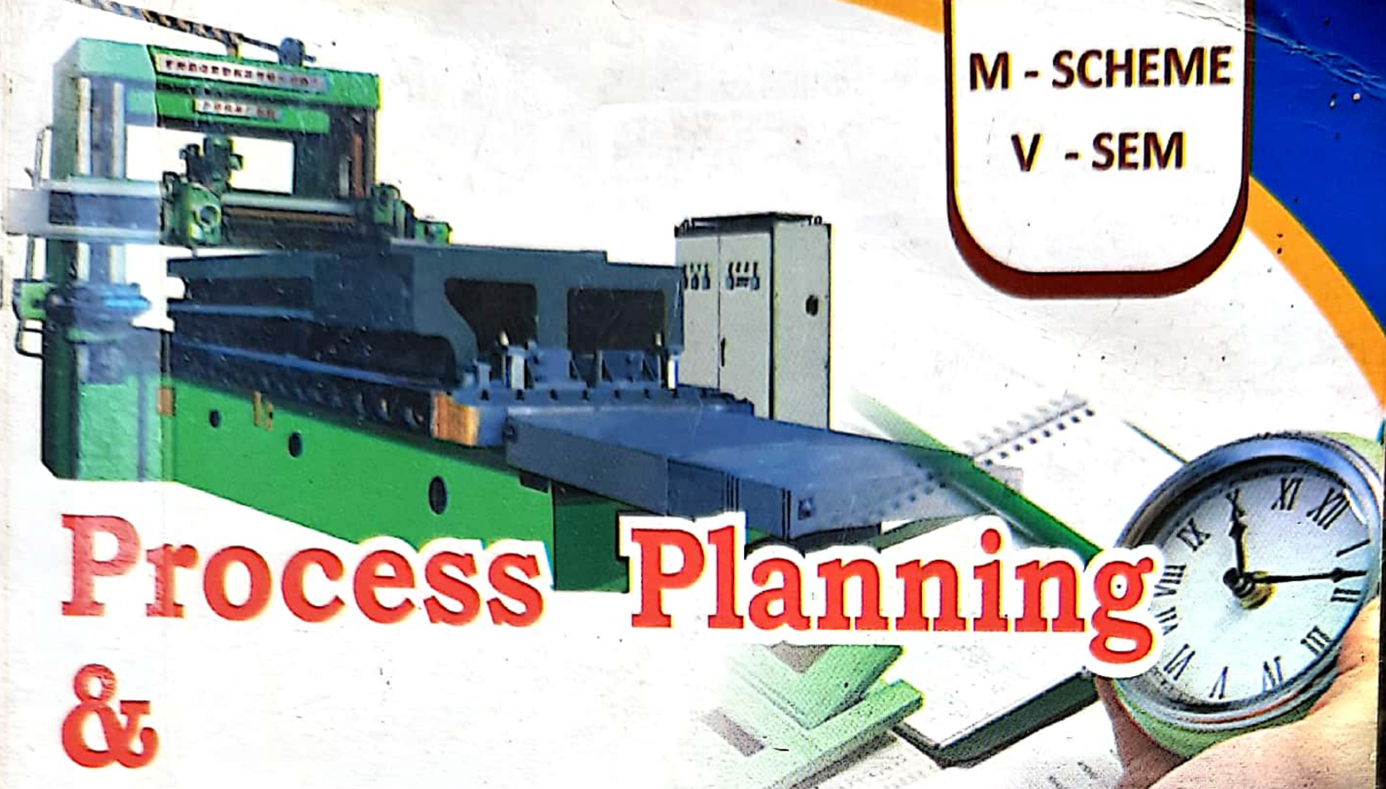
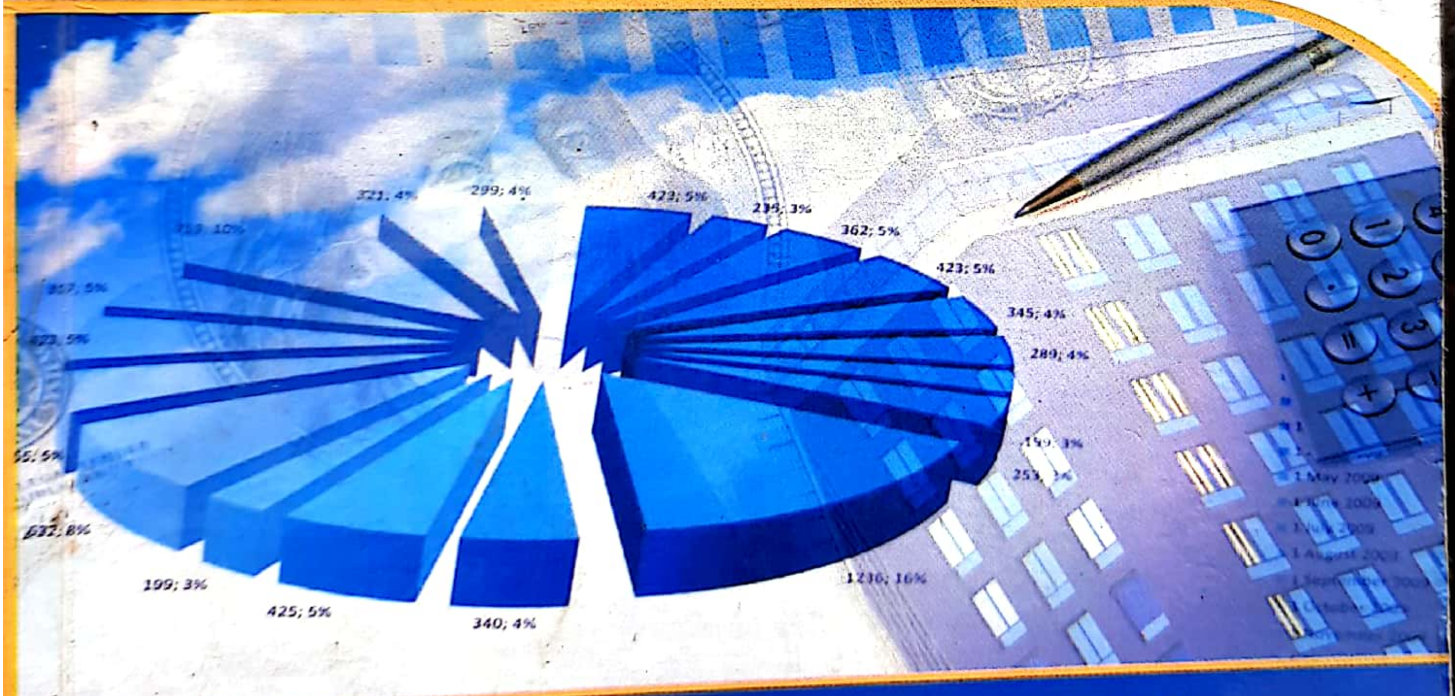
M - SCHEME

V - SEM



Process Planning & Cost Estimation



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UNIT - I

PROCESS PLANNING

1.1. Introduction

The product design for each product has been developed in the design department. To convert the product design into a product, a manufacturing plan is required. The activity of developing such a plan is called process planning.

Process planning consists of preparing the set of instructions that describe, how to manufacture the product and its parts.

The task of process planning consists of determining the manufacturing operations required to transform a part from a raw material to the finished state specified on the engineering drawing.

Process planning, also known as operations planning, is the systematic determination of the engineering processes and systems to manufacture a product competitively and economically.

1.2. Definition

Process planning can be defined as an "an act of preparing a detailed processing documentation for the manufacture of a part of assembly."

In other words it can be defined as "Process planning is the systematic determination of the methods by which a product is to be manufactured, economically and competitively."

1.3. Concept of process planning

The concept of process planning is to find the most economic method of doing an activity. It involves

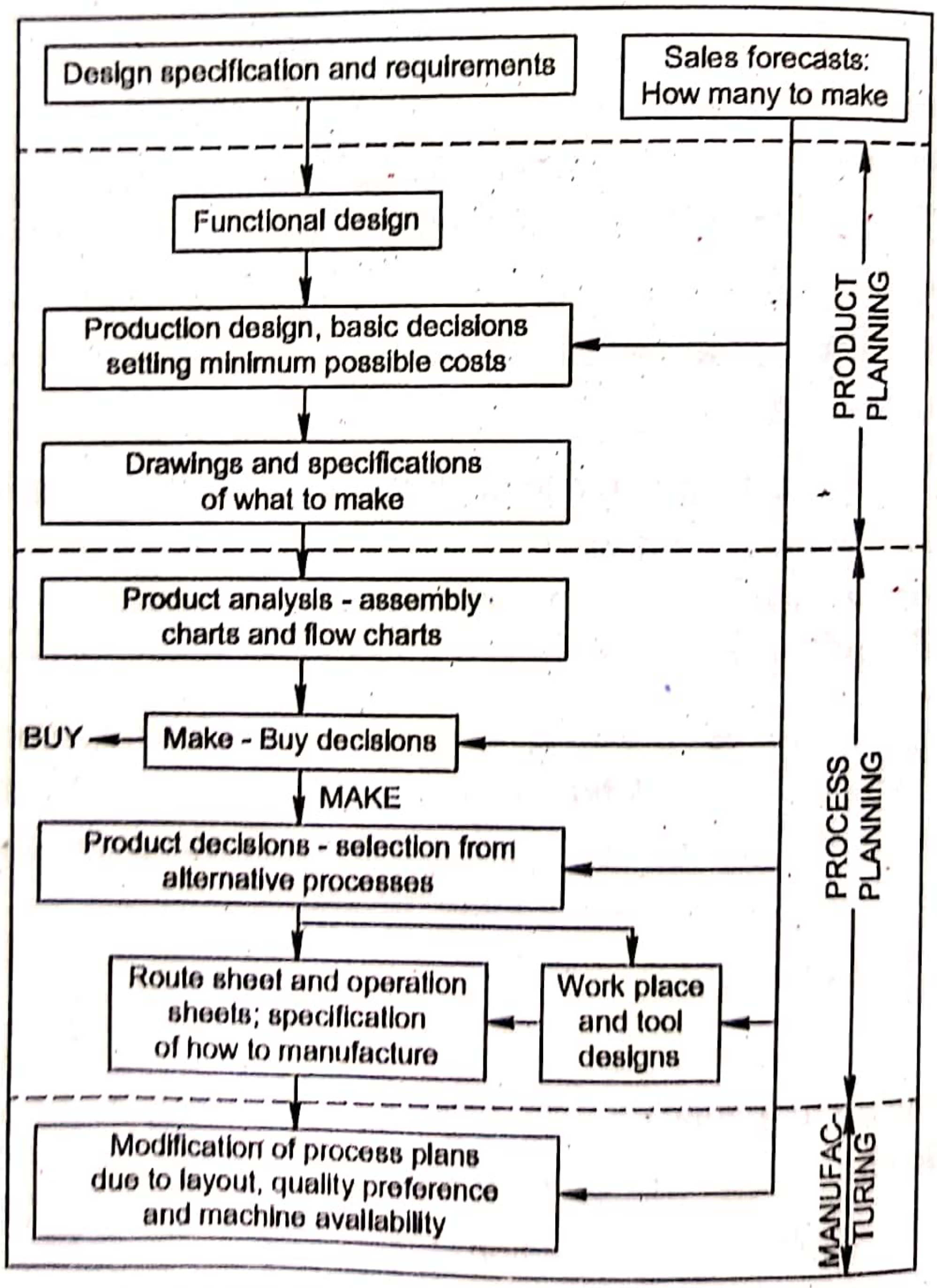

Fig.1.1 Overall development of processing plans

a. The various operations involved in production of each product.

b. The various machineries on which the operations are to be carried out.

c. The required tools, jigs and fixtures

d. The required materials.

e. The required speed, feed and depth of cut

f. The required labours.

g. The time needed for each operation.

1.4. Information required to do process planning

While doing process planning, the following information are very essential.

1. Quantity of work to be done along with product specifications.
2. Quality of work to be completed.
3. Availability of equipments, tools and personnels.
4. Sequence in which operations will be performed on the raw material.
5. Names of equipments on which the operations will be performed.
6. Standard time for each operation.
7. When the operations will be performed?

1.5. Factors affecting process planning

The various factors affecting process planning are as follows:

1. Volume of production.
2. The skill and expertise of manpower.

3. Delivery dates for parts or products.
4. Material specifications and availability.
5. Accuracy of products
6. Accuracy and process capability of machines.

1.6. Process Planning Procedure

The different steps involved in process planning are:

1. Preparation of working drawings.
2. Deciding to make or buy.
3. Selection of manufacturing process.
4. Machine capacity and machine selection.
5. Selection of material.
6. Selection of jigs, fixtures and other special attachments.
7. Operation planning and tooling requirements.
8. Finding the set up time and standard time for each operation.
9. Preparation of documents such as operation and route sheets etc.

1. Preparation of working drawing

Analyse the product requirements as per our requirement. It includes material, weight, dimensions, accuracy and the number of parts to be manufactured. Then as per the above items, the working drawing should be made.

2. Deciding to make or buy

While manufacturing the product, some parts may be made and some parts may be bought. Considering the economic aspect, decide to make or buy decision.

3. Selection of manufacturing process

In order to convert raw material into a finished product, a manufacturing process is necessary. Therefore it is important to select a manufacturing process of most economical one. It depends upon quality, quantity and delivery date.

4. Machine capacity and machine selection

As per the specifications of parts to be manufactured, it is essential to select the capacity of machine.

5. Selection of material

As per the specifications of parts to be manufactured, the material selection will be made. The material should have right quality and chemical composition.

6. Selection of jigs, fixtures and other special attachments

These items are necessary to give high production rate and reduce the cost of products.

7. Operation planning and tooling requirements

We have to make some planning of operations and the various requirements of tools by mean of operation process chart.

8. Finding the set up time and standard time

Then find the set up time for each operation and standard time for each product.

1.7. Make or buy decision using break even Analysis

Break even point is the point at which there is no profit or loss. This principle may be applied to take make or buy decision.

It is defined as a point at which the making or buying a part / product is most economical. Sometime, the cost of buying a part or product is cheaper than making. In some other time, the cost of making a part or product is cheaper than buying.

1.7.1. Factors affecting make or buy decision

a. Quantitative Factors

1. Opportunity costs

It may be defined as the monetary value sacrificed in rejecting an alternative. Facilities utilized in manufacturing a part or component are, in effect, sacrificed for any other use. The decision to make or buy often boils down to an attempt to optimize the utilization of facilities.

2. Incremental cost

Only those costs that vary with the decision to make or buy are generally considered relevant.

3. Idle facilities

Availability of idle facilities bears directly on the make or buy decision, particularly with regard to determining the incremental costs involved. If sufficient facilities are available, only variable costs. i.e., those costs that vary with volume, must be considered.

b. Qualitative factors

1. Product quality

Parts may be made in one's own factory is an attempt to control the overall quality of an end product even though it may be more economical to buy the parts from outside.

2. Patents

Legal restrictions may prevent a company from making certain parts.

3. Skill and materials

Required skills may be very technical or materials may be very rare and special, thereby precluding in-house manufacture of certain parts.

4. Long-term considerations

It may be more profitable in the short run, for example, during slow periods, to utilize idle facilities by manufacturing more parts in house. However, this may result in poor relations with suppliers, or even in non-availability of parts from outside sources during busy periods when in-house facilities could be used more profitable in other ways.

c. Other factors

Other factors that may influence the make or buy decision are:

1. Number of outside suppliers
2. Reliability of outside sources
3. Seasonal demands

1.7.2. Cost analysis (Break-even analysis) for decision making

1. The objective of the break-even analysis is to decide the optimum break-even points, i.e., where profits will be highest.
2. An important aspect of such cost analysis is that made between fixed and variable costs.

3. Fixed costs are those which remain fixed irrespective of the volume of production or sales. For example, a managing director's salary will not vary (change) with the volume of goods produced during any year. Road tax payable for a car will not vary with its annual mileage covered. Insurance premiums, rent charges, R&D costs are a few other typical examples of fixed costs.

4. Variable costs vary or change in response to changes in, say volume of production or sales or any other similar activity.

By adding graphically variable cost to to the fixed cost for different levels of activity (e.g. number of goods produced). A total cost curve can be drawn. If a revenue curve is super - imposed on the same graph, the result is the break-even chart which depicts the profits/loss picture for several possible cost-revenue situations at different levels of activity.

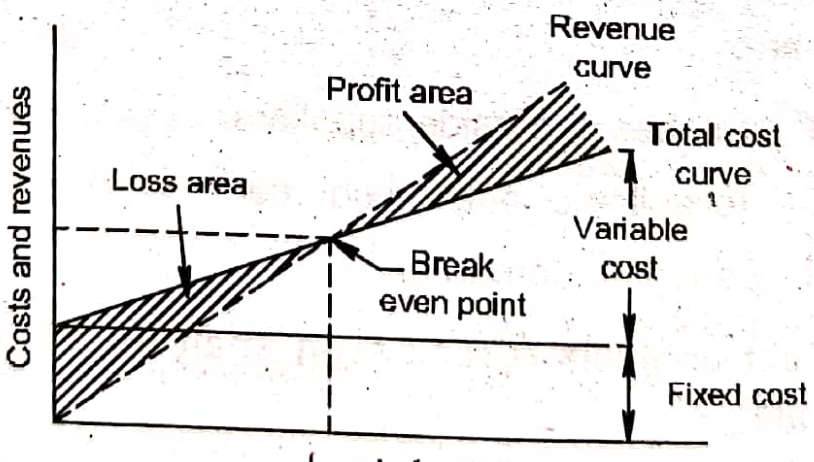

Fig.1.2 A break even chart analysis on make or buy decision

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It is determined by the following algebraic method.

Let, FC = Fixed cost

VC = Variable cost/unit

TC = Total cost

TR = Total revenue or income

Q = Sales volume or no of quantity sold

SP = Selling price

we know that,

Total cost = Fixed cost + variable cost

$TC = FC + (VC \times Q)$

Total renvenue = selling price x Quantity sold

$TR = SP \times Q$

At break even point, TC = TR

By substituting the values, $FC + (VC \times Q) = SP \times Q$

$$\text{Finally } Q_{BEP} = \frac{FC}{SP - VC}$$

1.7.3. Simple Problems

Problem 1

The fixed cost is Rs 15000 and variable cost is Rs 10/ unit. The selling price is Rs 25/. Find the break even point.

Solution

FC = Rs 15000/- VC = Rs 10/unit

SP = Rs 25/-

$$Q = \frac{FC}{SP - VC} = \frac{15000}{25 - 10} = 1000 \text{ units}$$

If the required unit is more than 1000 units, then it is better to make the product. If the requirement is less than 1000 units, it is better to buy the product.

Problem 2

A company is buying a product at the rate of Rs. 25/unit. Their annual requirement is 6000 units. If suppose the company is going to manufacture itself, the variable cost is Rs.5/unit and the fixed cost is Rs.1,50,000/. Make a decision on buy or make.

Solution

FC = Rs 150000/- VC = Rs 5/unit

SP = Rs 25/units Requirement = 6000 units

Sales price = 25 x 6000 = 1,50,000 /-

Total production cost = FC x VC

= 150000 + 5 x 6000

= 150000 + 30000

= 180000 /-

The cost of purchasing (1,50,000) is less than cost of producing (1,80,000), therefore it is better to take a decision on buy the product.

Problem 3

The cost of buying a gear is Rs.100/-. If it is made in the factory itself, the cost of material is Rs.30/unit and labour cost is Rs 40/unit. The annual fixed cost is Rs 80,000/-. The demand of gear is 4000 units per year. Do the break even point and take a decision on make as buy.

Solution

Gear Rate/SP = Rs 100/-

Variable Cost/VC = Material cost + Labour cost

Variable cost/VC = Rs 30/- + Rs 40/- = Rs 70/Unit.

Fixed Cost/FC = Rs 80,000/-

Requirement = 4000 units

Cost of buying = Rs 100 x 4000

= Rs 4,00,000/-

Cost of making = Fixed Cost + Variable Cost

= Rs 80,000/- + (4000 x Rs 70/-)

= Rs 80,000/- + Rs 2,80,000/-

= Rs 3,60,000/-

$$\text{Break even point} = \frac{FC}{SP - VC}$$

$$= \frac{80{,}000}{100 - 70} = \frac{80{,}000}{30} = 2667 \text{ units.}$$

From the above, it is better to take a decision on making the gears. The cost of making the gear is Rs 3,60,000/- which is less than the cost of buying (Rs 4,00,000/-).

Problem 4

A company is making the brackets for motor cycles. The fixed cost is Rs.1,00,000/- and the variable cost is Rs.30/- per unit. The annual requirement is 900 units. The cost of buying the bracket from market is Rs.80/-. Decide whether to make or buy the bracket and find the break even point.

Solution

Fixed Cost = Rs 1,00,000/-

Variable Cost = Rs 30/unit

Quantity/requirement = 900 units

Sales Price = Rs 180/- unit

Cost of buying = Rs 180/- x 900 = Rs 1,62,000/-

Cost of making= FC + (VC x Q)

= 1,00,000 + (30 x 900)

= 1,00,000 + 27,000 = Rs 1,27,000/-

From the above, it is better to make the bracket in the company itself. Because the cost of making(Rs 1,27,000/-)is less than cost of buying (Rs 1,62,000/-).

$$\text{Break even point} = \frac{1,00,000}{180 - 30} = \frac{1,00,000/-}{150}$$

$$= 667 \text{ units.}$$

If the requirement is less than 667 units, we can take a decision to buy. If the requirement is more than 667 units, we can take a decision to make the bracket in the company.

Problem 5

2500 components are required for an assembly line. This component is available at the rate of Rs 4/- per piece, in the local market. If the same component is to be manufactured in the factory itself, the fixed cost will be Rs 2500/- and the variable cost will be Rs 2/- per piece. Decide whether to make or buy.

Solution

Components Required = 2500 Nos

Rate/Cost = Rs 4/per piece

Fixed Cost = Rs 2500/-

Variable Cost = Rs 2/per piece

Variable Cost for 2500 pieces = Rs 2 x 2500

= Rs 5000/-

Cost of making for 2500 pieces= Fixed Cost + Variable Cost

= 2500 + 5000 = Rs 7500/-

Cost of buying for 2500 pieces = Rs 4 x 2500

= Rs 10,000/-

From the above, the cost of buying is more than the cost of making. Therefore, let us decide to make the component in the factory itself.

1.8. Methods of process planning

The process planning are generally classified into two types.

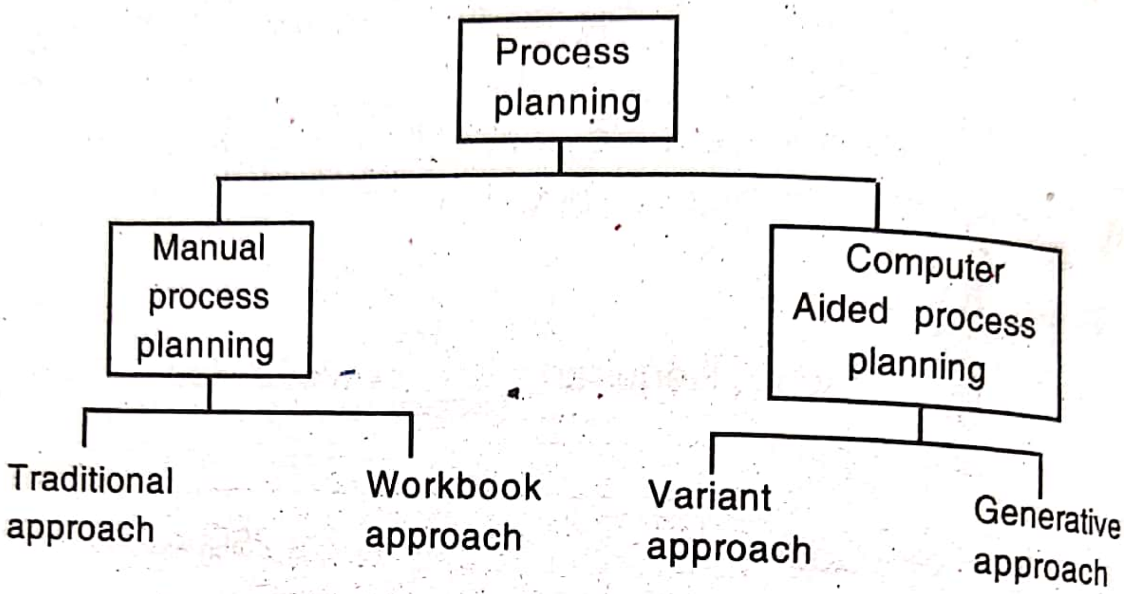


Fig. 1.3. Methods of process planning

1. Manual process planning,
   (i) Traditional Approach and
   (ii) Work book Approach
2. Computer Aided process planning (CAPP)
   (i) Retrieval CAPP system and
   (ii) Generative CAPP system

1.8.1. Manual Process Planning

In traditional process planning system, the process plan is prepared manually. The process involves examining and interpreting engineering drawings, making decisions on machining processes selection, equipment selection, operations sequence, and shop practices. Therefore, the manual process plan is very much dependent

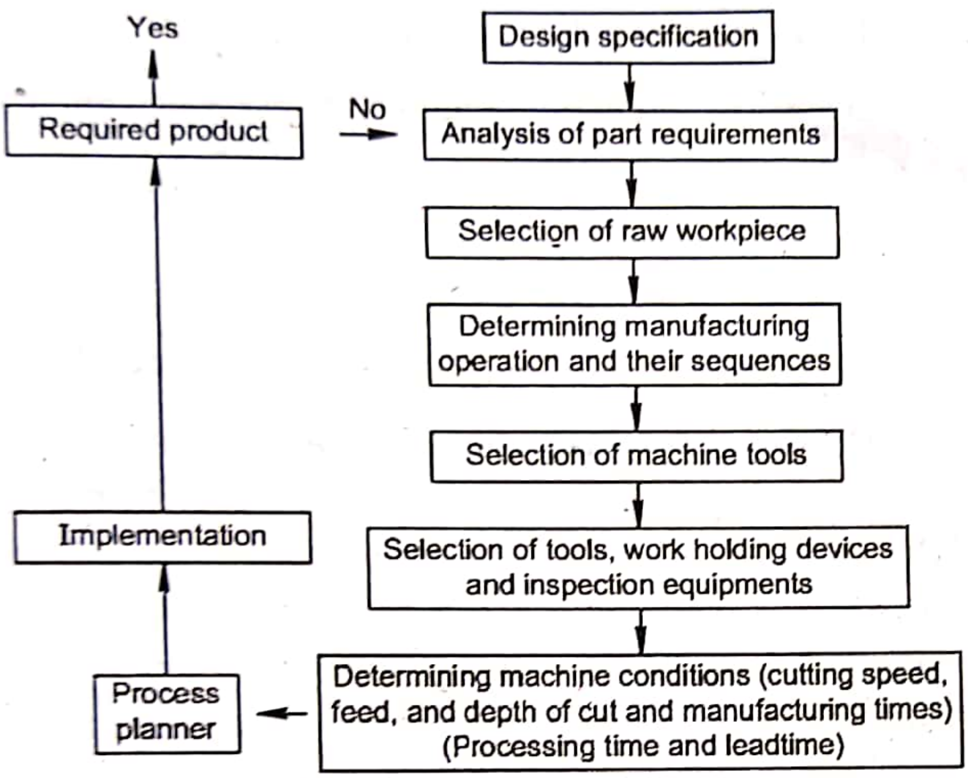


Fig.1.4 Manual process planning

Advantages

1. Manual process planning is most suitable for small scale industries.
2. It has few process plans to produce the component.
3. This method is highly flexible.
4. This requires low investment costs.

Disadvantages

1. Manual process planning is a very complex and time consuming.
2. It requires large amount of data.
3. This method requires the skilled operator.

4. It has more possibilities for human error because this method depends on the planner's skill and experience.
5. It increases more paper work.
6. This type may reduces productivity.

1.8.2. Computer Aided Process Planning (CAPP)

In order to overcome the drawbacks of manual process planning the Computer Aided Process Planning (CAPP) is used. With the use of computers in the process planning, one can reduce the routine clerical work of manufacturing engineers. Also it provides the opportunity to generate rations, consistent and optimum plans. In addition, CAPP provides the interface between CAD and CAM.

Advantages of CAPP

The advantages of implementing CAPP include the following.

1. Process rationalizations and standardization

CAPP leads to more logical and consistent process plans than manual process planning.

2. Productivity improvement

As a result of standard process plan, the productivity is improved (due to more efficient utilization of resources such as machines, tooling, stock material and labour)

3. Product cost reduction

Standard plans tend to result in lower manufacturing costs and higher product quality.

4. Elimination of human error

5. Reduction in time

As a result of computerizing the work, a job that used to take several days, is now done in a few minutes.

6. Reduced clerical effort and paper work

7. Improved legibility

Computer - prepared route sheets are neater and easier to read than manually prepared rout sheets.

8. Faster response to engineering changes

Since the logic is stored in the memory of the computer, CAPP becomes more responsive to any changes in the production parameters than the manual method of process planning.

9. Incorporation of other application programs

The CAPP programs can be interfaced with other application programs, such as cost estimating and work standards.

1.8.2.1. Retrieval (or variant) CAPP system

A retrieval CAPP system, also called a variant CAPP system, has been widely used in machining application.

The basic idea behind the retrieval CAPP is that similar parts will have similar process plans.

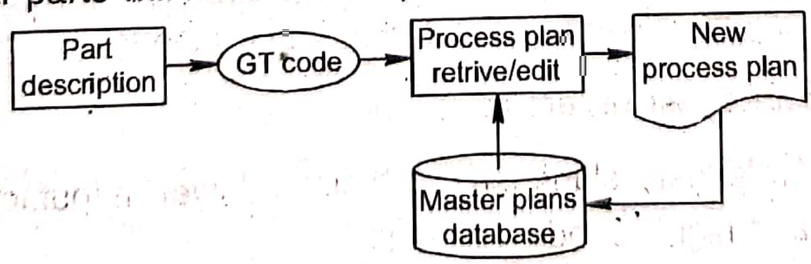


Fig.1.5 Block diagram of retrieval CAPP system

In this system, a process plan for a new part is created by recalling identifying and retrieving an existing plan for a similar part, and making the necessary modifications for the new part.

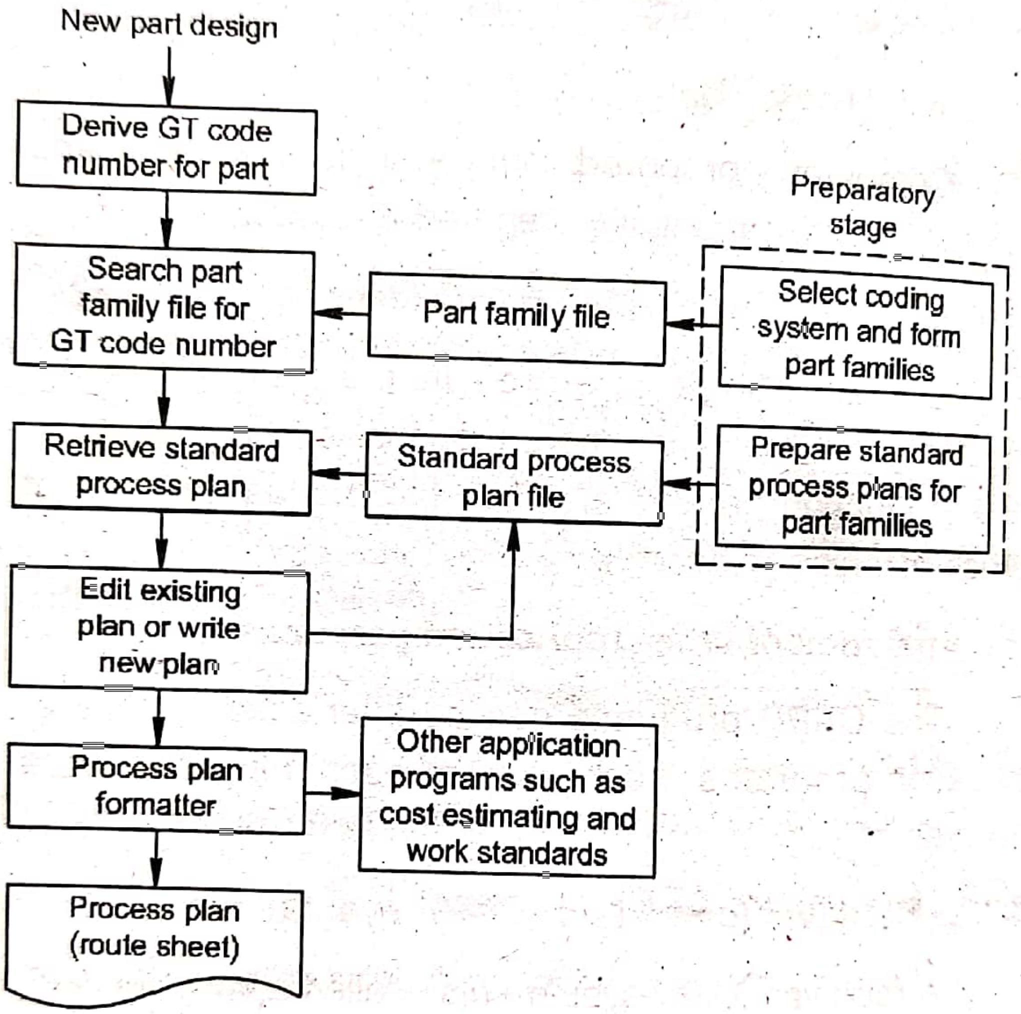


Fig.1.6 General procedure for using one of the retrieval CAPP systems

A retrieval CAPP system is based on the principles of group technology (GT) and parts classification and coding. In this system, for each part family a standard process plan (i.e., route sheet) is prepared and stored in computer files. Through classification and coding, a code number is generated. These codes are often used to identify the part family and the associated standard plan. The standard plan is retrieved and edited for the new part.

The figure illustrates the general procedure for using one of the retrieval CAPP systems.

Advantages of Retrieval CAPP system

1. The standard plan has been written, a variety of parts can be planned.
2. Comparatively simple programming and installation (compared with generative CAPP systems) is required to implement a planning system.
3. The system is understandable and the planner has control of the final plan.
4. It is easy to learn and easy to use.

Disadvantages of Retrieval CAPP system

1. The components to be planned are limited to similar components previously planned.
2. Experienced process planners are still required to modify the standard plan for the specific component.

1.8.2.2. Generative CAPP systems

1. The computer is used to synthesize or generate each individual process plan automatically and without reference to any prior plan.
2. A generative CAPP system generates the process plan based on decision logics and pre-coded algorithms. The computer stores the rules of manufacturing and the equipment capabilities.
3. When using a system, a specific process plan for a specific part can be generated without any involvement of a process planner.

4. The human role in running the system includes:

   (i) Inputting the GT code of the given part design, and

   (ii) Monitoring the function

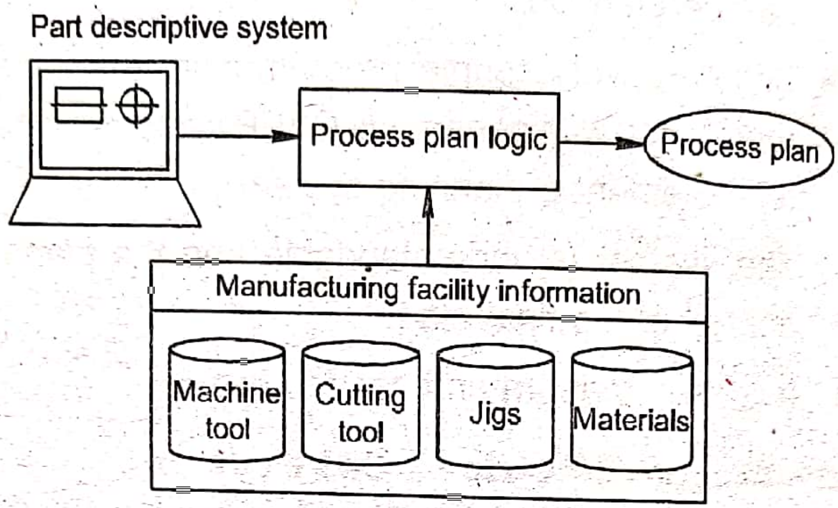


Fig.1.7 Block diagram for generative CAPP

Components of a Generative CAPP system

The various components of a generative systems are:

1. A part description, which identifies a series of component characteristics, including geometric features, dimensions, tolerances and surface condition.
2. A subsystem to define the machining parameters, for example using lookup tables and analytical results for cutting parameters.
3. A subsystem to select and sequence individual operations. Decision logic is used to associate appropriate operations with features of a component, and heuristic and algorithms are used to calculate operation steps, times and sequences.

4. A database of available machines and tolling.
5. A report generator which prepares the process plan report.

Advantages of Generative CAPP

1. It can generate consistent process plans rapidly.
2. New components can be planned as easily as existing components.
3. It has potential for integrative with an automated manufacturing facility to provide detailed control information.

Disadvantages of Generative CAPP

The generative approach is complicated and very difficult to develope.

1.9. Process planning Activities

The process planning activities are carried out as per the following steps.

a. Working drawing interpretation
b. Process and material selection
c. Selection of machines, Tools etc.
d. Determine process parameters
e. Selection of quality control methods
f. Calculation of manufacturing costs
g. Process planning Documentation
h. Communication

1.9.1. Working Drawing

A working drawing is a document complete in itself to manufacture a component or product. It shows component's geometrical shape, its dimensions with tolerances, if to be machined, surface finish required, and heat treatment, surface coating if required, bill of material and any other finish required, any heat treatment, surface coating if required, bill of material and any other information considered necessary so that the component can be manufactured and inspected without and difficulty.

From the interpretation of working drawing. The process planner should arrive the following informations.

i) Dimensions of product

ii) Material specification

iii) Tolerences, limit and fits

iv) Surface finish

v) Quantity

vi) Parts list

1.9.2. Process and material selction

The various process selection parameters like sequence of operations, dimensions, tolerencess production rate, Economic aspects. Size and weight, accuracy etc are to be selected.

Similarly the material selection parameter like mechanical properties, functions, cost etc are to be determined.

1.9.3. Selection of machines, tools etc

While selecting machineries, tool etc. The following points should be kept in mind.

i) Cost of machineries, tools etc
ii) Cost of production / unit
iii) Rate of production
iv) Life of machineries, tools etc
v) Shape and size to be produced
vi) Construction of machinery
vii) Tool material

1.9.4. Determine process parameters

This activity inclucles the determination of set up time and cycle time for each machine.

1.9.5. Selection of quality control methods

After determining the set up time and cycle time, the process planner have to finalise the inspection methods to find correct dimensions and required Tolerences.

1.9.6. Calculation of manufacturing costs

It is necessary to determine the cost of product planner should have thorough knowledge on Cost Estimation.

While calculating, the following points should be considered.

(i) What materials to use
(ii) The manufacturing process to use
(iii) Quantity to be produced and
(iv) Make or buy decision

1.9.7. Process planning documentation

From the above activities, the process planner should make documents like route sheet, operation planning / process sheet, bill of material etc. The documentation is done for future reference.

1.9.8. Communication

After documentations, the documents are communicated to shop floor for production. This documents hold good as basis for improved part consistence and quality in production.

1.10. Principle of line balancing

Line balancing is a manufacturing function in which whole collection of production line tasks are divided into equal portions. A production line is said to be in balance when every worker's task takes the same amount of time. Well balanced lines helps to increase productivity and decrease the labour idealness.

Line balancing is the process of assigning tasks to workstations. So that work stations have approximately equal time requirements.

1.11. Need for line balancing

The line balancing is needed for the following reasons.

a) Equalising the amount of work at each work station.

b) Improve productivity

c) Cost optimization

d) Reduce the ideal time for men and machine

e) Uniform distribution of labour work load

1.12. Value Engineering

It is defined as the process of reducing the cost of producing a product without reducing its quality. This is cancerned with new products.

Value engineering is a technique which is used to identify and eliminate unnecessary costs in product design, testing, manufacturing, construction, operation and maintenance.

1.13. Cost control

It is the process of monitoring and regulating the expenses. It involves a chain of functions like

(i) Preparation of budget

(ii) Evaluating the actual performance

(iii) Find out the reason for difference

(iv) Taking corrective actions for difference.

Cost control is defined as a practice of identifying and reducing expenses to increase profits.

1.14. Cost Reduction

It is a process of reducing the costs and increase the profits. It is a technique used to save the unit cost of the product without compromising its quality.

1.15. Cost control Vs Cost reduction

The following table gives the comparison between cost control and cost reduction.

S.No.	Cost Control	Cost Reduction
1.	Savings in total cost	Savings in unit cost
2.	Quality not ensured	No comprise with quality
3.	Past and present cost	Present & Future cost
4.	Focussing on decreasing the total cost.	Focussing on decreasing per unit cost
5.	Temporary in nature	Permanent in nature
6.	Process may be competed when the target is achieved	Process is continuous one
7.	Preventive function	Corrective function

1.16. Value analysis

It is the process of analysis and evaluation of existing products to reduce costs. It is a systematic application of established techniques to identify the functions of a product and to provide the desired function at the lowest total lost. It is a creative approach to eliminate unnecessary costs.

It is a really a very valuable technique of cost reduction and quality improvement. The advantages of value analysis are

i) Improvement in product design
ii) High quality is maintained
iii) Elimination of waste
iv) Generation of new ideas and products
v) Savings in costs.

1.17. When to apply value analysis

During the following occasions, we have to apply value analysis technique.

i) Development of new product

ii) Sales of product is going down

iii) Rise in the cost of production

iv) Not to meet delivery promises.

v) Poor performance of products.

REVIEW QUESTIONS

PART - A

1. Define process planning.
2. What is process planning?
3. What is the concept of process planning?
4. List any two factors affecting process planning.
5. What are the methods of process planning?
6. What is make or buy decision?
7. List any two process planning activites.
8. What are the documents used in process planning?
9. List the advantages of computer aided process planning.
10. What is line balancing?
11. What is the need for line balancing?
12. What is value analysis?
14. What is cost control?
15. What is cost reduction?

PART - B

1. What are factors affecting the process planning.
2. What is manual process planning.
3. What are the advantages of manual process planning?
4. List the disadvantages of process planning.
5. Write short notes on computer aided process planning.
6. What are the advantages of CAPP.
7. Mention the components of CAPP.
8. List the information required to do process planning.
9. What is the principle of line balancing..
10. Compare value engineering and value analysis.

PART - C

1. What is process planning? Explain the concept of proces planning?
2. Discuss the various factors that affect process planning.
3. What are the approaches of process planning? Explain briefly the manual process planning.
4. Write in detail the computer aided process planning.
5. Write briefly the variant CAAP.
6. Explain briefly the components of CAAP.
7. Write about the process planning procedure.
8. What are factors that affect make or buy decision?
9. With a neat sketch the break even analysis for on make or buy decision.
10. Discuss the process planning activities.
11. Write briefly the principle and need of line balancing.
12. Write briefly when we do value analysis.

UNIT - II

PROCESS SELECTION

2.1. Introduction

Manufacturing involves turning raw material to finished products, to be used for various purposes. There are a large number of processes available. Therefore the process selection is important.

Process selection refers to the way a company choses to produce its products. It takes into account selection of technology, capacity planning, layout of facilities and design of work systems.

Process selection determines how the product will be produced. It involves

a. Technological choice

   1. Major technological choice

   2. Minor technological choice

b. Specific component choice

Ans 2 c. Process flow choice

2.2. Technological choice

1. Major technological choice

1. Does technology exist to make the product?

2. Are there competing technologies among which we should choose?

3. Should the technology be developed in the country itself?

4. Should innovations be lincensed from foreign countries?

2. Minor technological choice

There may be a number of minor technological process alternatives available. The operation manager should be involved in evaluating alternatives for costs and for consistency with the desired product and capacity plans.

An assembly line process on the other hand, follows the same series steps as mass production but need not run for 24 hours a day. e.g., automobile and ready-made garment industries.

Job shop process produces items in small lots, perhaps cutom-made for a given customer/market.

Suppose, we make a job shop choice. The alternatives do not end here. For example, in a factory, the fabrication, joining together and finishing of two pieces of metal may represent only a minuscule part of creating a finished product. There may be numerous ways of casting and moulding, several ways of cutting, forming, assembly and finishing.

2.3. Specific component choice

In this case, the following questions should be asked.

(i) What type of equipment (and degree of automation) should be used?

(ii) Should the equipment be specific purpose or general purpose?

(iii) To what degree should machines be used to replace human labour in performing and automatically controlling the work.

2.4. Process flow choice

(i) How should the product flow through the operations systems?

(ii) The final process-selection step determines how materials and products will move through the system.

(iii) Assembly drawing, assembly charts, route sheets and flow process charts are used to analyse process flow.

(iv) Analysis may lead to resequencing, combining, or eliminating operations in order to reduce materials handling and storage costs.

These phases of process selection are closely interrelated. In each phase, choices should be made to minimize the process operations costs.

2

2.5. Factors affecting process selection

While selecting the process. The following factors should be considered.

(i) Current product commitments

If enough work has already been allocated to more efficient equipments, the current work may have to be passed on to less efficient machines to complete the same in time.

(ii) Delivery date

The delivery date may:

(a) Force the use of less efficient machines

(b) Rule out the use of special tools and jigs as they will take time for design and fabrication.

(iii) Quantity to be produced

Small quantity will not probably justify the high cost of preparation and efficient setups. Thus, quite possible they may have to be made on less efficient machines and vice-versa.

(iv) Quality standards

Quality standards may limit the choice of making the product on a particular machine.

(v) Component size and weight

(vi) Surface finish specification

(vii) Economic considerations

(viii) Material form

(ix) Dimensional accuracy

2.6. Machine capacity

Capacity is a rate of output, in a given time. Machine capacity is defined as the calculation of number of pieces that can be produced through one machine for a given period of time.

2.7. Analysis of Machine Capacity

- The process of obtaining accurate information regarding the capacity of the available machines to produce the desired output is known as machine analysis.
- An objective of machine analysis is to obtain the answers to certain definite questions in regard to the use of manufacturing machines.
  1. How long will a certain machine take to perform its operation on a unit quantity of material?
  2. How many units of material can be processed on this machine per day, week or month?
  3. What is the maximum plant capacity per day for each process on each material?
- The first question can be answered either.
  - (a) From standard data
  - (b) By actual experiment and trial or
  - (c) By reference to records of past performance
- The second question can be answered when the machining time and set up time are known and when an adequate allowance has been made for the inevitable idle time.
- The third question is answered by aggregating the number of units which can be processed by similar machine to give the total plant capacity in units of product.

The various information available from the above are.

(a) Machine availability $= \frac{\text{Machine available time}}{\text{Total machine time}} \times 100$

(b) Machine utilisation $= \frac{\text{Actual running time}}{\text{Machine available time}} \times 100$

(c) Machine efficiency $= \frac{\text{Standard running time}}{\text{Actual running time}} \times 100$

(d) Machine effective utilisation

$$= \frac{\text{Standard running time}}{\text{Machine available time}} \times 100$$

3

2.8. Process and Equipment selection procedure

The process and equipment selection procedure are:

(a) Manufacturing operations

(b) Provisional process

(c) Develop a list of process alternatives

(d) Production process

(e) Completion of process selection

(f) Performing detailed processing

a. Developing a general statement of the manufacturing operations to be performed.

b. Establish a provisional process to provide each individual feature. Several additional inputs are necessary before beginning the selection of the provisional process. They are

(i) Establish targets for facility and piece costs

(ii) Raw material

(iii) Estimate hourly production volume to machine capacity.

(iv) Estimate timing

(v) Select the provisional process

(vi) Develop judgemental costs of facilities and materials.

(vii) Develop the preliminary piece cost of the components for the final assemblies.

c. After completing the provisional processing steps, develop a list of process alternatives.

d. A careful step-by-step comparison between each phase of the provisional process with each phase of the alternative process will allow to select the compromised position, which optimizes all the elements of cost, quality, flexibility and inherent risk.

e. After completion of process selection, it is communicated to the product engineering, industrial engineering, plant and maintenance engineering, industrial relations and finance departments. This will provide coordination and communication among all concerned which is essential for the successful adaptation of new technology to existing plant and staff.

f. Perform detailed processing. When the process has been selected and communicated to all affected departments, the final detailed processing is initiated.

2.9. Determination of man, machine and material requirements

During the process selection. We should consider the following for effective selection.

(a) Determination man power requirement

(b) Determination machine requirement

(c) Determination material requirement

4

2.9.1. Determination of man power requirement

In general one day means eight hour. If worker works for one hour, it is called as one man hour. In the process selection, man hour plays an important role. Therefore, it is necessary to calculate the man power as follows.

(i) Number of man hours required for load on hand - H_1 hrs.

(ii) Number of man hour required due to new load - H_2 hrs

(iii) Allowances for leave, absents etc - H_3 hrs.

(iv) Total man hour required - $H_1 + H_2 + H_3$ hrs

(v) Available man hours - H_4 hrs

(vi) Additional man hours required - $(H_1 + H_2 + H_3) - H_4$ hrs.

Assume 8 hrs x 5 Days x 50 weeks = 2000 man hours/ year

(vii) No of additional man hour required = $\dfrac{(H_1 + H_2 + H_3) - H_4}{2000}$

2.9.2. Determination of machine required

While determining the machine requirement, we have to consider the following.

(i) Accuracy

(ii) Rate of output

(iii) Cost

The requirement of machinery is calculated as follows.

Load on machines due to work on hand = H_1 hrs

New load on mahcines based on process sheet = H_2 hrs.

Total load on machines = $H_1 + H_2$ hrs

Time required for maintenance = H_3 hrs.

Number of machine hours/year/machine = h hrs

Number of machines required = $\frac{H_1 + H_2 + H_3}{h} = N_1$

Available machine = N_2

additional machine required = $N_1 - N_2$

2.9.3. Determination of material requirement

See Article 2.10

2.10. Selection of material, Jigs, fixture etc

The selection of material depends upon the types of material, shape and size. Material should be of right quality and chemical composition as per the product specifications. Shape and size of material should reduce the scrap

While calculating the material requirement, we have to consider the following

(a) Material required for work already on hand - Q1

(b) Material required for new work - Q2

(c) Total material requirement - Q + Q2

(d) Material available in stores - Q3

(e) Additional material to be purchased (Q1 + Q2) – Q3

The selection of jig, fixtures etc will give

(i) Higher production rate

(ii) Reduce the cost of production/pieces

(iii) Reduce production time.

2.11. Factors influencing choice of machinery

The following factors are having influence in the choice of machinery.

(a) Accuracy

(b) Rate of output

(c) Cost

(d) Technical factors

- (i) Physical size
- (ii) Surface finish
- (iii) Cutting forces
- (iv) Power rating

(e) Operational factors

- (i) Batch size
- (ii) Capacity
- (iii) Availability

(a) Accuracy

High accuracy machines produces high quality products. Therefore, the machine should be capable of giving the required accuracy.

(b) Rate of output

If the output required is more, we have to select the machines which gives move output like CNC machines.

If the output required is less. We have to select the conventional machines like lathe, drilling machine etc. Therefore, the machine should be capable of giving the required rate of output.

(c) Cost

The machine with required accuracy and rate of output producing the required quantity of product at the less cost should be selected.

(d) Technical factors

(i) Physical size

The machine selected should be of accepting the physical size of work piece.

(ii) Surface finish

The surface finish of the products comes out of machines should be our required surface.

(iii) Cutting forces

The machining parameters like feed speed and depth of cut influence the magnitude of cutting forces of the selected machines. Hence the machine should be capable of giving the required cutting forces.

(iv) Power rating

The power rating should be sufficient enough to provide the required power to machines.

(e) Operational factors

(i) Batch size

The economic batch quantity or economic lot size is calculated for each process.

(ii) Capacity

It is the production rate of the machine. The machines should be able to do the required production rate.

(iii) Availability

It is the time, a machine is actually available to perform the required work.

2.12. Selection of machinery

While doing the selection of machinery, the following methods are used.

(a) Break even point analysis

(b) Process-cost comparison

(c) Production cost comparison

(d) Selection among the two suitable machines

(a) Break even point analysis

It is one of the method used to make a choice between two machines.

To find the most economical machine from two machines, the total cost of the two machines is plotted against the number of units. The point at which the two lines representing the total costs of the two machines meet each other is called as break even point.

Let, F_A - Fixed cost of machine A

F_B - Fixed cost of machine B

V_A - Variable cost of machine A

V_B - Variable cost of machine B

Q - Required quantity

Then,

$$(F_A + Q)\,V_A = (F_B + Q) + V_B$$

$$\therefore Q = \frac{F_B - F_A}{V_A - V_B}$$

(b) Process cost comparison

There are more manufacturing processes are available for manufacturing a product. The most economical process is one which is producting the product with least total cost.

Let, N_t - Total no of parts produced

Q - Quantity at Break even point

T_a - Total Tool cost for 'A' method

T_b - Total Tool cost for 'B' method

P_a - Units tool process cost for 'A' method

P_b - Units tool process cost for 'B' method

C_a - Total unit cost for 'A' method

C_b - Total unit cost for 'B' method

Then,

$$\text{Total cost for A} = \text{Total cost for B}$$

$$T_a + Q \cdot P_a = T_b + Q \cdot P_b$$

$$Q = \frac{T_a - T_b}{P_a - P_a}$$

$$\text{Total unit cost for A} = \text{Fixed cost A} + \text{variable cost B}$$

$$C_a + N_t = T_a + (P_a \times N_t)$$

$$\therefore \; C_a = \frac{T_a + (P_a \times N_t)}{N_t}$$

Similarly,

$$C_b \times N_t = T_b + (P_b \times N_t)$$

$$C_b = \frac{T_b + (P_b \times N_t)}{N_t}$$

(c) Production cost comparison

This method is also uses break even analysis. In this method, the following items are to be considered.

1. Time to produce a product
2. Setup time
3. Direct labour cost
4. Overheads

Let,

For Ist machine	For IInd machine
t - Time/piece in min	T - Time/piece in min
o - Overhead cost/hr	O - Overhead cost/hr

s	-	set up time in hr	S	-	Set up time in hr
sr	-	set up vate/hr	Sr	-	Setup rate/hr
l	-	labour cost	L	-	Labour cost

By calculation,

Fixed cost = setup cost

Variable cost = Direct labour cost + overhead cost

$$Q = \frac{60\,(SS_r - ss_r)}{t\,(l + 0) - T\,(L + 0)}$$

(d) Selection among suitable machine

If for a product, the choice lies between two machines, Then the machine with least cost per unit of production will be selected.

2.13. Preparation of operation planning sheet

While preparing the operation planning sheet. The below mentioned datas are required.

(a) Quantity of work with specifications.

(b) Quality to be required.

(c) Availability of men, machines and materials.

(d) Sequence of operations

(e) Name of equipments.

(f) Standard time for each operation.

(g) Delivery time.

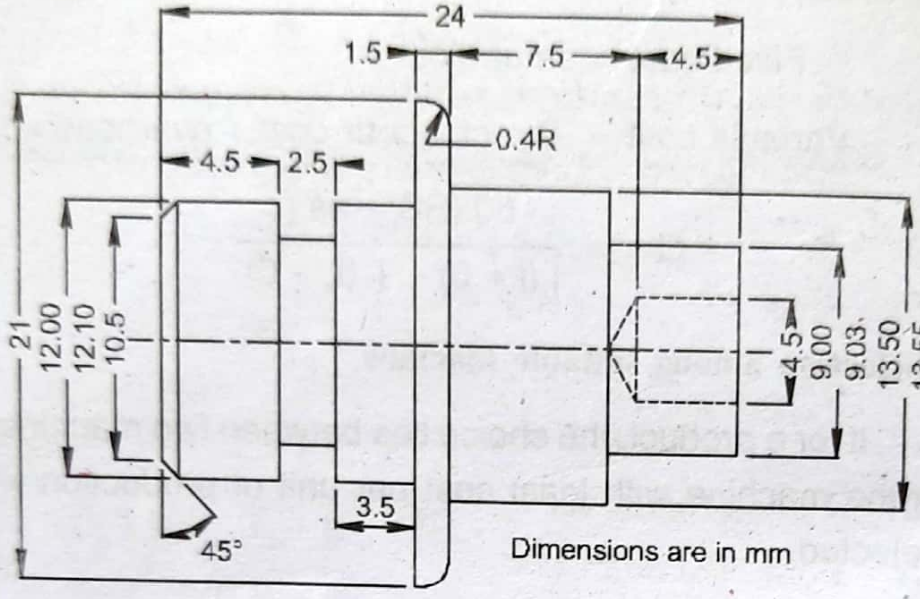
(h) Cutting speed, feed and depth of cut.

(i) Material with specifications.

(j) Job Rating of labours.

Problem

1. The hub shown in made of carbon steel. Discuss the steps of planning the process to manufacture this part. Draw the operation sheet also.



Solution

The problem can be solved by following the steps given below.

1. Study and analyze the part pring

From the study of the part print, the first factors to consider are: shape and size of the bar stock. From the part print, it is clear that some dimensions are given in fractions. It is important to clarify with the product engineer about the tolerances from fractional dimensions. The largest diameter given fractionally is 21mm. Assuming a tolerance of 0.250 mm, it would be possible to finish this outside diameter to +20.75 mm. For this, the part can be produced from 21mm bar stock. However, if the final diameter had been specified as 21mm, a larger diameter bar stock has to be used.

2. *Consult with product designer*

Under this step, the process planner will discuss with the product designer regarding the dimensions and tolerances. After getting everything clarified, he will proceed further.

3. *List the basic operations required to produce the part*

The following operations are required to produce the part

(i) Stop drill

(ii) Drill 4.5mm-diameter hole.

(iii) Turn 13.525 mm dia.

(iv) Turn 9.15mm dia

(v) Form 12.00mm dia

(vi) Face outer end of part

(vii) Generation 0.4mm radius next to shoulder

(viii) Cut off

4. *Select the machine tool*

From the shape of the part, it is clear that a machine tool of lathe family will be suitable to produce this part. Depending upon the quantity to be produced, the machine tool can be: Engine lathe, Turret lathe or Automatic lathe. Assuming that the quantity to be produced is not large, turret lathe can be selected for the part.

5. *Combine the operations and put them in sequence*

In this step, the workpiece is distributed as evenly as possible among the tooling stations. After combining the operations, the operation sequence can be as follows.

(i) Feed out bar, position for length and close collect.

(ii) Spot drill end of bar and knee turn the 13.525mm dia. Slightly larger than the finish size using turret slide.

(iii) Drill 4.5mm dia. hole and knee turn 9.15mm dia. Oversize using the turret slide. Rough form the area behind the shoulder with the cross slide.

(iv) Face the outer end using the end slide. Rough form the area behind the shoulder with the cross slide.

(v) Finish for all areas back of shoulder.

(vi) Rollers shave the area in front of the shoulder using the cross slide.

(vii) Cut off the part using the end slide.

6. Specify the gauging

The gauging requirements for this sproblem are quite simple. The following gauges are needed:

(i) Micrometers for checking the various diameters.

(ii) A depth plug gauge for the 4.5mm dia, hole.

(iii) A template gauge to check the overall shoulder lengths and the width and position of grooves.

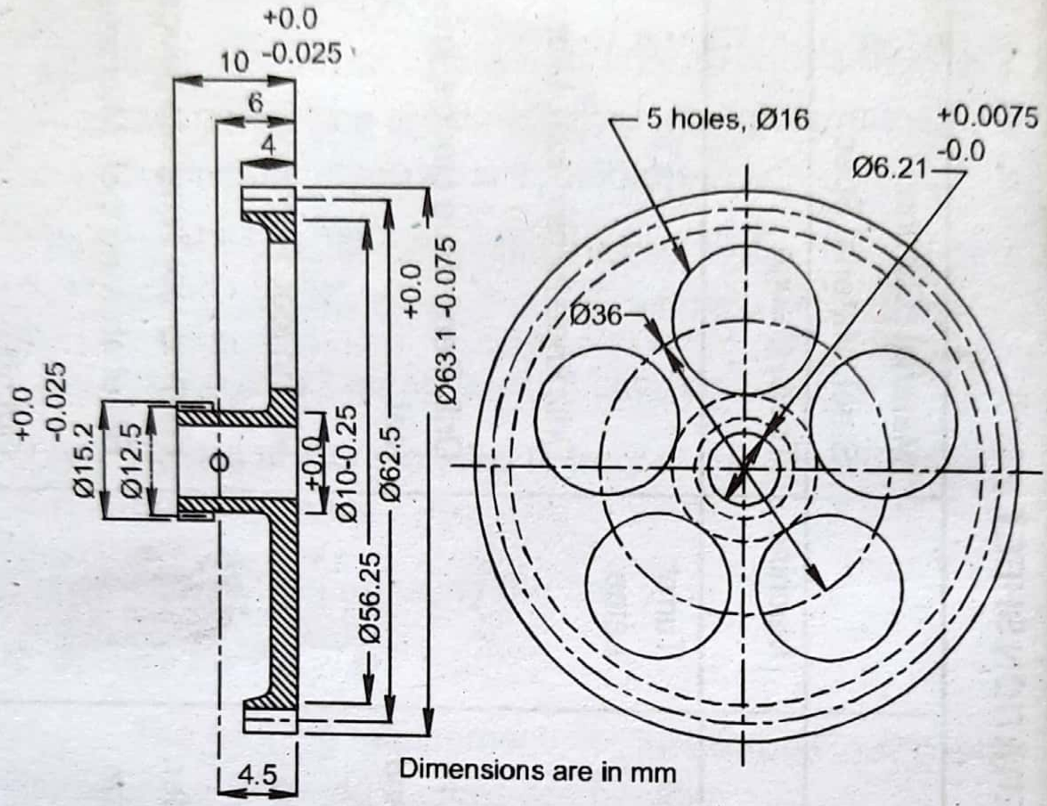
7. Operation sheet

A simplified operation sheet for the problem is given below:

OPERATION SHEET

	PART NAME : Hub Part No.		Material : Carbon Steel, Material Spec.
Oper. No.	Description of operation	Machine	Tools, Gauge
1.	Feed out bar, position for length and close collect	Turret Lathe	- - -
2.	Spot drill end of bar, knee turn the 13.525 mm dia.	,,	Drill, knee turning tool, Micrometer
3.	Drill 4.5mm dia. hole, knee turn 9.15 mm dia. Rough form the area behind the shoulder.	,,	Drill, Depth Plug Gauge, knee turning tool
4.	Face the outer end, Rough form the area behind the shoulder.	,,	Facing tool, Form tool
5.	Finish form all area back of shoulder.	,,	Forming tool Template gauge
6.	Roller shave the areas in front of the shoulder.	,,	Roller shaving tool. Micrometer
7.	Cut off.	,,	Cut off

2. The gear shown in is to be made for a total quantity of 50,000 pieces. Prepare an operation sheet for this. The material of the gear is medium C-steel.



Solution

After the process engineer has satisfied himself with the part print, dimensions specifications and tolerances, in consultation with the product engineer, the next step is to select the initial form of the material and the machine tools to manufacture the gear. The two convenient material sources from which the gear blanks can be made are: Bar stock and forging.

The major drawback of starting with bar stock is that lot of stock will have to be removed which will go as waste. With forging, there is lot of material saving and we can start directly with the machining operations. So, we will start with blanks made from forging. It clear, then, that the principle process operation for manufacturing the gear will be : Machining.

Selection of Machine tool

Considering the quantity to be made, the use of engine lathe for the urning and boring operations, is ruled out. Next, we have the choice from three machines: Turret lathe, automatic chucking machine and multiple-spindle automatic. The multiple-spindle automatic is ideal for rapid stock removal, but cannot be relied upon for holding the tolerances required. So, we have a choice between a turret lathe and an automatic chucking machine. The other machine tools needed are: Gear shaper for cutting the teeth, drilling machine for drilling the holes and machines for finishing the gear (say buffing machine)

Operation sequence

The sequnce of operations can be as follows:

1. Rough turning all over
2. Drilling of 5 holes
3. Heat treating
4. Flattening
5. finish turning all over, drilling and rough-boring centre hole
6. Precision-boring hole in hub.
7. Cutting teeth
8. Shaving teeth
9. Drilling holes in neck of the part

10. Finishing
11. Stamping part number

The reasons for the above sequence of operations may be explained as follows:

Rough-turning

The purpose of rough turning the forged blank is to: remove surface scale and hardness and also to remove as much material as possible to enable finish-machining operations more precise. This will also provide reasonably accurate location points for drilling the five holes.

Drilling

Drilling of five holes is done before heat treatment so as to increase the tool life of drill.

Heat Treating

This operation has to be done before final finishing operations to ensure accuracy of the finished component.

Flattening

This operation may be necessary as the part may get warped after heat treatment.

Finish turning

Finish turning of external surfaces will provide accurate location points of precision boring and cutting teeth.

Finish boring

Finish boring should be done before cutting of teeth as this will provide best location for cutting teeth.

Cutting teeth

This is one of the major operations and should be done after all final finishing of external surfaces and precision boring has been done.

Shaving teeth

This operation is done to produce surface finish requirements of teeth.

Drilling holes in neck

This operation could have been done before teeth cutting but after precision boring.

Finishing

After the part is completely machined, its all surfaces must be convered as per plating specification.

Finally, the part number should be stamped on the finished part. Now, we are ready to write the operation sheet.

OPERATION SHEET

Part Name: gear — Material : Medium C-steel

Part No.

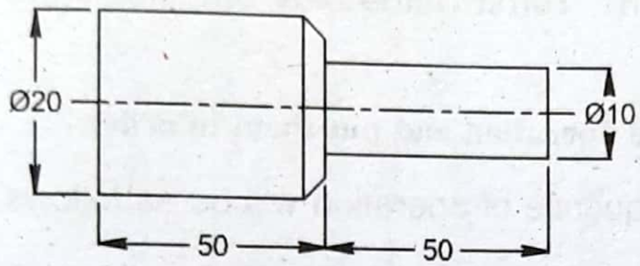
Oper.	Description of operation	Machine	Tools, Gauge
10	Forge blanks and trim flash	Drop hammer, puch press	Forging die, a trimming die
20	Stress-anneal	Electric furnace	Snap gauge
30	Inspect		3 Jaw chuck
40	Rough turn hub; rough-face hub; Rough-recess hub and face; Rough face large diameter.	Turret lathe	
50	Inspect		Snap gauges, depth pin gauges, profile gauges 3-Jaw chuck
60	Rough-turn outside diameter, Rough large face	Turret lathe	Snap gauges
70	Inspect		Drilling jig, 16mm diameter drill
80	Drill 5, 15 mm diameter holes	Drill press	
90	Heat-treat for hardness	Electric oven	Rockwell tester
100	Inspection		Flattening die

Part Name: gear		Material : Medium C-steel	
Part No.			
Oper.	**Description of operation**	**Machine**	**Tools, Gauge**
110	Flatten, if necessaryqPunch press	Straight edge	
120	Inspection		3-Jaw chuck, centre drill, drill, boring tool, mill file
130	Centre drill; drill; rough bore; finish large face; finish-turn outside diameter burr sharp corner	Turret lathe	
140	Inspection		Plug gauge, snap gauges 3-Jaw chuck, 3 tool bits, form tool, mill file
150	Finish turn small diameter; finish face small diameter finish face relief 'finish groove' finishface large diameter; burr sharp corners.	Turret lathe	
160	Inspection		Snape gauges, depth pin gauges, profile gauge
170	Precision boring	Precision boring machine	Boring fixture, Boring bar and bit

Part Name: gear Material : Medium C-steel
Part No.

Oper.	Description of operation	Machine	Tools, Gauge
180	Inspection		Plug gague
190	Cut teeth-small gear	Gear shaper	Fixture, gear cutter
200	Cut teeth-large gear	Gear shaper	Fixture, gear cutter, shaving cutter
201	Shave teeth-small gear	Gear shaving machine	Master gear, adapter,pitch diameter gear gauge
230	Shave teeth-large gear	Gear shaving machine	Shaving cutter
240	Inspection		Master gear, adapter, pitch diameter gear gauge
250	Drill holes in the nec of gear	Multispindle drill press	Drilling Jig, drills
260	Remove all burs	Hand operation	File, scraper, emery cloth
270	Buff edges of gear teeth	Buffing machine	Buffing wheel
280	Finish (black oxide)		
290	Stamp		Hand stamp
300	Final inspection		Various gauges already mentioned

5 3. **Prepare an operation planning sheet for the component given below.**



Solution

1. Study and analysis of the part drawing

Read the shape and size of the bar stock required from the part drawing. The maximum diameter is 20 mm. Considering 0.50 as tolerance, we can take 21 mm diameter bar stock.

2. Consultation with product designer

The process planner will discuss with product designer about dimensions and tolerances. Only after this discussion, we will proceed further.

3. List of the basic operations

a. Bar stock stop

b. Turn to 20 mm diameter

c. Turning operation is done for the diameter of 10 mm from right end.

d. Chamfering is next operation at shoulder.

e. Cutting off the part.

4. Selection of Machine Tool

From the drawing, it is advisable to select lathe for making the part. Turret lathe may be selected to do this part.

5. Combine the operation and put them in order

The sequence of operation will be as follows.

a. Feed the bar and close the collet.

b. Face the end of the part.

c. Turn 20 mm diameter for the length of 100 mm from the right end.

d. Turn 10 mm diameter for the length of 48 mm from the right end.

e. Chamfering operation is done at shoulder.

f. Cutting off the part.

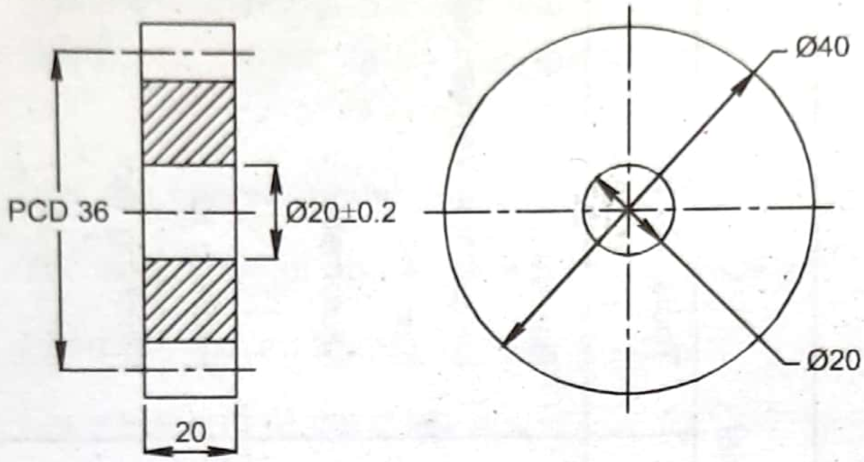
6. Specification of gauging

Vernier Caliper/Micrometer is used to check the diameter.

7. Operation planning sheet

Part Name: Part No.		Material : Specification of material :	
Operation Number	Description of operation	Machine	Tools, Gauge
1.	Feed the bar and close the collet.	Turret lathe	Bar stop
2.	Turn 20mm diameter for the length of 100mm from right end.	Turret lathe	Micrometer, Vernier caliper & knee turn.
3.	Turn 10 mm diameter for the length of 48mm from the right end.	Turret lather	Micrometer
4.	Chamfering	Turret lathe	Forming tool
5.	Final finishing / Touching	Turret lathe	Finishing tool
6	Cutting off	Turret lathe	Parting tool

4. Prepare on operation planning sheet for the given component



1. Study and analysis of part drawing

The given component drawing is studied and the following particulars are observed.

- No.of teeth is 18 and module is 2 mm.
- The pressure angle is 20°.
- Tooth depth is 4.5 mm.
- Outer diameter-40 mm;
- Pitch circle dia-36 mm;
- Simple indexing method.
- Drill size ϕ20 mm.

2. Consult with product Designer

The process planner will discuss with product designer about dimensions and tolerances. Only after this discussion, we will proceed further. From the above particular, we can take ϕ45 mm and 25 mm thick cast iron blank.

3. List of basic operations

a. Facing the width of the job to 20 mm

b. OD Turning to 40 mm

c. Drilling and Boring to ϕ20 mm
d. Holding the job in the mandrel
e. Indexing
f. Gear finishing operations.
g. Inspection.

4. Selection of Machine Tools

From the drawing, it is advisable to select centre lathe and universal milling machine with universal dividing head.

5. Combine the operations and put them in order

The sequence of operation will be as follows

a. Boring operation-ϕ15 mm drilling is carried out before boring operation.
b. Facing operation-both sides for 20 mm width.
c. Turning operation-To obtain the OD 40 mm.
d. Inspecton-Vernier caliper & Inside micrometer.
e. Setting the job in the Milling machine by the use of mandrel.
f. Indexing-Universal dividing head-simple indexing method.
g. Gear Tooth groove forming-Form cutter with 2 mm module.
h. Finishing operation-Gear lapping.
i. Inspection-Gear Tooth Vernier.
j. Metal coating & inspection.

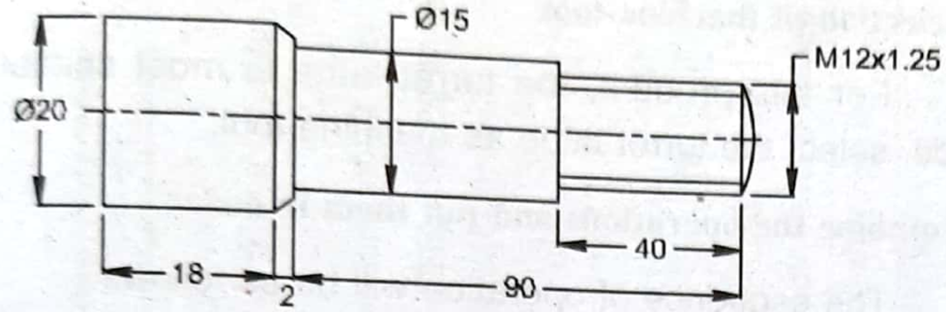
6. Specification of Gauging

Vernier Caliper, Inside micrometer and gear tooth vernier are used to check the dimensions.

7. Operation planning sheet

Part Name: Spur Gear Part No. S5		Material : Cast iton Material specification: Blank type (ϕ 45 x 25)	
Oper.	Description of operation	Machine tool	Tools and Gauge
01	Drilling ϕ 15mm and Boring for ϕ 20 mm	Centre lathe Tailstock, Tool post	Drill bit size 15 mm (H.S.S) Boring bar - Boring Tool. - Inside micrometer
02	Facing operation - at both ends to reduce the width from 25 mm to 20mm	Centre lathe - – Front tool post	Facing tool (H.S.S) – Vernier Caliper.
03	Turning operation - To reduce the dia from 45mm to 40 mm	Centre lathe	Turning Tool – Vernier Caliper
04	Setting the job for milling operation	–	Mandrel - Try Square – Spanner
05	Indexing - simple indexing method	Universal milling m/c Universal Dividing head	–
06	Gear Tooth groove forming	Universal milling m/c	Disc type form cutter with 2mm module
07	Gear burnishing	Gear burnishing gears	Coolant is applied
08	Inspection	–	Gear Tooth Caliper
09	Metal coating	Spray gun	–

5. Prepare an operation planning sheet for the component given below



Solution

1. Study and analysis of part drawing

Find the shape and size of the bar stock required from the drawing given. The maximum diameter is 20 mm. Considering 0.50 mm as tolerance, we can take 21 mm diameter bar stock.

2. Consult with product designer

The process planner will discuss with product designer about dimensions and tolerances. Only after this discussion, we will continue to start the machine operation.

3. List of the basic operations

The following operations are listed to make the component.

a. Bar stock stop
b. Turn 20 mm diameter
c. Turn 15 mm diameter
d. Turn 12 mm diameter
e. Forming on the end of part
f. Thread cutting

g. Chamfering

h. Cutting off.

4. Selection of machine tool

For this product, the turret lathe is most suitable. Hence, select the turret lathe as machine tool.

5. Combine the operations and put them in order

The sequence of operation will be as follows

a. Feed the bar in position for required length and close the collet. Face the end of part.

b. Turn 20 mm diameter for a length of 110 mm from right end of the bar stock.

c. Turn 15 mm diameter for a length of 90 mm from right end.

d. Turn 12 mm diameter for a length of 40 mm from the right end.

e. Using end forming tool, perform end forming.

f. By changing the gear train, do the threading for a pitch of 1.25 mm.

g. Next, chamfering is to be done.

h. Cut off the part by using end slide.

6. Specification of gauging

Micrometer and Thread Micrometer(or) pitch gauge are used for the gauging.

7. Operation planning sheet

This is given below

Part Name:		Material : Medium C-steel	
Part No.		Material Specification:	
Oper.	Description of operation	Machine	Tools, Gauge
1	Feed the bar in position for a given length and close the collet.	Turret lathe	Bar stop
2	Turn 20mm diameter for a length of 110 mm from right end	Turret lathe	Knee turn tool & Micrometer
3	Turn 15 mm diameter for a length of 90mm from right end.	Turret lathe	Knee Turn Tool & Micrometer
4	Turn 12mm diameter for a length of 40mm from right end.	Turret lathe	Knee turn tool & Micrometer
5	Threading on 12mm diameter for a pitch of 1.25mm	Turret lathe	Threading Tool & Thread micrometer
6	Chamfering at right end	Turret lathe	Threading tool & thread micrometer
7	Final Finishing	Turret lathe	Finishing tool
8	Cut off the part	Turret lathe	Parting tool.

REVIEW QUESTIONS

PART - A (2 Mark Questions)

1. What is process selection?
2. What are steps involved in process selection?
3. List some factors affecting the process selection.
4. What is machine capacity?
5. What is machine availability?
6. What is machine utilisation?
7. What is machine efficiency?
8. List any two steps in the process and equipment selection.
9. What is the determination man requirement?
10. What is the determination machine requirement?
11. What is the determination material requirement?
12. List any two factors which influence the choice of machinery.
13. Mention the methods of selection of machinery.

PART - B (3 Mark Questions)

1. How the process selection determine the product manufacture?
2. What is technological choice?
3. What is specific component choice?
4. What is the process flow choice?

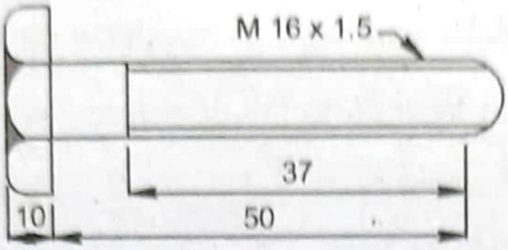
5. Explain briefly the factors affecting the process selection.
6. Write briefly the analysis of machine capacity.
7. What are the factors to be cosidered while calculating the material requirement?
8. How the material selection made?
9. Write the formulas to determine the man, machine and material requirement.
10. How the selection of machinery made by Break even analysis.

PART - C (5 or 10 Mark Questions)

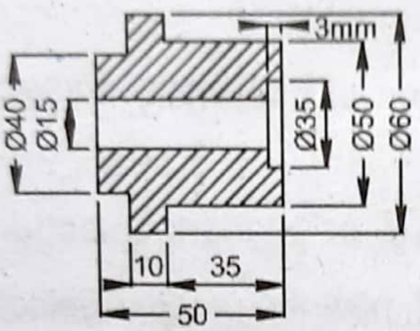
1. Explain in detail, how the process selection is made?
2. Explain in detail, the various factors affecting the process selection.
3. What is machine capacity? Explain its analysis.
4. Write briefly the process and equipment selection procedure.
5. How to determine the man, machine and material requirement?
6. How the selection of material, jigs and fixtures made?
7. What are the factors influences the choice of machinery?
8. What are the methods of selecting a machinery? Explain any one in detail.
9. Explain the preparation of operation planning sheet.

10. Prepare an operation planning sheet for the components given below.

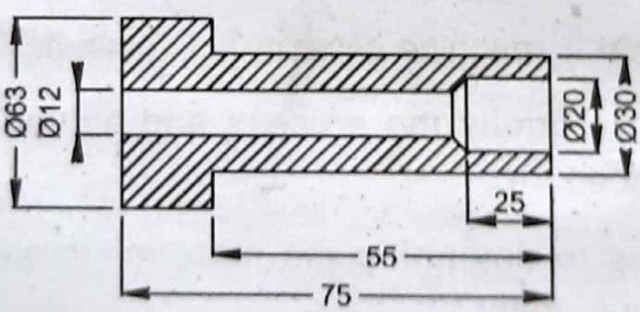
(a)



(b)



(c)



(d)