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# UNIT 6 CHOICE OF TECHNOLOGY AND SELECTION OF SITE

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## Objectives

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

- explain why product or service design is important to any organisation
- discuss various stages involved in product design
- identify major aspects that determine process
- identify and discuss some of the criteria used to evaluate process
- explain why location decisions are important
- identify and discuss the general factors involved in determining the location of a business
- use the techniques presented to solve typical problems

## Structure

- 6.1 Introduction
- 6.2 Product/Service Design
- 6.3 Technology Determination
- 6.4 Selection of Site
- 6.5 Summary
- 6.6 Key Words
- 6.7 Self-assessment Questions
- 6.8 Further Readings

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## 6.1 INTRODUCTION

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Man has been striving to convert the scientific discoveries to application of human needs through invention, development, and innovation. The results of the efforts will be products and services to satisfy human needs. The backbone of any small business is the products or services it offers. The decisions related to product and service design will significantly affect the future of a small business organisation. The most effective way to approach a small business is either by creating an unique product or service that would be in great demand or to adopt something that is currently on the market.

Product and process go together and are critical elements of a small business operating strategy. The environment in which small business prevails is dynamic and pressures for change in product or service design can come from within the firm, competitors, suppliers, legal sources and legislations. A manufacturer is liable for any injuries or damages caused by a faulty product either because of poor workmanship or design. This aspect, known as product liability, provided under Consumer Protection Act, 1986 is a strong incentive for design improvements. The relationship between the product selected and the organisation structure can best be seen by considering the technology by which the product is produced. For new organisations the choice of product essentially determines the technology of production.

Processes can be defined as the facilities, skills and technologies used to produce a product or service. Technology selection will significantly affect the management of human resources, plant and materials capacity of the operation system. It also affects the external environment like markets, competitors and society. The technology chosen to produce should be flexible to take care of the changes in design of product or service.

Decisions relating to location are dynamic in nature and are important to new organisations. An ideal plant location is one where the unit cost of production and physical distribution is minimum and revenues are maximum. It should also provide an opportunity for the organisation to grow. It is important to avoid a troublesome location rather than finding an ideal site.



## 6.2 PRODUCT/SERVICE DESIGN

Decisions relating to the final product/service design will influence or determine the firms image, profitability, opportunity and as well as the problems it may face in the future. Product design specifications paves way for the Manager to take a decision regarding process selection, quantity, quality, and type of materials, the required labour skills and supervision to manufacture the product.

The first step in evolution of an effective operational system is the design of the product or service that is to be offered. The path from conception of an idea to a finished product depends upon the firm, the product and numerous other factors. Figure 6.1 shows detailed stages involved in product design. The concepts of standardisation, reliability, product simplification, modular design, reproducibility, maintainability, consumer quality level, value analysis-are important considerations in evaluating designs in order to prevent unnecessary investment in equipment, labour, materials and overhead costs.

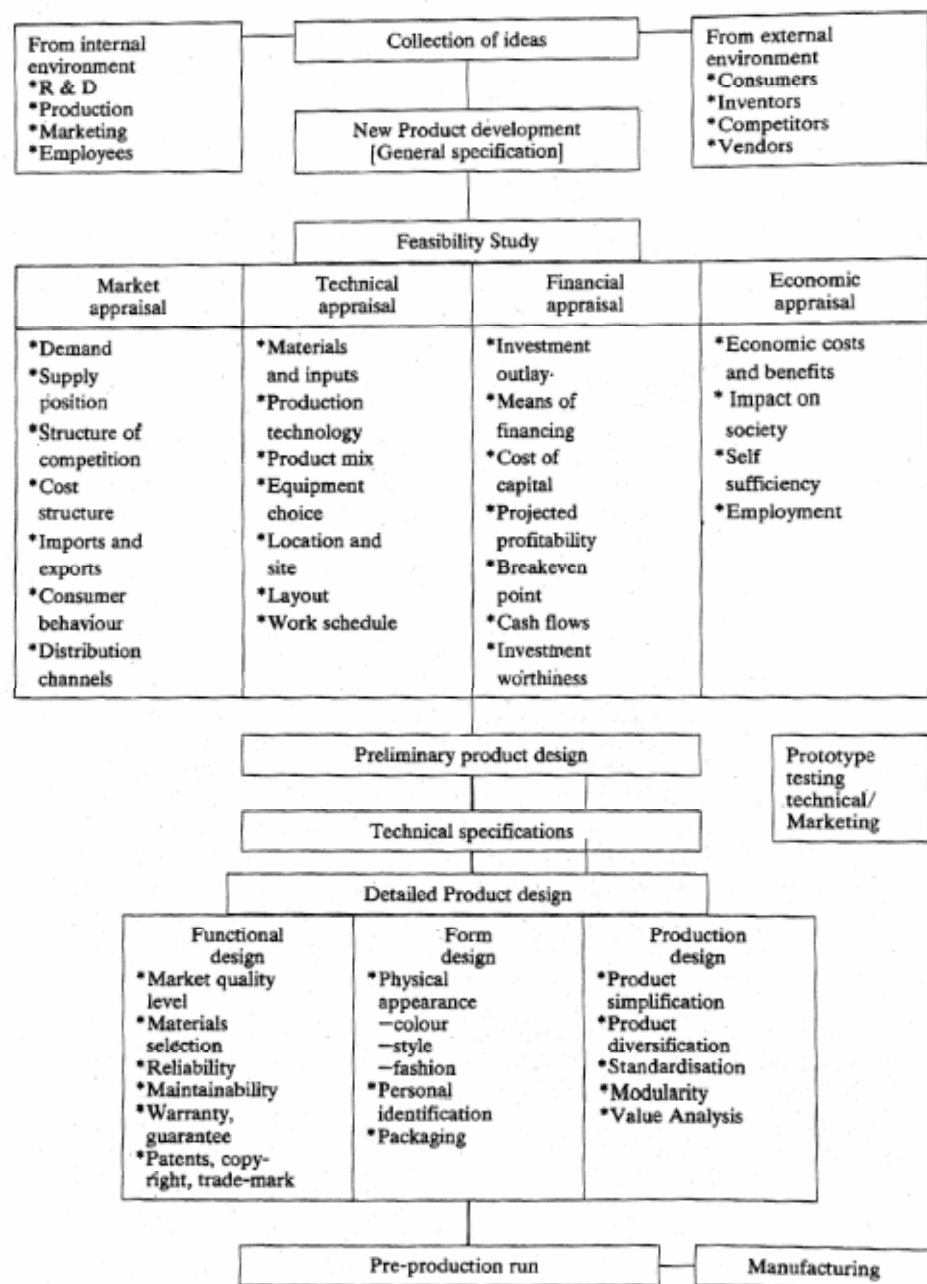


Figure 6.1: Stages in product design



Service systems like entertainment centres, health. centres, hotels, public transportation, retail establishments, educational institutes, personal services, financial services etc., have acquired a greater importance in to days business world. The concept of designing the services is more difficult than product designing. Service organisations will concentrate more on lines of services offered, level of service and service availability in designing services.

Service organisations deliver their services mainly through the human resources of the productive system. The technology of transformation should be flexible enough to allow variation in needs of the customers. Since human resources are flexible and trainable, they can at tune to almost any service requirements which the environment needs. While designing the services, care is taken regarding methods of delivering the service rather than engineering specifications and productive process technologies. In fact it will be difficult to specify the service prior to the start of service. Market acceptability of intangible services are determined through surveys rather than through testing and demonstration. Services must be specified in a way to assure their conformity to the intended function. right timing. optimum cost and right quantity.

### Activity 1

Select two service organisations and two product organisations from the SSI sector, study them to find out:

- a) What were the considerations used in designing the product /service?
- b) How do considerations for designing services vary from designing those for product?

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## 6.3 TECHNOLOGY DETERMINATION

Process decisions commence with product analysis that extends to every subassembly, raw material or component comprising the final product. Before taking up the process selection issue, the fundamental question to be considered is whether to make or buy the product. New and small enterprises concentrate on increasing the turnover through the buying process. Make or buy is a strategic decision and must be made periodically on each material or component required by the finished product. Some of the factors influencing make or buy decision are:

- 1) Idle facilities
- 2) Plant capabilities (Product quality, quantity and service, Personnel, equipment, future capabilities)
- 3) Economic advantage
- 4) Suppliers reliability (Quality, quantity, service, schedule)
- 5) Trade relations
- 6) Employment stabilisations
- 7) Trade union views
- 8) Alternative resource uses
- 9) Legal restrictions (Patents)

Make or buy analysis provides the planners with the comparison whether to produce or buy. After arriving at the decision of making the product ourselves the process determination phase can begin. The major aspects that determine process are technological and sequential. Technology can be defined as a combination of labour, machines, processes, energy and other inputs directly involved in the transformation of materials into products. Technology has increased the outputs of industrial and non-industrial sectors. It has improved the quality and reliability of the products, and saved the capital costs. Technology has not only been a primary source of improving productivity but also created new resources. Technological considerations occur at two levels.



- 1) General technological feasibility.
- 2) Specific choice of equipment.

General technology, feasibility maybe thought of decision regarding the theoretical feasibility of the making the product (Major technological-choice), the general nature of be processing system (Minor technological choice), the specific equipment to be employed (specific component choice).

Sequential considerations are those that aim at determining the most efficient relationships between processing steps. Firms using existing technology should maintain a continuing interest in improving it as long as changes are economically desirable and can be justified. Increasing the output rate, reducing unit costs and improving the yield are the motives for seeking improvements in existing technologies.

Service organisations must decide how wide and deep their lines of service shall be. In many situations, firms depend on the financial resources to provide a wide range of lines. To arrive at the load of service the organisation has to trade off between its ability to supply the services against the need to operate economically at the same time. The managers need to plan how long the service will be available in a day and week. It is also essential to locate the service ideally to provide better service to the customers.

Various criteria for evaluating production process and equipment selection are

- 1) Product/service requirements
- 2) Technological feasibility
- 3) Financial considerations
- 4) Labour and skill requirements
- 5) Output and capacity needs
- 6) Compatibility with existing facilities
- 7) Flexibility
- 8) Raw material requirements
- 9) Size and weight limits imposed by plant or building
- 10) Maintainability
- 11) Spare parts inventory requirements

The selection of the most desirable technology can be aided by tools like economic analysis, capital investment analysis, linear programming, marginal analysis, breakeven and incremental analysis. Motion and time study, work standards, and ionic measurement are the aids for integrating the human factors in process equation. For further reading you can refer Work and job Design (Blocks 2 and 3) of MS-5 Management of machines and materials.

The sources of process knowhow for small manufacturing units are as follows:

- 1) National Research and Development Corporation, Council of Scientific and Industrial Research.
- 2) Private research laboratories recognised by CSIR like Shri Ram Research Institute, New Delhi, Ghardal Research Centre, Bombay or Shroff Technical Services, Bombay.
- 3) Individuals who have experience in similar lines.
- 4) From turnkey suppliers of plant and machinery.
- 5) Foreign Technology.

Following is a list of institutions equipped with the facilities of pilot plant, prototype product manufacturing facilities, testing of product, R and D of new products:

- 1) Industrial Research Laboratories set up by different State Governments.
- 2) Central Institute for Plastics Engineering and Training Madras/Ahmedabad.
- 3) Prototype Training Centres of Small Industries Service Institute located at different places in our country.

### **Activity**

Contact five entrepreneurs in your town and study them to gather the following information:

- a) What were the criteria used while selecting the technology in use?
- b) What were their sources of information regarding the technology?



## 6.4 SELECTION OF SITE

Any new organisation has to take the major strategic decision on locating its facilities. The general objective in selecting a site is to minimise total cost of production and distribution. The selected site should also maximise revenue and provide an opportunity for further growth and expansion. Regardless of the type of business, there are some general factors that will influence locating an operation. The most important factors may be:

- 1) Personal factors.
- 2) Economics (Purchasing power of community, number of people employed in the area, per capita retail sales etc.).
- 3) Competition.
- 4) Geographic considerations.
- 5) Local laws and regulations.

Small business can avail benefits provided by the government through its policies on licensing, locating public sectors, subsidies, financial concessions, taxes, duties, and establishing industrial estates.

### General procedure for making location decisions

Selecting a facility location usually involves a sequence of decisions. The general procedure proposed by William J Stevenson for making location decisions consists of the following steps.

- 1). Determine the criteria that will be used to evaluate location alternatives, such as increased revenues or community service.
- 2). Identify factors that are important, such as location of markets or materials.
- 3). Develop location alternatives.
  - i). Identify the general region for a location.
  - ii). Identify a small number of community site alternatives.
- 4). Evaluate the alternatives and make a selection.

A summary of the factors that affect location is provided in Table No. 1.

**Table 1: Factors Affecting Location Decisions**

Level	Factors	Considerations
Region/ Country	Locations of raw materials or supplies Location of Markets Labour	Proximity, modes and costs of transportation, quantity available Proximity distribution costs target market Trade practices/restrictions Availability [general and for specific skills] age distribution of work force, attitudes toward work, nonunion, productivity, wage scales, compensation laws
Community	Facilities Services Attitudes Taxes Environmental regulations Utilities Development support	Schools, churches, shopping, housing, entertainment, etc. Medical fire and police Pro/con State/local direct and indirect State/local Cost and availability Bond issues, tax abatement, low-cost loans, grants
Site	Land Transportation Environmental/legal	Cost, degree of development required, soil room for expansion drainage parking Type [access roads, rail spurs, air freight] Zoning restrictions

**Source:** Production and Operations Management by William J. Stevenson, Richard D. Irwin, Inc. Illinois; 1982



To make a thorough evaluation of pertinent factors involved in plant location it would be convenient to classify locational problems as follows.

### 1) Single facility location

Many locational problems like location of a manufacturing unit, a warehouse etc. which may fall under single facility location require the selection of a site. An important assumption made here is that revenue, costs and other facility characteristics of the firm do not depend on the location of other facilities of the firm or competitors. Single facility location situation can be evaluated by qualitative factor rating and locational break-even analysis.

#### Procedure for qualitative factor rating

- 1) Identify and evolve a list of relevant factors.
- 2) Allot a weight to each factor to indicate its relative importance [weights may total 1.0] among the factors considered to take a decision.
- 3) Establish a common numerical preference rating scale [0-100 points] to all factors.
- 4) Score each potential location based on comparison with other potential locations.
- 5) Multiply the preference rating by the weights and obtain resultant weighted score.
- 6) Sum up the weighted scores for each location.
- 7) The location with the maximum points is desirable.

#### Example 1

Tamil Nadu Glass Company is evaluating three locations for a new plant and has weighted the relevant factors as shown in Table 2. Scores have been assigned with higher values indicative of preferred conditions. Using these scores, develop a qualitative factor comparison for the three locations.

**Table 2**

		Trichy		Madurai		Coimbatore	
		Score	Weighted score	Score	Weighted score	Score	Weighted score
Relevant factor	Assigned weight						
Production cost	0.35	55	19.25	40	14.00	35	12.25
Raw Material supply	0.20	75	15.00	80	16.00	74	14.80
Labour availability	0.15	55	8.25	72	10.80	60	9.00
Cost of living	0.10	82	8.20	70	7.00	50	5.00
Environment	0.02	65	1.30	60	1.20	70	1.4
Markets	0.18	80	14.40	90	16.20	85	15.30
Total Location Score			66.80		65.10		51.75

Weighted scores are computed by multiplying the score times the assigned weight for example,  $55 \times 0.35 = 19.25$ . Weighted scores for each location are summed up to obtain total location score. Based on this data, Trichy is preferred location.

#### Procedure for locational break-even analysis

- 1) Determine all relevant costs that are associated with the locations.
- 2) Classify the costs for each location into annual fixed costs [F C] and per unit variable costs [V C]
- 3) Plot the costs associated with each location on a single chart of annual costs on Y axis versus annual volume of X axis.
- 4) Choose the location with the lowest total (T C) at the expected production volume [V]

**Example 2**

Potential locations at Trichy, Madurai, and Coimbatore have cost structures shown in Table 3 for a product expected to sell for Rs. 1501-.

- Find the most economical location for an expected volume of 7,000 units per year.
- What is the expected profit if the site selected in [a] is used?
- For what output range is each location best?

**Table 3**

Potential location	Fixed cost per year	Variable cost per unit
Trichy	Rs. 1,50,000/-	Rs. 75/-
Madurai	Rs. 2,00,000/-	Rs. 50/-
Coimbatore	Rs. 4,00,000/-	Rs. 25/-

- For each set, equate total costs to the sum of fixed costs and variable costs.

$$TC = FC + VC [V]$$

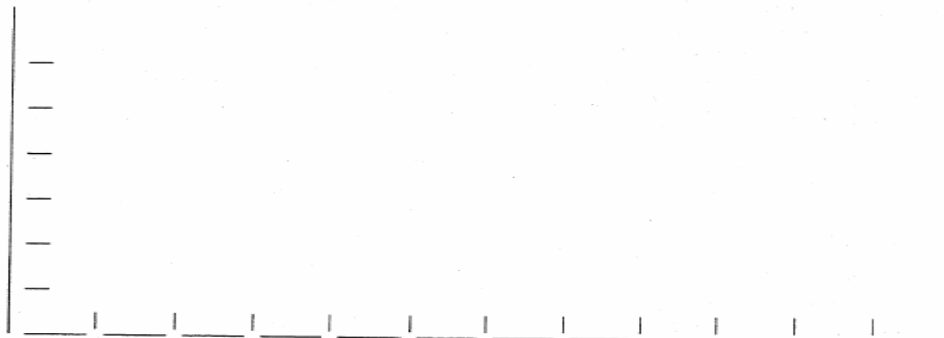
Trichy :  $TC = \text{Rs. } 1,50,000 + \text{Rs. } 75 [7,000] = \text{Rs. } 6,75,000.$

Madurai :  $TC = \text{Rs. } 2,00,000 + \text{Rs. } 50 [7,000] = \text{Rs. } 5,50,000.$

Coimbatore :  $TC = \text{Rs. } 4,00,000 + \text{Rs. } 25 [7,000] = \text{Rs. } 5,75,000.$

Total costs for Madurai is least hence the most economical location for an expected volume of 7,000 units per year.

- Expected profits [Choosing Madurai] =  $\text{Rs. } 150 \times 7000 - 5,50,000 = \text{Rs. } 5,00,000/\text{year}.$
- Plotting for each location the total costs on Y axis and volumes on X axis, we have
  - Total cost curves of Trichy and Madurai intersecting at 2000 units, And Rs. 3,00,000.
  - Total Cost curves of Madurai and Coimbatore intersecting at 8000 units and Rs. 6,00,000.



Hence for volumes  
upto 2000 units Trichy will be preferable,  
between 2000 units and 8000 units Madurai will be preferable  
for 8000 units or more Coimbatore will be preferable.

**Activity 3**

With respect to enterprises studied for Activity 3, study the criteria used for selection of site. To any one of the enterprises, apply the break-even analysis to determine whether the location decision was justified on this basis.

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**2) The multi facility location**

In the case of single facility location problem we have been concerned to select the.



minimum cost location, whereas in a multi facility location problem we must select the location which when added to existing locations minimises the cost of the entire system.

### **Location of multiple factories and warehouses**

In this type of location problem, total distribution costs and perhaps total production costs will be affected by the location decision. This problem is usually formulated by considering a production distribution network of plants and warehouses with criterion of minimising a transportation cost, subject to satisfying overall supply and demand requirements. The transportation linear programming [L P] method may be useful. For further reading the reader can refer Chapter 6 "Location and Distribution" of Modern production/operations management, Elwood S. Buffa, Wiley Eastern Limited, 1983.

### **3) Location of competitive retail stores .**

Many retail location problems can be formulated with the criterion of maximising revenue. These problems typically occur for retail stores, departmental stores and restaurants, where the revenue of a particular site depends on the intensity of competition from other competitor's locations nearby. Most retail location models are based on the assumption that revenue is proportional to the size of the facility and inversely proportional to the time the customer has to travel to the facility. The basic statement of the retailing model developed by D.L. Huff is  $E_{ij} = P_{ij}C_i$  where

$E_{ij}$  = expected number of customers at i likely to travel to shopping center j.

$C_i$  = number of customers at i.

$P_{ij}$  = probability of a customer at point of origin i travelling to shopping center j. P is a function of the size of shopping center j, the travel time for a customer at point of origin i to travel to shopping center j, and the effect of travel time on various types of trips.

### **4) Emergency-Service location**

A significant class of location problems concerns the delivery of emergency services like fire, police, and ambulance. These problems often have minimum response time as a decision criterion, since time is of the essence in delivering emergency service. These problems illustrate location decisions where a measure of service, such as response time, is the most important location criterion. Emergency response time can be estimated for different location sites by using simulation models. These models permit the incorporation of factors such as density of calls, speed of travel, despatching rules, and number of vehicles available. For further reading the reader can refer Chapter 6 "Location and Distribution" of Modern production/operations management, Elwood S Buffa, Wiley Eastern Limited, 1983.

### **Activity 4**

Study the location criteria applied for the establishment of

- A retail store
- An emergency service outlet

How do these criteria vary and why?

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## **6.5 SUMMARY**

Product of service design and process selection form an important part of operations strategy. Decisions on what to produce and how to produce are central to all other elements of operations strategy. Ever changing nature of environment subjects product and service design to continual changes for improvements. Product improvements come from internal and external sources. Product feasibility is carefully assessed before a product is designed. The primary concerns in product design relate to standardisation, reliability, simplification, reproducibility, maintainability, and modular design. Process determination consists of evaluating a series of decisions on the alternative ways of producing a product/service, the type of technology to adopt, the plant and machinery to be employed, the work flow system for the product/service and the method of performing the job.





The location of a facility involve far-reaching, decisions which affect a new enterprise. Many factors like location of raw materials and sources of supply, labour supply, market considerations, community related factors, site related factors, and climate influence location of a facility. On a long-term basis these factors exhibit a potential impact. A common approach to take a decision on locating a facility is to classify the location problem as single facility, multiple facility, retail stores, emergency service and apply appropriate tools and superimpose the solutions with behavioural aspects to arrive at a solution which may not be an optimal but an ideal one with minimum problems.

## 6.6 KEY WORDS

**Capacity:** The amount of output that can be realised under a specific set of conditions, circumstances, and time. It generally refers to an upper limit on the rate of output.

**Design:** A detailed plan for a product or service that may include drawings, sketches, and measurements.

**Effectiveness:** The actual accomplishment of multiple objectives with a possible prioritisation within objectives. “**Going right things**”.

**Efficiency:** Producing the desired output of goods, and services with a minimum of effort, expense, waste, resources, and time. It is measured in total by dividing output by input. “**Doing things right**”.

**Maintainability:** It refers to the ability of a product or system to stay in operating condition with a reasonable amount of effort.

**Modular design:** It allows manager a variety of final product models with only a few basic components, Modules are common components grouped into interchangeable subassemblies.

**Planning.** The managerial function of projecting appropriate action well on time about a predetermined objective together with the means needed to achieve that objective.

**Process:** The sequence of steps or the system used to convert inputs of labour, materials, and machines into outputs of semifinished or finished parts, components, or products.

**Productivity:** A measure of the relationship between the output of goods or services and the resources required for their production. "Efficiency of production"

**Products:** Tangible outputs resulting from combining materials, labour, capital, and managerial skills.

**Prototype:** A model of a product or part of a product; first embodiment of features of a product to be used for testing.

**Quality:** Is a measure of how closely a good or a service conforms to specific standards.

**Reliability:** It refers to the ability of a product, part or system to perform its designed function satisfactorily for a specified period of time under a given set of conditions.

**Reproducibility:** It refers to, the ability of the, productive system to produce products of desired quality consistently.

**Research:** The deliberate and planned effort to seek anything new such as new relationships or new applications.

**Research and development:** Research with subsequent efforts to more clearly define uses and applications.

**Services:** Activities performed to provide people with benefits such as transportation or health care.

**Simplification:** It refers to reducing unnecessary variety in product line by decreasing the number and variety of products produced.

**Simulation:** Is a means of modelling the essence of an activity or system -so that "experiments can be conducted to evaluate the systems behaviour or response over time.

**Specification:** Is a detailed description in form of measurements, quantities, or qualities, required of a product or service; if it is to meet the design requirements for function and aesthetics.

**Standardisation:** It refers to the attempt to gain uniformity in characteristics of a product such as size, shape, colour, quantity, and performance.



**Strategic:** In application to goals and strategies, the identification of those most important to a firm's long run survival and prosperity.

**Strategy:** The plan of activities identified as being necessary to achieve a specific goal or objectives.

**Technology:** Is the systematic process of using scientific, material and human resources to produce goods and services for human purposes.

**Transformation:** The act or means for converting inputs of one form into outputs of another.

**Technological feasibility:** When a process or machine is inherently capable of performing the necessary transformation requirements set forth in the design specifications.

**Value analysis:** The use of comparative cost and function figures in making purchasing and design decisions. It aims at ensuring that every element of cost contributes proportionately to the function of the product.

## 6.7 SELF-ASSESS QUESTIONS

- 1) What are the basic steps in system of bringing a product/service from an idea to a finished product/service?
- 2) How does production design relate to technology determination and equipment selection?
- 3) The swastik company is considering to start a manufacturing plant in either Madras, Coimbatore, or Madurai. The company has collected the economic and non economic data shown below.

Factor	Madras	Coimbatore	Madurai
Transportation Cost/week	Rs. 860	Rs. 660	Rs. 490
Labour costs per week	Rs. 1100	Rs. 1080	Rs. 1260
Selected criteria scores (based on a scale of 0-100 points)			
Raw material	45	85	75
Housing facilities	55	35	40
Maintenance facilities	60	80	75

Company has pre-established weights for various factors, ranging from 0-to 1.0. They include a standard of .2 for each Rs. 10 per week of economic advantage. Other weights that are applicable are .35 on raw material, .15 on housing facilities, and .3 on maintenance facilities. Develop a qualitative factor comparison for the three locations?

- 4) Describe briefly how transportation linear programming can be used to help analyse location problems?
- 5) Describe how an entrepreneur may simultaneously consider both quantitative and qualitative factors in facility location analysis?

## 6.8 FURTHER READINGS

*Effective Small Business Management*-Richard M. Hodgetts, Donald F. Kuratko, Academic Press College Division, 1986.

*Modern Production/Operations Management*--Elwood S. Buffa, Wiley Eastern Limited, 1983.

*Production and Operations Management, A Problem Solving and Decision Making Approach* Norman Gaither, The Dryden Press International, 1987.

*Production and Operations Management*-S.N. Chary, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1988.