that of managing the `material' flow into, through, and out of the production system. If we try to detail out the flow characteristics inside the conversion systems, we shall find that some systems have very smooth and streamlined flow; some others may have more complex flow characteristics. In general, the more complex the flow characteristics inside the system, the more difficult it becomes to manage the system. On the basis of material flow characteristics, the production system can be grouped into the following four categories:

a) Mass production or flow line production system
b) Batch production system
c) Job shop
d) Unit manufacture of projects.

The main focus of production management problems will therefore depend upon the type of the system. Problems which are very crucial for mass production may not be relevant for batch production and rice-versa. It is therefore very important to identify the type of systems we are managing and then focus on main problems of planning and control relevant to that system. A brief description of these problems are given in the following sub-sections. Figure IV shows the flow characteristics of a typical production system.

Figure IV: Material Flow Characteristics of A Typical Production Process



Source: Menipaz, E. 1984. Essentials of production and Operations Management, Prentice-Hall Inc.: Englewood-Cliffs.

Mass Production or Flow Line Production Systems

These systems have simplest flow characteristics constituting straight line flow. Facilities are arranged according to sequence of operations where the output of one stage becomes input to the next stage. The whole system is cascaded.

Major production management problems in mass production systems are-balancing of production/assembly lines, machine maintenance and raw materials supply. In a production line consists of the series of production centres, if workload is unbalanced, then the most bottle-necked production stage will govern the whole output rate. This will result in increased throughput time and poor capacity utilisation thus contributing to low productivity. Hence a production or assembly line should be designed such that its workload is as evenly balanced as possible. Maintenance becomes important because if any production stage is under breakdown it will block the whole line unless quickly restored back into operational effectiveness. Raw material to first stage is important to avoid shortage and subsequent starvation of the whole line.

There are methods and techniques available to attend to the above mentioned problem areas. Some of these will be discussed in a later unit on operations planning and control aspect of mass production system.

Batch Production System

If a variety of products are made with relatively small volume of production, it may not be possible to layout a separate line for each product. In such cases, batch production concept is adopted when a product is made in a certain quantity called as `batch quantity' on a machine, and after a while it is discontinued and another product is scheduled in a certain batch quantity. Thus various products compete for the share of a machine. The machines are for general purposes. Material flow in such systems is more complex than in mass production systems. Accordingly, the planning and control aspects are relatively more difficult. Some prominent problem areas are:

a) Optimal layout planning for the production system;
b) Aggregate production planning to absorb demand fluctuations economically;
c) Machine-job allocation problem;
d) Determination of economic batch quantity; and
e) Scheduling and sequencing of operations.

Production control assumes significance in such systems as the status of progress of various products must be.chased up and effectively monitored.

Job Shop

A job shop does not have its own standard product but accepts whatever customer orders come in. Thus it is essentially a group of facilities and processes a wide variety of customer orders in varying batch sizes. Each order may be a new order requiring process planning, tooling and sequencing. Material flow in job shop like situation is quite complex. A dynamic job shop where even customer orders come' in a random fashion is a very difficult system to analyse at least from the point of view of production, planning and control. The main problem is despatching priority rule to determine the sequence in which various waiting job orders are to be processed on manufacturing facilities. For example, a production manager may sequence the job orders on the basis of the short processing time (SPT) rule. The job requiring smallest operation time gets top most priority in order-scheduling. From analytical point of view a job shop can be treated as a network of queues and the waiting line models or simulation techniques can be used to analyse it.

Unit Manufacture or Projects

Suppose we want to make a ship. Obviously due to large size of the product, the entire concept of material flow should change. In the previous three cases the manpower and facilities were fixed and product (or material) was moving from place to place. Here product remains fixed and manpower/facilities put work on it some chosen sequence. Since such products are not made in large number and have long throughput time, we can treat each product as a project. Thus project planning, scheduling and monitoring techniques based on network models such as PERT/CPM can be used for planning and control of such production systems.

1.6 MANAGEMENT OF MATERIALS IN PRODUCTION SYSTEMS

As mentioned previously, problems of production management essentially concern management of material flow into, through and out of the system. This makes materials management a vital subject. Since materials constitute an extremely important and costly resource to a production system, an improvement in materials productivity will lead to overall improvement in systems performance and cost reduction.

Role of Materials Management

Materials in Indian context constitute more than half the total cost of production in most industries and projects. In some industries 60-70% of total production cost is due to materials. This makes materials management the biggest single area having tremendous potential for cost reduction. A well coordinated materials management programme may lead to 15-20% cost reduction.

If inventories are taken as an index of materials management effectiveness, then there is so much that can be done to cut inventories in Indian industries. If inventory is viewed as `usable but idle resource' then we can also call it a necessary evil'. Our materials planning system should be such that we are able to ensure adequate supply of materials to meet anticipated demand pattern with the minimum amount of capital blocked in inventories in a non-productive manner.

Need for Integrated Approach to Materials Management

To be most effective, our desire to maximise materials productivity must aim at getting most out of every rupee invested in materials. This calls for a well coordinated and integrated approach towards various problem areas involving decision-making with respect to materials. It can be seen for example that the inventory in the system can be lessened by reducing uncertainties in demand and supply, by reducing procurement lead time, by reducing excessive material varieties through standardisation, codification and variety reduction programmes. Thus development of reliable sources of supplies to have `just in time' supply will reduce inventories substantially.

Other important areas to improve efficiency on materials management front are:

a) Value analysis, purchase price analysis: In this we want to put right kind of material through competitive prices to reduce the material bill. Value analysis aims at getting the required function performed at minimum cost and therefore value analysis technique has a major role in materials related cost reduction.

b) Materials handling: Materials handling provides place (location) utility only. Otherwise it does not add to functional or esthetic value of materials but is an element of cost. Thus our aim should be to design systems of production and storage to minimise the costs associated with movement and handling of materials.

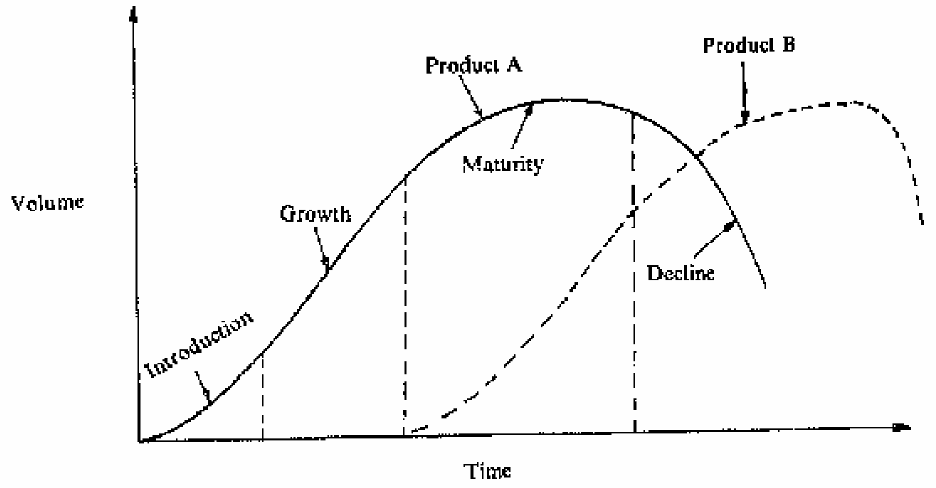
c) Inventory control: Here we try to plan our procurement actions so that we can get the demand satisfied reasonably well without having to stock (in inventory) too much of materials. This is a very well discussed problem area in literature on materials management.

d) Stores management: Stores function looks after physical custody of materials. By proper planning of layout, storage materials and issuing policies we can ensure faster service so that items demanded by production can be supplied without delay. Avoidance of pilferage, wastage and storage losses are also important aspects of stores management.

e) Waste management: - Materials waste must be minimized if not eliminated. Waste can also be consider as a barometer of materials productivity. If materials waste is minimum, productivity of materials improves.

An integrated approach to materials management must look at all the above mentioned problem areas in a coordinated manner with a view to maximise materials management effectineness

Figure V: Product Life-Cycle



1.7 CONCEPTS IN SYSTEMS LIFE-CYCLE

The life-cycle concept or `womb to tomb' concept draws analogy from living organisms. It assumes that every system (product) has a definite life-cycle and it passes through growth, maturity, saturation and decline phases. Figure V shows a typical life-cycle of a product. Similar pattern could exist for the entire production systems. Life-cycle concept enables us to understand various decisions and their inter-dependence in a better perspective. For example if some of the strategic decisions like product selection or plant location, which are made at the early stages of systems life-cycle are wrong, then these would continue to influence day-to-day operations planning and control decisions adversely and no amount of day-to-day effectiveness will be able to undo the damage done by poor decisions at initial stages of life-cycle.

This concept also enables us to be alert to the external environment and start phasing out a dying product and substitute, it with a new product well in time so that continued survival of the organisation can be planned. Figure V shows how introducing new product well in time can cause long-term survival of the organisation even if individual products follow life-cycle pattern. Life span of a product may vary from few months (such as fashion goods) to few decades.

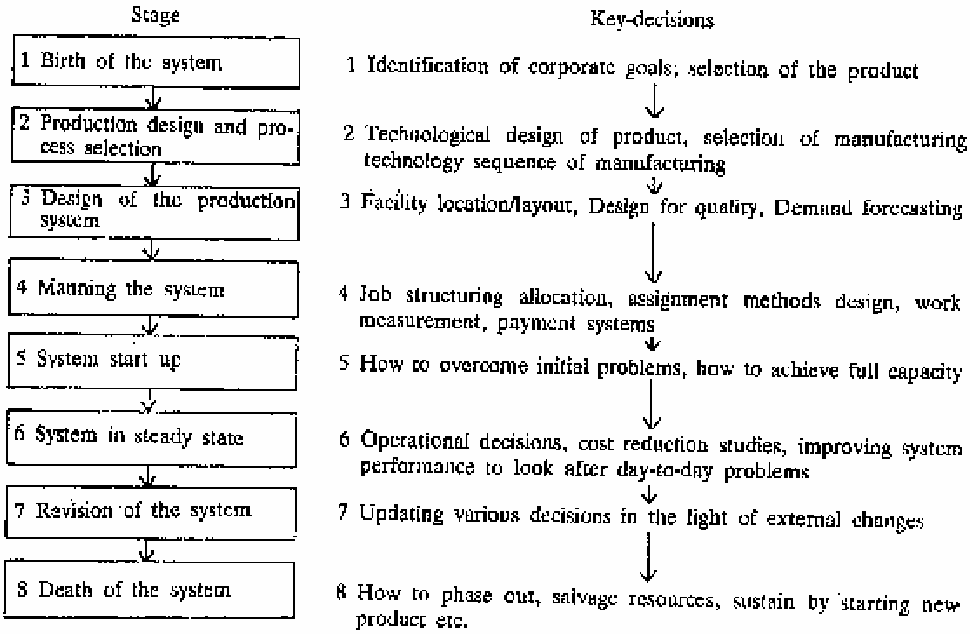
Stages in Systems Life-cycle

Figure VI shows the eight stages of the system life-cycle along with the associated key decisions to be made at each stage. Some of the initial decisions like product selection, technology selection. location and layout selection are of strategic importance. Once the system has achieved steady state-most on-going organisation we work in are probably at that stage-then most problems of operations management are of tactical or operational nature. Short-term planning and control and cost reduction strategies are the main focus at that stage. The steady state experiences minor perturbations due to external and internal factors. Moderate level changes can be accommodated by updating and revising of the previous decisions. When the system cannot adjust to even major revisions due to extreme changes in external environment, then the systems must come to end-through liquidation or through sale or merger. Termination or phasing out of operations may be sometimes deliberate.

Life-cycle Costing

A very important concept in costing has emerged in recent years-that of life-cycle costing. It says that when we evaluate the cost implications of our decisions we should not consider the short-term cost alone but the entire costs during the life-cycle of the system and equipment. Thus long-term cost repercussion must be examined rather than immediate short-term alone. Such a concept may change our perspectives and

Figure VI: Stages of Life-cycle and key-decisions involved



Source: Chase, R.B. and N.J. Aquilano, 1973. Production and Operations Management: A Life-cycle Approach, Richard D. Irwin: Homewood.

seemingly good decisions may not remain attractive if life-cycle costs are computed. For example while purchasing a machine, the short-term cost may mean only initial purchase price and we may be tempted to buy a cheaper equipment or machine. It may however require too much repair, maintenance and operating expenses. If all these costs including initial costs are compared during the life-cycle of the machine, we may find that an expensive machine with very little maintenance repair and operating cost may be preferred alternative over initially inexpensive but `costly-to-maintain' machine. Thus while making important decisions regarding design and planning aspects of production sy stems we should consider life-cycle costs. These could even be converted to present values by discounted cash flow techniques, accounting for the time value of money.

1.8 ROLE OF SCIENTIFIC METHODS IN OPERATIONS MANAGEMENT

Methods and techniques of scientific management have tremendous role to play in helping us to make rational and logical decisions in the context of production and operations management. Through scientific methods, tools and techniques of industrial engineering and operations research along with behavioural science we can look at all facets of the problems and evaluate the consequences of our actions before arriving at a decision. These techniques thus reinforce the subjective or intuitive judgement and contribute to better management.

The Role of Industrial Engineering

Indian Institution of Industrial Engineering (IIIE) has adopted the following definition of Industrial Engineering:

"Industrial Engineering is concerned with the design, improvement and installation of integrated systems of men, materials and equipment. It draws upon specialised knowledge and skills in mathematical, physical and social sciences together with the principles and methods of engineering analysis and design to specify, predict and evaluate the results to be obtained from such systems."

It can therefore be seen that industrial engineers are designers of management systems and industrial engineering approach integrates various approaches such as operations research, systems analysis, behavioural science etc. towards the integrated design of organisations. In this book many industrial engineering techniques will be used in various units which helps us in better management of production systems.

The Role of Models

Models are representation of systems with a view to explain certain aspects of system's behaviour. Generally a mathematical model is preferred in decision-making because it tries to explain system's objectives and function in terms of decision variables subject to our control as well as non-controllable parameters due to environment or resource constraints etc. Thus a simplified form of a model is:

$$E = f(x_j, y_i)$$

Where E =Measure of effectiveness or objective function

x_j =Controllable (decision), variable, j = 1 ... n

y_j =Non-controllable parameter, i =1 ... m

Thus a model provides us a cause-effect relationship so that we can evaluate our alternative courses of action on the basis of our objectives and choose an optimal (best under the circumstances) strategy to maximise our effectiveness. Thus models provide a valuable tool to compare our options and thus improve the quality of decisions and provide us a better insight into our decision process. However, it must be noted that models are a means to achieve an end (better decisions) and not an end in itself. We must choose a simple, valid and logical model of the decision situation. A large number of model based techniques have been developed in the subject called `Operations Research' (OR) which help in mathematical conceptualisation of many decision-making problems relevant to production/operations management. Some very versatile and powerful techniques like linear programming, queuing theory and simulation have been applied extensively to study various problem areas in production management. Some of these will be described, though briefly, in appropriate units in this book.

The Role of Computers

In a large sized problem, a computer becomes a very efficient tool in problem solving and evaluation of alternatives. A big size linear programming or simulation problem can be efficiently solved on computers. Due to fast developments in computering facilities and application software, many OR models can he implemented via computers. Computers also have tremendous role in management information systems to provide useful, relevant and timely information for planning, monitoring and control of production systems-thus providing decision support through information.

The Role of Behavioural Science

Since people are integral part of our production system, understanding of human behaviour is very important so that managers can evaluate the consequences of their actions on human relations, morale, motivation and productivity. Supervisor's relationship with his subordinates, organisation structure, individual and group behaviour, work habits and attitude, incentives, participation in decision-making, performance appraisal systems have impact on worker morale and motivation. Behavioural science provides us some insight on these aspects and therefore has a role to play in production and operations management.

1.9 BRIEF HISTORY OF OPERATIONS MANAGEMENT

Historically speaking, the field of operations management has evolved in a very short span of time. Its roots however go back to the concept of `division of labour advocated by Adam Smith in his book "The Wealth of Nations" in 1776. In 1832, Charles Babbage, a mathematician extended Smith's work by recommending the use of scientific methods for analysing factory problems.

However, the era of scientific management as it is now known started with the work of F.W. Taylor in 1878 who subsequently came to be recognised as the Father of Scientific Management'. Taylor is credited with recognising the potential improvements to be gained from analysing the work content of a job and designing the job for maximum efficiency. His experiments conducted on the shop floor brought about significant and rapid increases in productivity. He explained the four principles of scientific management in the following way:

a) Development of a science for each element of a man's work thereby replacing the old rule of thumb methods.

b) Selection of the best worker for each task and then training and developing the workman on individual basis.

c) Striving for cooperation between management and the workers to simultaneously obtain both maximum production and high worker wages.

d) Dividing the work between management and workers so that each is working on what they are most proficient in doing.

Taylor described his management philosophy in a book "The Principles of Scientific Management" published in 1911. This event, more than any other, can be considered as the beginning of the field of Operations Management. The colleagues, contemporaries and followers of Taylor were many and included the following people.

Frank Gilbreth and his wife Lillian Gilbreth are recognised for their contributions to motion study. Gilbreth developed the concept of `Therbligs' and `Chronocyclegraphs' for motion study in 1911. Lillian Gilbreth wrote her book `The Psychology of Management' which was one of the earliest works concerning the human factor in organisations.

In 1913, Henry Ford developed the concept of mass production and arranged work stations into an assembly line with moving belt. In 1913 also, Henry Gantt made his best known contribution in charting the production schedules using a visual-diagrammatic tool which is popularly known as `Gantt-Chart' and is an effective practical tool even today.

In 1913, Harrington Emerson applied Taylor's ideas to develop organisation structure and suggested the use of experts in organisations to improve efficiency.

Wilson developed the concept of Economic Order Quantity (EOQ) in 1928 which is still recognised as the classical work in the scientific analysis of inventory systems and works of subsequent researchers were essentially further refinements of Wilson's lot size formula.

In 1931, F.H. Dodge,.H.G. Roming and W. Shewhart developed the concept of sampling inspection and published statistical tables. Earlier in 1924, W. Shewhart pioneered the concept of statistical quality control and developed control charts for monitoring the quality of production processes.

In 1933, Elton Mayo conducted his famous experiments at Western Electric's Hawthorne plant looking into human and social aspects of work. This paved the way for the behavioural school' of management. Mayo felt that scientific management often emphasised technical skills at the expense of adaptive skills. Some other notable developments in these lines include the concept of `managerial grid' developed by a Robert Blake and Maslow's hierarchy of needs and Doughlas McGregor's Theory X and Theory Y in management.

In 1937, L.H.C. Tippett developed the concept of work sampling to gauge the level of machine and manpower utilisation and for setting work standards.

In and around 1950 two major developments that influenced operations management were the emergence, of techniques of 'Operations Research' beyond military context and developments in engineering offered by L.D. Miles. The OR is application of scientific methods to. study and devise solutions to managerial problems in decision-making. Using mathematical models and-the systems approach OR has helped solve resource allocation, scheduling, processing, inventory, location, layout and control problems. Techniques of value engineering helped in efficiently identifying the unnecessary costs so that products and systems could perform their function at minimum costs.

Developments in computers led to computerised applications of Industrial Engineering and OR techniques to production management problems. Development in MIS and DSS (Decision Support Systems) provided a further fillip to the developments in operations management. In 1958 the concepts of CPM and PERT were developed for analysis of large projects and since then a number of network based techniques of project management have been developed.

In the late 1950s scholars and researchers in the field began to generalise the problems. and techniques of manufacturing management to other production organisations such as petroleum, chemical and other process industries leading to the emergence of the concept of `production management' as a functional management discipline. In the late 1960s the concept of `Operations Management' expanded to include the service sectors as well. Only recently the service sector has received as much attention as production sector from the point of view of scientific management of systems operations.

Systems approach taking a holistic (integrated) look at the problems of operating systems emerged in the 1970s which considered the inter-play of various sub-systems in organisations. Developments in the computer simulation of integrated production-inventory systems are some of the current thrusts in modelling of production management problems.

In the more recent past there has been a major thrust on the adoption of Japanese management techniques like the' just in time (JIT) system 'or 'Kanban system 'for production scheduling and inventory control and the concepts in quality circles (QC). These concepts have apparently done well in Japanese context but should be cautiously adopted in other situations only if external work environment and work ethos make them appropriate elsewhere too. Other notable developments in recent past have been group technology (GT) or cellular manufacturing systems (CMS), flexible manufacturing systems (FMS), computer-aided design/manufacturing (CAD/CAM) etc. Thus future of operations managements looks bright.

1.10 SUMMARY

This unit has attempted to give a general overview of operations management. A systems approach treating each operation as a value addition process has been described. The concept of operations management includes both the production of goods as well as services. Operations as the conversion process have been identified to be central function of virtually every organisation. Value is primarily added to entities by changing them directly in space, in time or in our minds. The important characteristics of conversion process have been identified as its efficiency, effectiveness, quality, lead times, capacity and flexibility. Objectives of operations management may be in terms of customer satisfaction or performance objectives as well as cost objectives.

Various decision areas have been categorised as strategic or operational decisions, periodic or continual decisions and various problem areas have been listed under each group. Management of production systems depends upon the structure of the systems and complexity of material flow and accordingly the production systems can be classified as mass, batch, job shop and project production systems. The characteristics of each of these systems together with the relevant production management problems have been highlighted. Role of materials management becomes crucial as materials are responsible for more than half the total cost of production systems. An integrated approach involving coordinated efforts to attempt various problems of materials management is emphasised.

Life-cycle approach to products and systems provides a good insight into the key decisions at every stage and concepts in life-cycle costing provide new perspectives to decision-making. Role of scientific techniques of industrial engineering, operations research together with behavioural science and computers is outlined. A brief unit-wise overview of the plan of the book is given so that the relevance of various units to the common theme of the book can be linked.

Finally, a brief historical profile of the subject from the era of Taylor to modern times including modern Japanese management techniques provides a synoptic view of the growth and development of the subject.

1.11 KEYWORDS

Behavioural science: Systematic study of human behaviour.

Batch production: A production system between mass and job shop. A number of products are made in batches on the manufacturing facility.

Control: A management function aimed at ensuring that actual performance is in accordance with the plans formulated to achieve its objectives.

Conversion process: Transformation of inputs to outputs thereby leading to value addition.

Ergonomics: Branch of technology concerned with the problems of the mutual adjustment between man and his work.

External environment: Comprises external surroundings in which an organisation functions and which has an impact on its performance.

Feedback: The process of comparing the actual performance and the planned one in order to initiate action for control purposes.

Inputs: All types of resources required by the conversion process for producing goods or services.

Inventory: Usable but idle resource.

Job shop: Manufacturing of varieties of products in small batch sizes according to customer orders.

Lead time: Total manufacturing (procurement) time in completing the production after initiating the work. It is a measure of how quickly the output can be produced.

Life-cycle: The cycle of birth-growth-maturity and decline of a product or a system.

Management: The process of planning, organising, directing and control.

Mass production: Making of a single product in very large quantities so that facilities can be arranged according to sequence of operations for the product.

Model: A representation of reality intended to explain some aspect of it.

Monitoring: Process of measuring actual performance or progress of work for the purpose of control.

Operations: The process of changing inputs into outputs. It is a purposeful function vital to virtually all organisations.

Operations research: Application of scientific methods, tools and techniques to the problems of decision-making in order to find optimal solution to problems.

Organising: Allocating human and material resources in appropriate combination to implement action plans. It defines tasks, structures and then allocate resources.

Output: Final product or rendering of a service.

Planning: Determining what is to be achieved, setting goals and identifying means to achieve them.

Production: The process of creating goods and services (synonymous to operation).

Productivity: The efficiency of conversion process expressed as output per unit of input.

Project: A set of tasks having sequential dependence with a definite starting and ending point.

Quality: A composite of characteristics that determines the extent to which a product or service satisfies the customer needs.

Schedule: A time table e1 production system indicating the time when a particular job will be processed on a particular machine.

Sequence: The order in which waiting jobs are to be processed on a machine or a facility.

Service: A bundle of benefits, some may be tangible and others intangible.

Simulation: A technique which feigns systems on paper or on computer in order to describe system behaviour.

Systems: A purposeful collection of people, objects and procedures for operating within an environment.

Strategic decisions: Important decisions having long-term impact.

Value engineering: A systematic procedure to identify and eliminate unnecessary costs to provide equivalent function at lowest costs.

1.12 SELF-ASSESSMENT EXERCISES

1 Identify the inputs, transformation process and outputs in the following operations systems:

a) Manufacture of television sets

b) Bank

c) Hospital

d) Warehouse

e) Educational institution

2 At what stage of product life-cycle will you put the following?

a) Steam locomotive

b) Colour television

c) Bicycle

d) Computer aided manufacture

e) Automated warehousing

3 Identify the main objectives relevant to the performance of the following operating systems:

a) Transportation system in a metropolitan city

b) Post office

c) Factory making cotton textiles

d) Insurance company

e) Construction of a house

4 Write True or False against the following statements:

a) Location of a plant is an important strategic decision

b) Mass production system is suitable for products with large variety and small volume of production.

c) Efficiency and effectiveness are synonymous terms.

d) Productivity is a ratio of output/input.

e) Feedback control is not needed if you plan your operations.

5 Describe four activities performed by the Operations Manager.

6 Does external environment affect the performance of a system?

7 List five symptoms of a poorly managed transport corporation.

8 List five symptoms of a soundly managed hospital.

9 Why is it more difficult to increase productivity of a service system as compared to a production system?

10 Consider the following situation:

You have been asked to look into the operations of a company which is in the business of repairing and overhauling automobiles. Current practices have led to an extreme amount of customer dissatisfaction due to very high waiting time, discourteous behaviour of work force with the clients, poor quality of workmanship and high cost of repairing automobiles. As a result the customers have started getting their services elsewhere. The owner is very keen to improve the situation but he finds that his people are not motivated by a spirit of service basically because of poor wages and indifferent supervision. This operation is located in an environmentally alert community and they have also keen complaining to the local municipal authorities that the nasty way in which operations are handled and waste water disposed off, is causing lot of inconvenience in the locality. The owner-manager wants your help in improving the effectiveness of systems operations.

How will you analyse the situation? What further information you may need? Prepare a short working paper outlining your suggestions to improve the systems operations.

1.13 FURTHER READINGS

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