ME 16006

Process Planning and Cost Estimation

ME 16006 PP and CE

UNIT I	INTRODUCTION TO PROCESS PLANNING
UNIT II	PROCESS PLANNING ACTIVITIES
UNIT III	COSTING AND ESTIMATION
UNIT IV	PRODUCTION COST ESTIMATION
UNIT V	MACHINING COST ESTIMATION

UNIT 1 INTRODUCTION TO PROCESS PLANNING

Introduction – process planning activities – Drawing interpretation – Material evaluation and process selection – Production equipment and tooling selection.

UNIT 1 INTRODUCTION TO PROCESS PLANNING

Drawing Interpretation

1. Aims and objectives
2. Engineering communication
    1. Communication in design
    2. Engineering drawing - *Detail drawings, Assembly drawings, Combined drawings*
    3. Orthographic projection
    4. Sectioning
    5. Dimensions

3. Identifying useful Supplementary information

4. Material and specification

5. Special material treatments

6. Equivalent parts (interchangeability and standardization)

7. Screw thread forms

8. Dimensional tolerances

9. Limits and fits - *Hole basis, shaft basis, clearance fit, interference fit, transition fit*

10. Gauge references

11. Geometrical tolerances

12. Surface finish

Identifying critical processing factors

there are three distinct analysis and outputs from drawing interpretation. These are:

geometry analysis,

manufacturing information analysis and

material evaluation

These analyses will include

geometric shape,

dimensions and associated tolerances,

geometric tolerances,

surface finish specifications,

Raw material size and the number of parts required.

Identifying critical processing factors

- Particular attention should be paid to instances where there are combinations of

  dimensional tolerances and geometrical tolerances and/or surface finish specifications.

Material evaluation and process selection

Objective

Classification of materials - Metals (ferrous, non-ferrous), Ceramics, Polymers, Composites and semi-conducter

Basic material properties – mechanical, physical, etc.

Material selection process and methods

material selection process,

material selection method

Material evaluation method – shape/ geometry, property required, manufacturing consideration,

Manufacturing Processes – casting, forming and shaping, machining, joining, etc.

Process selection – Factors, guidelines

Material evaluation and process selection

material selection process:

- design and development of a new product
- modification of an existing product.

design and development of a new product

1. Specify the performance parameters of the design and translate these into the required material properties, for example, strength, hardness, etc. taking into account the cost and availability of materials.
2. Specify the manufacturing considerations such as the quantity/ batch size; size, weight and complexity of the part; dimensional and geometrical accuracy required, the surface finish required, any quality requirements and the overall manufacturability of the material.
3. Draw up a shortlist of candidate materials from the largest possible database of materials deemed suitable for the application.
4. Evaluate the candidate materials in more detail. Compare each, based on product performance, cost, availability and manufacturability. The result of this evaluation should be the selection of a single material

Material evaluation method

prime consideration is the shapes / features required:

- Flat surface
- Parts with cavity
- Parts with sharp corner
- Thin hollow shape
- Tubular shape
- Surface texture

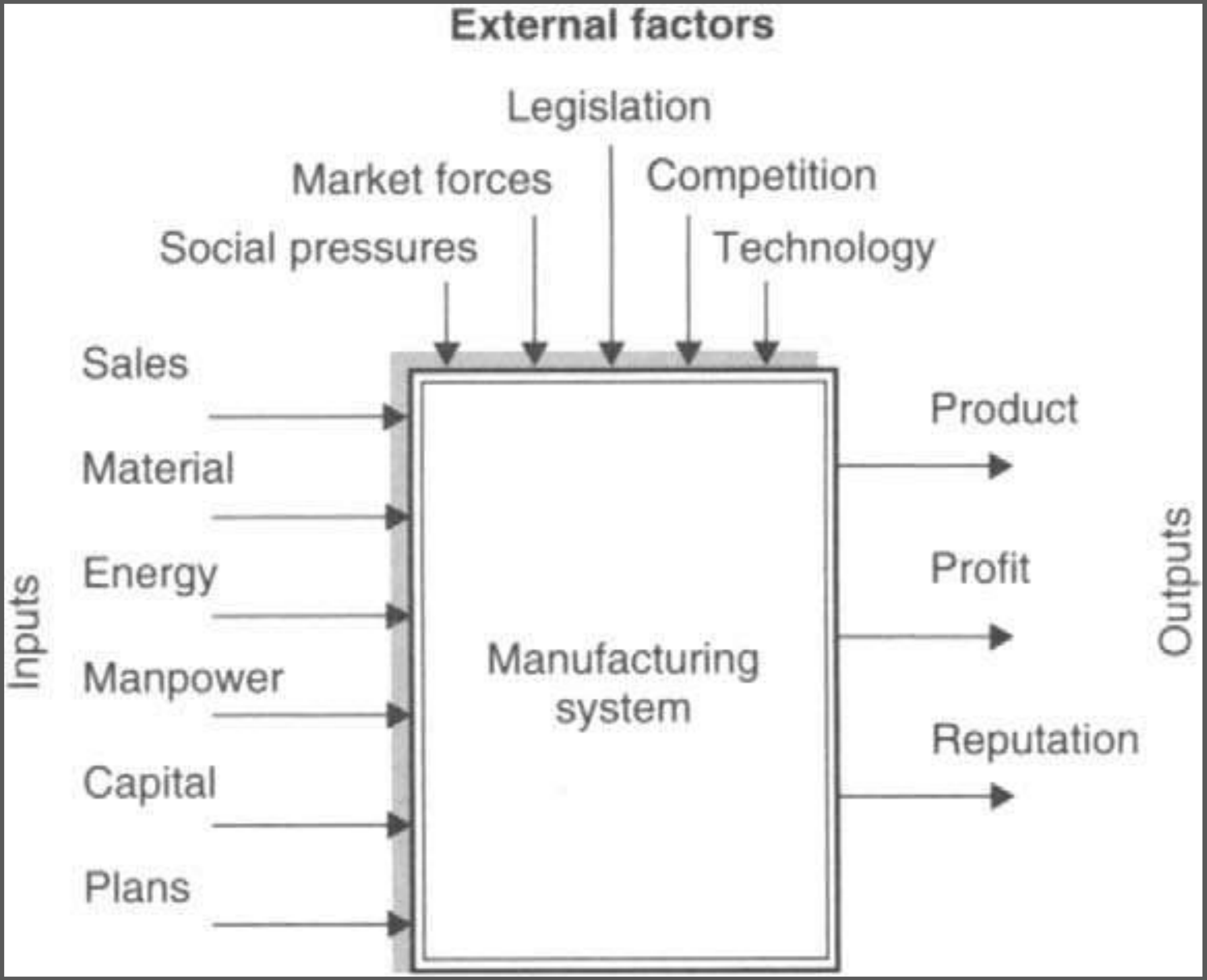
three-stages are in evaluation procedure:

- shape or geometry considerations
- material property requirements;
- manufacturing considerations

Factors in Tooling Selection

- most important is the manufacturing process, the work piece material, processing time and the use of cutting fluids.
- **Constraints on tool selection**
  - *Manufacturing practice*
  - *Manufacturing process*
  - ***Machine tool characteristics***
  - *Capability*
  - ***Processing time***
  - ***Cutting tool availability***
- **Operating requirements for tool selection**
  - *Workpiece material*
  - ***Operation***
  - ***Part geometry***
  - ***Tooling data***

3. Inputs and outputs of a MS



4. Common characteristics of a MS

1. All systems will have specific business objectives to meet in the most **cost-effective** manner.

2. All systems consist of an integrated set of sub-systems, usually based on functions, which have to be linked according to the material processing.

3. All systems must have some means of controlling the sub-systems and the overall system.

4. To operate properly, all systems need a flow of information and a decision-making process.

5. Developing a manufacturing strategy

Manufacturing strategy can be defined as a long range plan to use the resources of the manufacturing system to support the business strategy and in turn meet the business objectives.

Capacity decision

Process decision

Facility decision

Make or buy decision

Infrastructure decision

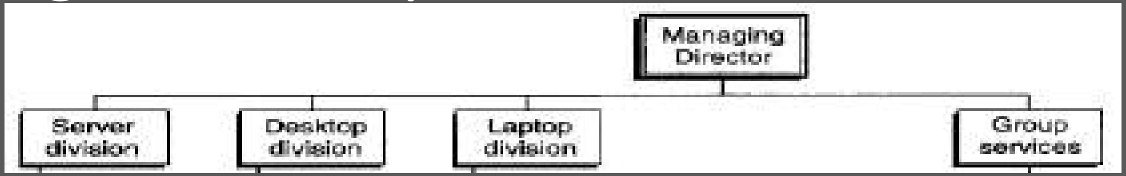
HR decision

Figure 1.4 *Developing a manufacturing strategy*

6. Manufacturing organizational structures

functional structure: departments around the functions within the organization.

product structure: organizations produce a diverse range of products.



matrix structure: an attempt to obtain the benefits of both functional and product structures.

7. Categories of MS

There are two basic categories of manufacturing system:

– discrete parts manufacturing;

project manufacture;

batch manufacture;

mass/flow manufacture

jobbing shop manufacture

– continuous process manufacturing;

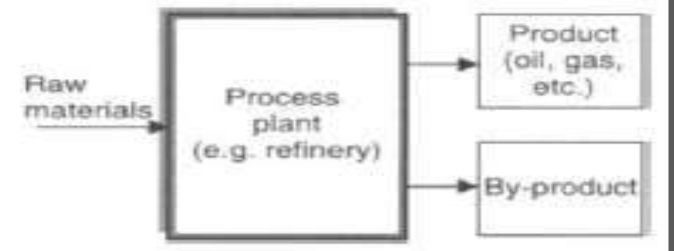


Figure 1.8 *Continuous manufacture*

8. Processing strategies

The process decision is further linked to four distinct strategies within manufacturing,

– make to stock (MTS);

– assemble to order (ATO);

– make to order (MTO);

– engineer to order (ETO).

9. Plant Layout

What is plant layout?

physical arrangements of departments, workgroups within departments, workstations, machines and stock-holding points within a manufacturing facility.

Plant facility systems design:

structural systems, heating, ventilation and air conditioning (HVAC) and general services, that is, water, electrics, lighting, etc.

Plant layout design:

equipment and machinery within the production area, all production related areas and often personnel areas within the facility.

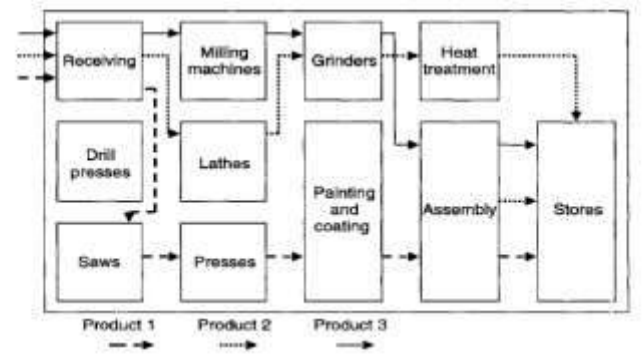
Material handling systems design:

materials, personnel and equipment handling systems required to support production.

9. Plant Layout

Four types of plant layout:

- fixed position layout
- process layout
- product layouts
- cellular layout (or) hybrid layout



igure 1.12 *Process-focused layout*

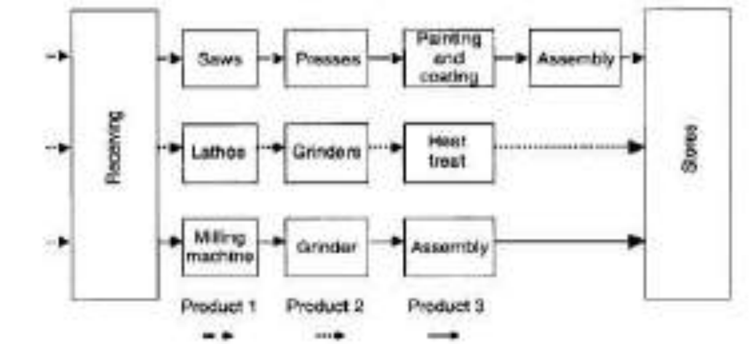


Figure 1.13 *Product-focused layout*

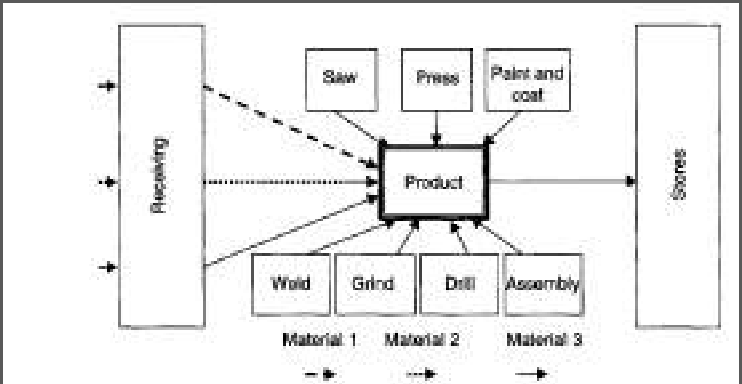


Figure 1.14 *Fixed position layout*

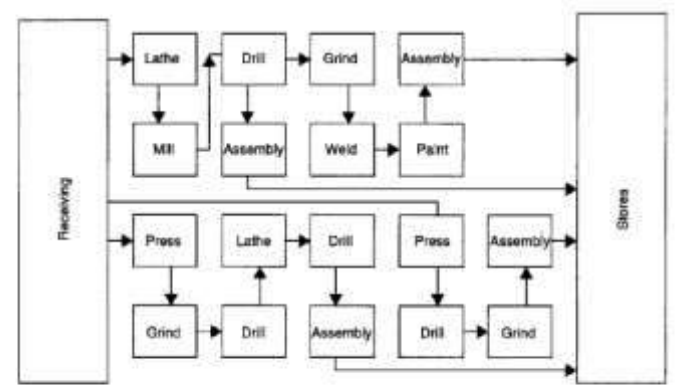


Figure 1.15 *Hybrid layout*

9. Plant Layout

The major influence in determining / selecting the most suitable Plant layout:

volume and variety of product to be manufactured.

Other criteria include

cost of the layout,

materials handling requirements,

flexibility of the layout,

stock requirements and

ease of maintenance.

10. Manufacturing Engineering

two distinct engineering functions with direct responsibility for the manufacture of a product:

- industrial engineering
- manufacturing engineering

Industrial engineering, whose main responsibility is usually to support manufacturing engineering.

Therefore, industrial engineering is involved in:

Methods analysis

Work measurement

Plant layout

Material handling

Plant maintenance

Manufacturing engineering, responsible for all phases of product manufacture, with the exception of product design. There are four specific areas:

Manufacturing systems development

Process development

Process evaluation

Process planning

PROCESS

What do you mean by PROCESS?

- Conversion of a work-piece from its initial form to a final form predetermined (usually by a design engineer)
- Group of action to achieve the output in accordance with a specified measure of effectiveness.

Various manufacturing processes:

Casting :	Establishing
Forming:	Moving of material
Machining:	Subtractive / Removing Technique
Fabrication / Welding:	Additive / Joining Technique
Finishing Process:	Final / aesthetic aspects

PROCESS PLANNING

What do you mean by PROCESS PLANNING?

- Systematic determination of the processes and its sequence by which the product is to be manufactured economically and competitively within the limits of design specifications.

- It consists of devising, selecting and specifying
  - processes,
  - machineries and equipment,
  - tools

  to transform the raw material into finished product as per the specifications.

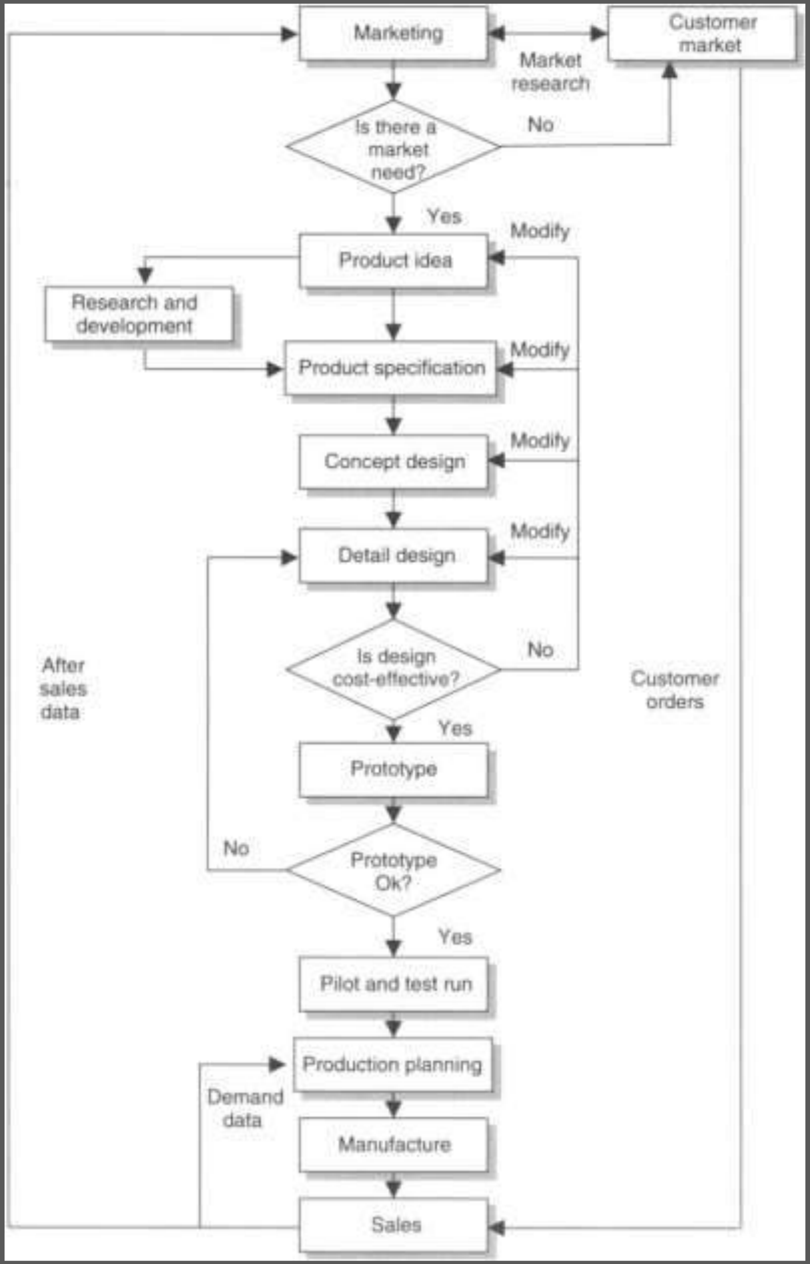
- Intermediate stage between design & manufacturing

Designing → **PROCESS PLANNING** → Manufacturing

PROCESS PLANNING: Aims & Objectives

- To identify functions involved in design and manufacture;
- To define the process planning activity;
- To identify and describe the main tasks undertaken during process planning;
- To identify and describe the various data used in process planning;
- To identify and describe the main process planning documentation;
- To identify and describe the relationship between process planning and other manufacturing functions.

Process Planning: Design & Manufacture Cycle



Marketing:

- Promotion - exist
- Market research - new

R & D:

- Concept design
- Detail design

Prototype

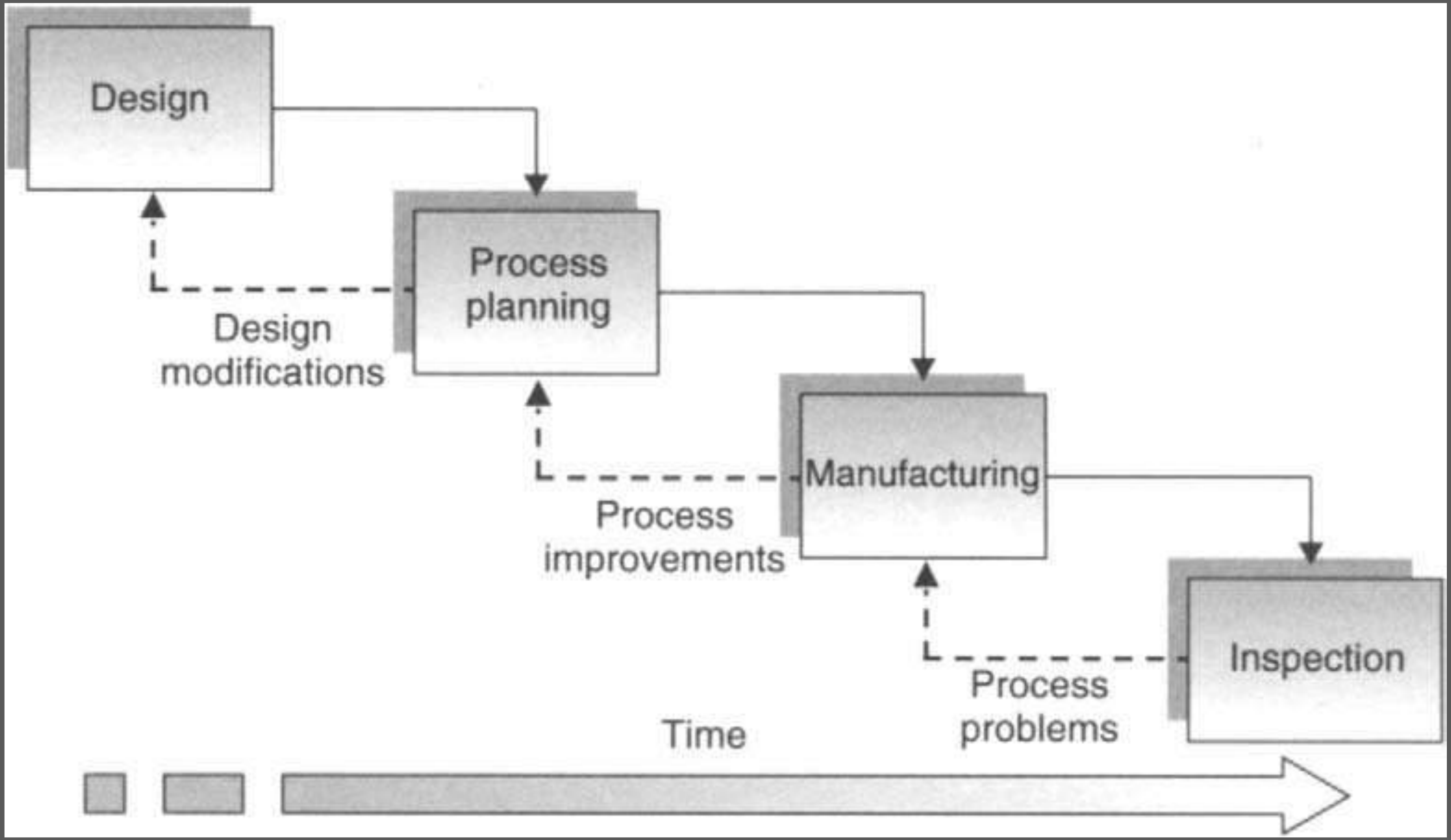
Trial

Pilot batch

Manufacture

Sales

Process Planning: Design & Manufacture interface



Process Planning Activities

Preparing the process plan includes

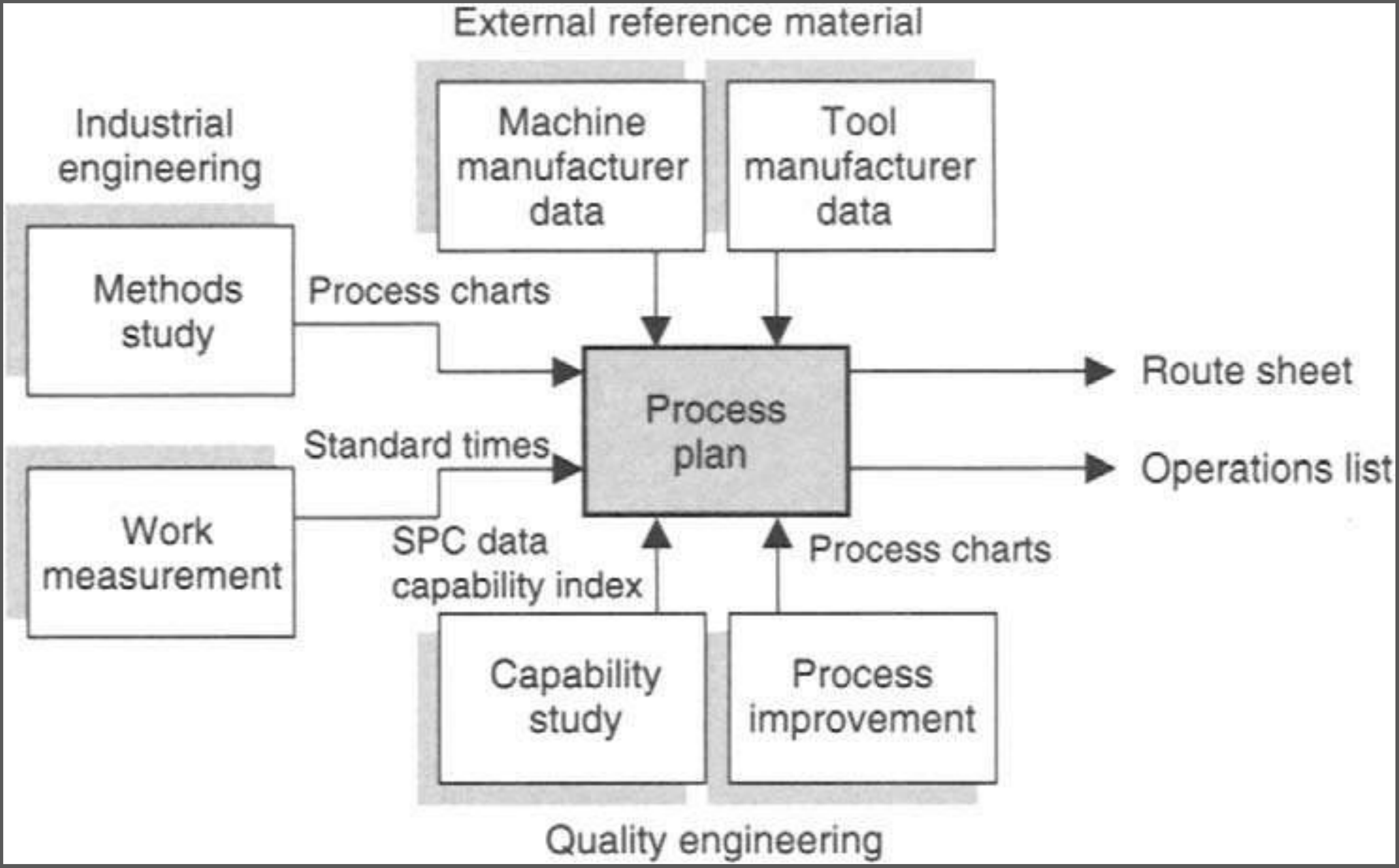
- Drawing Interpretation
- Material evaluation and process selection
- Machines and tool selection
- Setting process parameters
- Workholding devices
- Selecting quality assurance methods
- Costing
- Documentation: Routing sheet, Operations List, etc.

An engineer should have

- knowledge of materials for manufacture;
- knowledge of manufacturing processes;
- knowledge of jigs and fixtures;
- an ability to use reference material, Ex: m/c data
- knowledge of the relative costs of materials, tooling;
- an ability to calculate manufacturing parameters and costs;
- knowledge of inspection/QA procedures and specifications.

Process Planning and Industrial Engineering

main o/p of process planning: Routing sheet and Operations sheet.



Process Planning and Quality Assurance

seven wastes in production:

overproduction,

waiting,

transporting,

inappropriate processing,

unnecessary inventory,

unnecessary motion and

defects.

Process Planner & Quality Inspector:

Process Planning and Production Planning

process planning & production planning are separate functions.

process planner is to determine how a job is to be done and how long it will take. Therefore, the process planner is not concerned with resources of the shopfloor.

outputs of the process planning are the main inputs to the production planning.

Process Planning Methods

two basic methods employed in process planning:

manual process planning and

computer-aided process planning (CAPP)

Manual process planning can be broken down further into two distinct approaches:

traditional approach

workbook approach

CAPP methods can be categorized further as

variant CAPP

generative CAPP

Process Planning Methods: Traditional

Process Planner's activities are outlined in three stages:

1. He looks drawing and uses his experience of manufacturing methods, combined with knowledge of the types of resource available, to decide how the component or assembly should be made.

2. He refers manuals to ascertain the company's recommended tools, feeds and speeds for the particular material on the selected machine.
3. Documents in routing sheet, which lists all the operations.

Process Planning Methods: Workbook

1. It is a derivative of the traditional approach.

2. This is considered a more efficient approach.

3. It involves developing workbooks of pre-determined sequences of operations for given types of workpieces.

4. The pre-determined sequence of operations are selected from the workbook and incorporated into the process plan.

General guidelines for manual process planning

1. establishing one datum and using this as a reference for all subsequent operations;

2. creating as many surfaces as possible at the same setting (i.e. without clamping and unclamping) to maximize dimensional accuracy;

3. avoid the use of secondary surface data as much as possible;

4. precision operations (ex: producing high-quality surface finishes) should be carried out last to reduce the possibility of damage;

5. inspection operations should be included at appropriate intervals to minimize scrap and rework.

Advantages & disadvantages of manual process planning

Advantage of manual process planning:

it is a low-cost task and is flexible, i.e. system can be changed easily.

Disadvantages of manual process planning:

1. Excessive clerical content: more paperwork, labour intensive
2. Lack of consistency in planning: due to different planners,
3. Late design modifications: design changes,required at later stage,
4. Changing technology: rapid change in manufacturing environment, new processes, tooling and materials, etc.

Computer aided process planning

Advantage of CAPP:

- less time spent on process planning;
- less reliance on the knowledge and experience of the process planner;
- more efficient use of manufacturing resources leading to improvements in costs;
- improved productivity;
- improved accuracy and consistency of process plans.

Computer aided process planning

Computer Aided Process Planning (CAPP) can be categorized in two major areas:

(1) Variant or Retrieval method of process planning.
(2) Generative method of process planning.

Variant process planning, where library retrieval procedures are applied to find standard plans for similar components.

Generative process planning, where plans are generated automatically for new components without reference to existing plans.

The latter system is most desirable but also the most difficult way of performing CAPP.

Variant Method of Process Planning (Retrieval CAPP System)

computer makes a search of its storage or a data base or a no. of standard or completed process plans that have been previously developed by the company's process planners.

The development of the data base of these process plans requires substantial knowledge of machining, time and efforts.

Using the current design data supplied by the CAD system, (after a component has been designed and dimensioned), it searches for a process plan that was based on a part of similar design. (This search can make effective use of GT, Group Technology, design coding to simplify the search for similar part design).

The process plan retrieved is then modified or suitably varied (i.e., altered) by the process planner, to suit the exact requirements of the current part design.

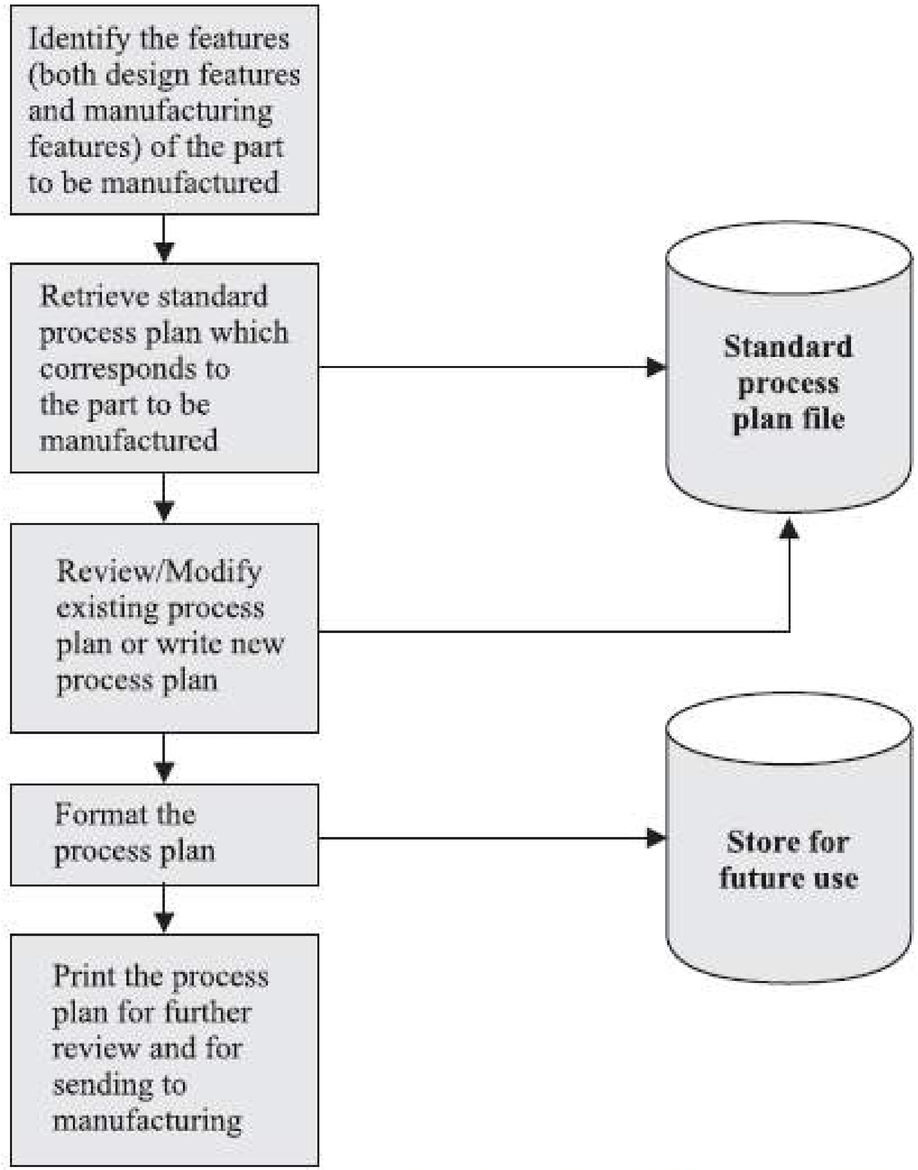
Variant Method of Process Planning
(Retrieval CAPP System)

The use of Computer and Group Procedure for developing the Retrieval type Technology (GT) to search for the most appropriate or similar part design, and to retrieve the process plan for that design, significantly reduces the work required of the process planners.

This approach of process planning is also known as Retrieval CAPP system. This is based on the principles of Group Technology and parts classification and coding.

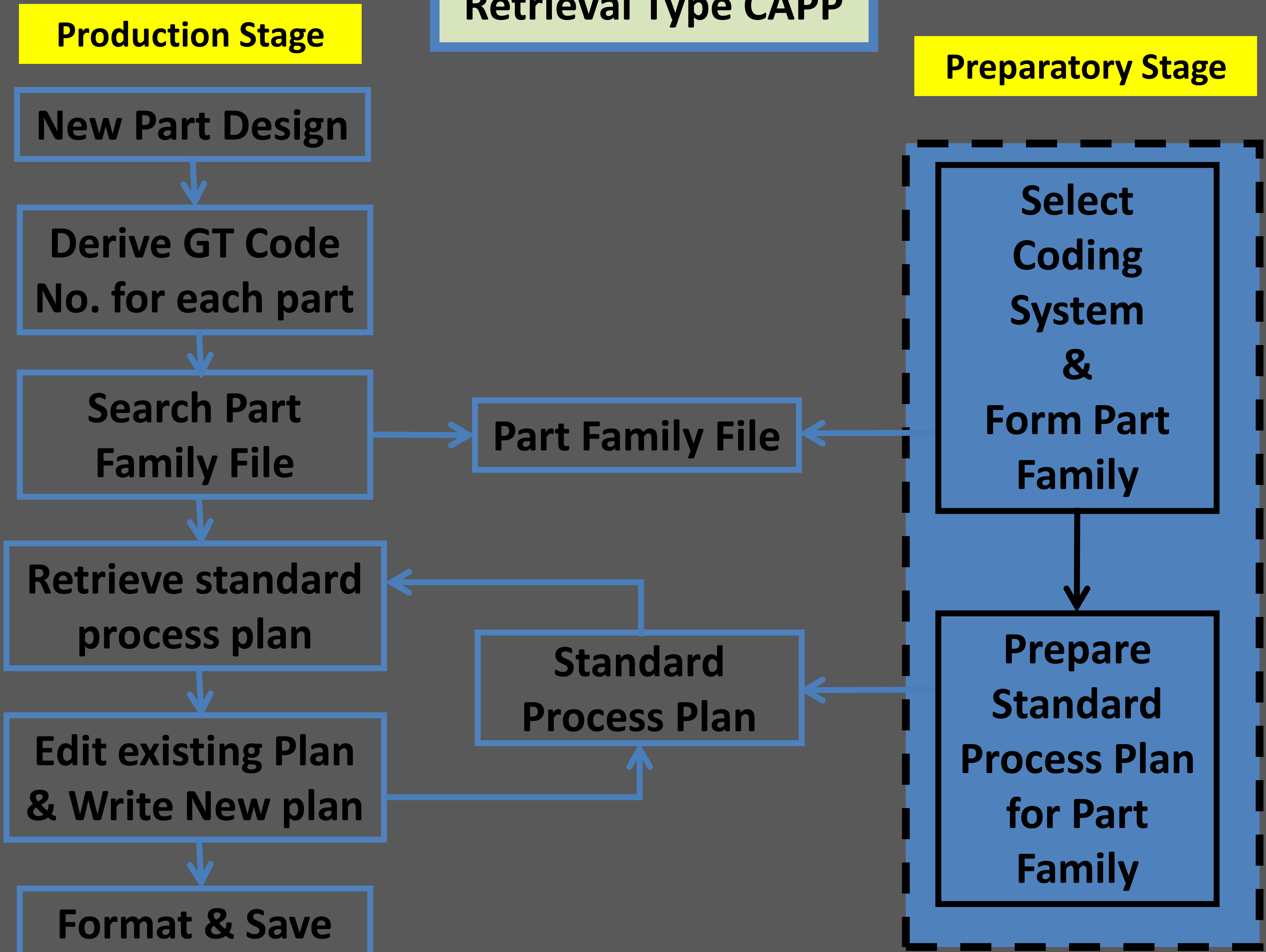
One of the pre-requisites for implementation of this method is that the industries must develop and maintain a large computer data base of standard completed process plans. In addition, the part designs are to be developed using CAD systems.

Variant Method of Process Planning (Retrieval CAPP System)



Procedure for developing the Retrieval type Computer—Aided Process Planning (CAPP) system

Retrieval Type CAPP



Advantages of Retrieval CAPP System

1. Once a standard plan has been written, a variety of components can be planned.
2. Programming is simple.
3. The system is understandable, and the planner has control of the final plan.
4. It is easy to use by small & medium scale companies, where product variety is not so high.

Disadvantages of Retrieval CAPP System

1. The components are limited to previously planned similar components.
2. Experienced process planners are still required to modify the standard plan for the specific component.
3. Details of the plan cannot be generated.
4. Variant planning cannot be used in an entirely automated manufacturing system, without additional process planning.

Generative Method of Process Planning
(Generative CAPP System)

A process plan is created from scratch without human intervention.

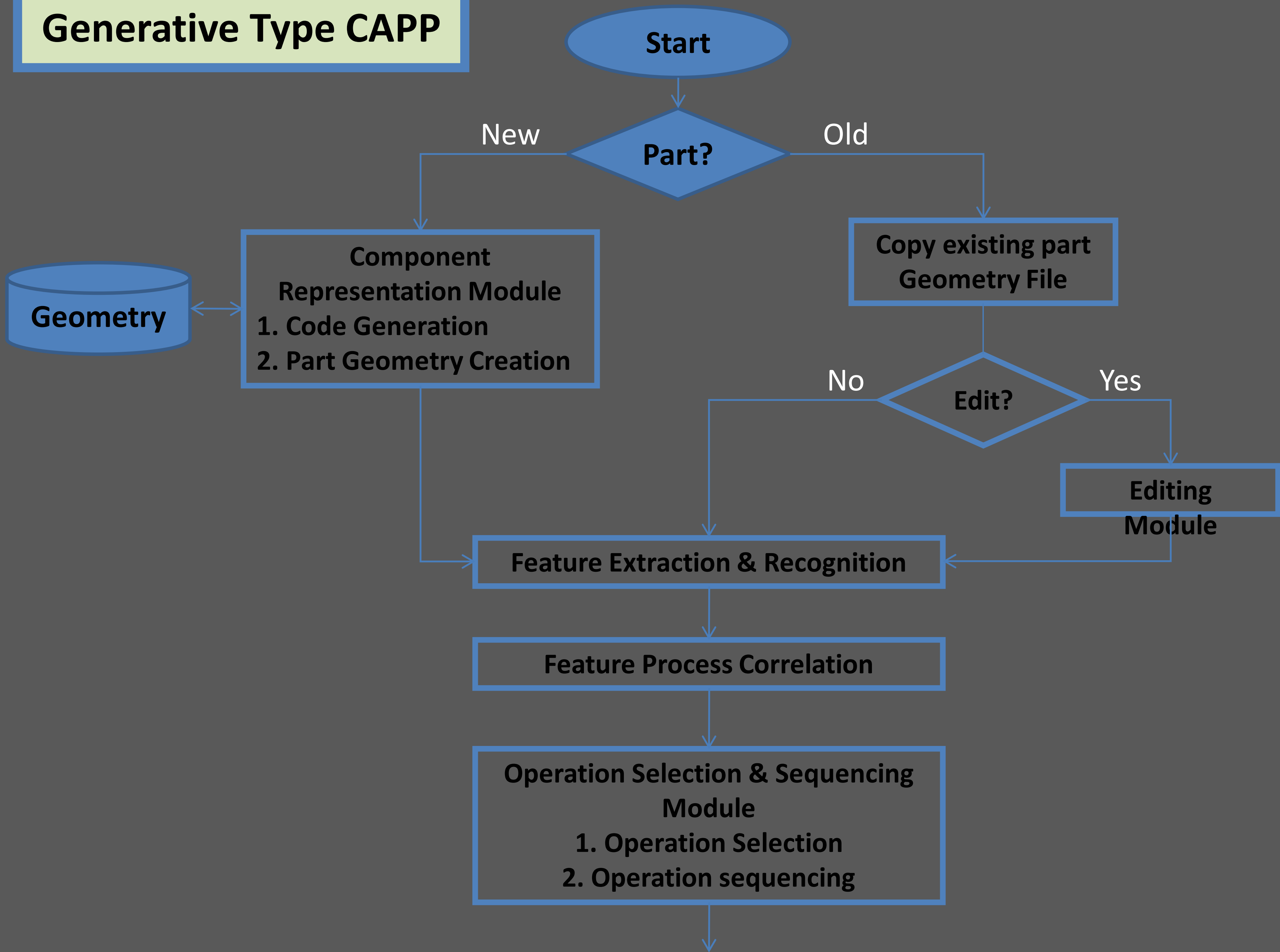
computer uses the stored data (manufacturing and design) to generate process plan that could be used to manufacture the current part.

It searches this list for the one which optimizes the cost function. This method always yields the optimum process plan for manufacturing a particular part.

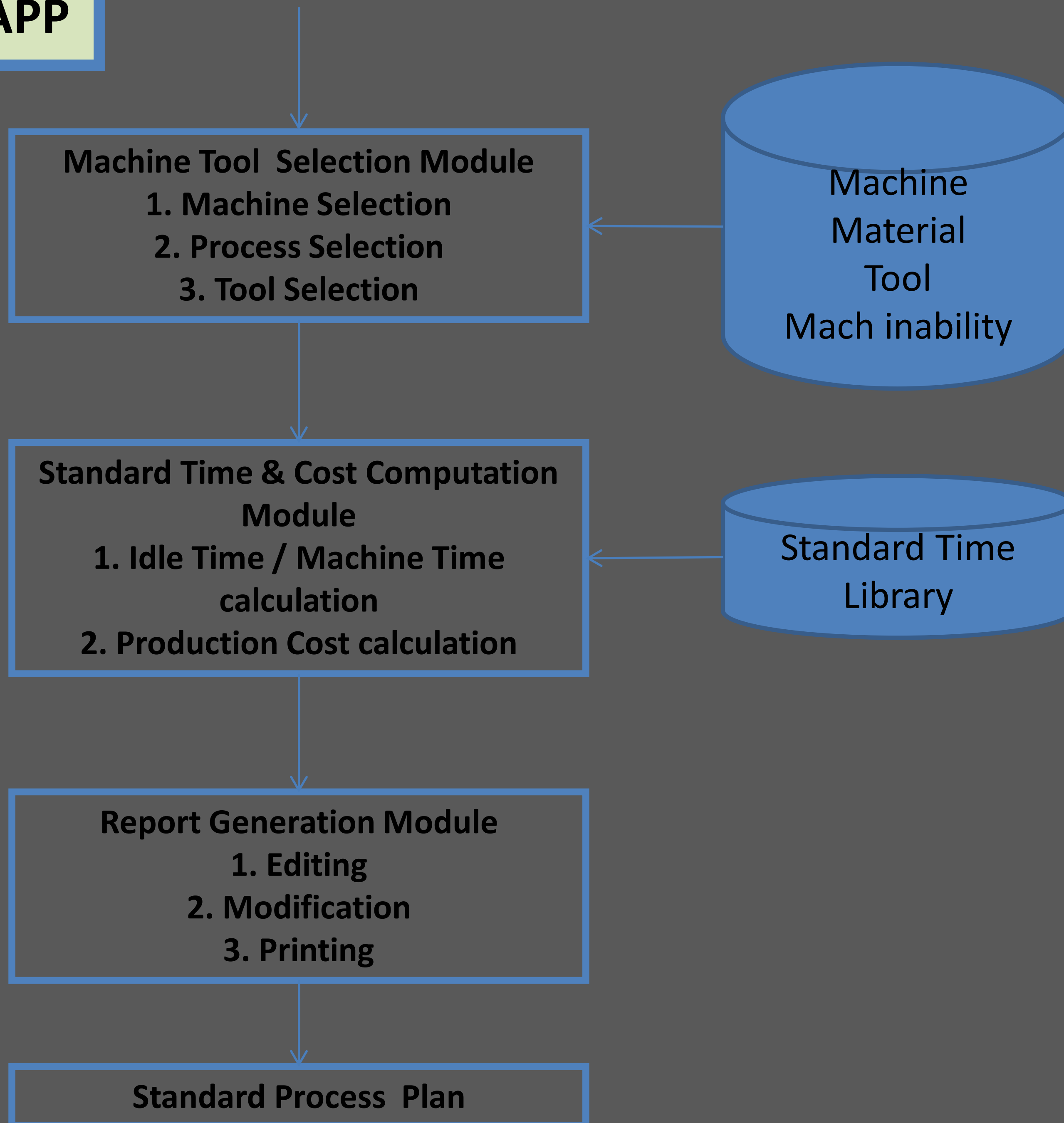
However, it has a very high cost in terms of time and computer processing expenses.

To repeat this for every feasible process plan or a part can become very costly.

Generative Type CAPP



Generative Type CAPP



Advantages of Generative CAPP System

1. Consistent process plans can be generated rapidly.

2. New components can be planned as easily as existing components.

3. It has potential for integrating with an automated manufacturing facility to provide detailed control information.

Process Planning: Basic terminology

The three basic terms employed in process planning:

1. Process: It is the basic unit for compiling a process plan. An operator machines a workpiece on a machine. Ex: rough turning on a lathe, drilling a hole on a drilling machine

2. Operation: It is the sub-unit of a process. A process will consist of a number of operations. The operations are carded out in a desired order known as operations sequencing.

3. Cut: It is the sub-unit of an operation. Cutting tool passes-over the workpiece surface. Some operations may require several cuts, or only one cut.

CHAPTER 3: DRAWING INTERPRETATION

1. Introduction
2. Aims and objectives
3. Engineering communication
4. Identifying useful supplementary information
5. Equivalent parts (interchangeability and standardization)
6. Screw thread forms
7. Dimensional tolerances
8. Limits and fits
9. Gauge references
10. Geometrical tolerances
11. Surface finish
12. Identifying the critical processing factors
13. Summary

3.1 INTRODUCTION

1. the main i/p to the process planning activity is <u>product design.</u>

2. So, the manufacturing engineer is to deal with engg. drawings.

3. Drawing interpretation requires knowledge on standards and symbols used for both dimensional and geometric tolerances.

3.2 AIMS and OBJECTIVES

1. to interpret dimensional information from the drawing;

2. to interpret geometric information from the drawing;

3. to identify the critical processing factors from the dimensional and geometric information.

3.3 ENGINEERING COMMUNICATION

1. The detail design is a complete description of the product in written and/or graphical form.

2. The main thrust of this output will be the engineering drawings.

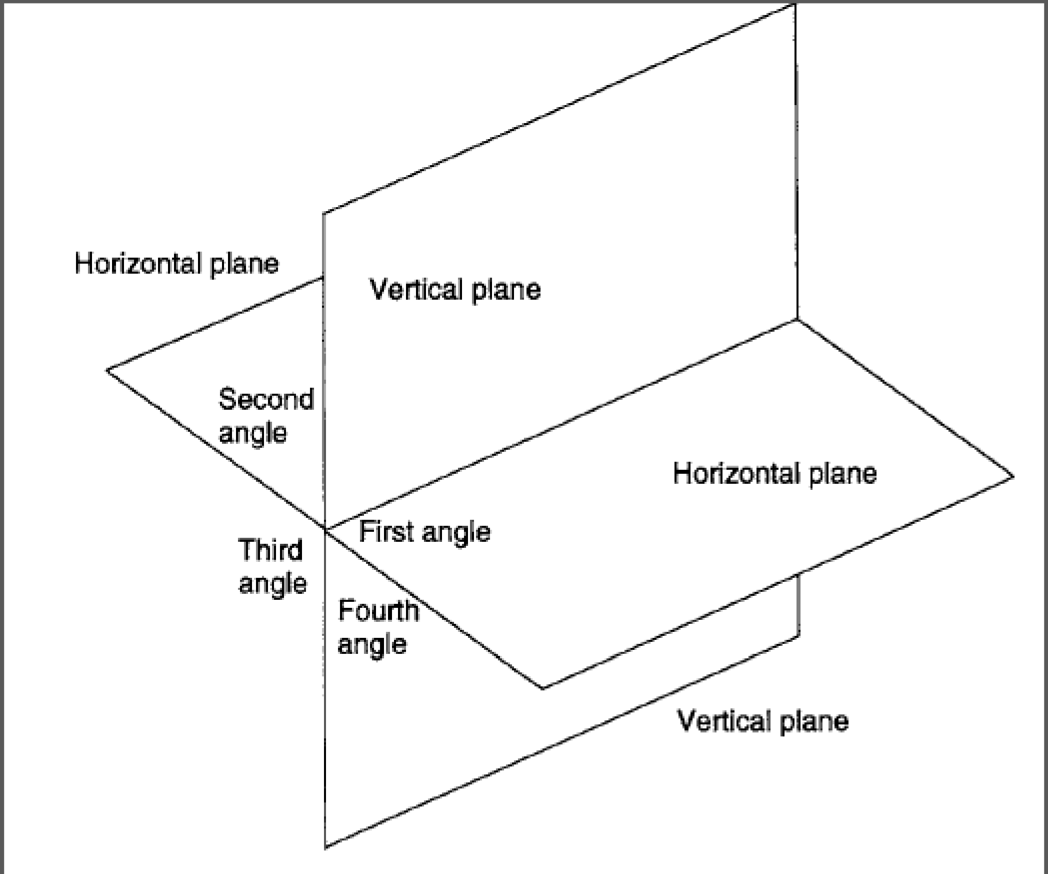
3. It should contain all the information, required for Process Planning.

different types of engineering drawings used in manufacturing:

1. detail drawings: contains all information required to manufacture i.e. dimensions, tolerances, surface finish specifications, material specifications, etc.
2. assembly drawings: contain all the information required to assemble two or more parts together
3. combined drawings: shows an assembly with parts list and the details of these parts on one drawing

3.3 ENGINEERING COMMUNICATION

1. Orthographic projection:
   method of detailing a three-dimensional object on paper, into a two-dimensional plane surface with the views of front (a front elevation), the top (a plan) and the side (a side elevation)



3.3 ENGINEERING COMMUNICATION

All engineering drawings will normally be in either first or third angle orthographic projection.

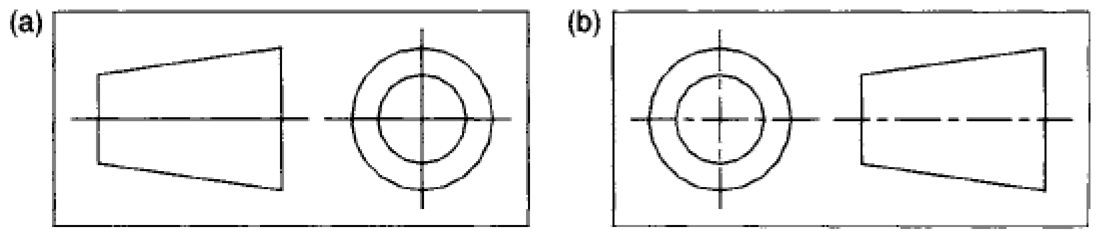
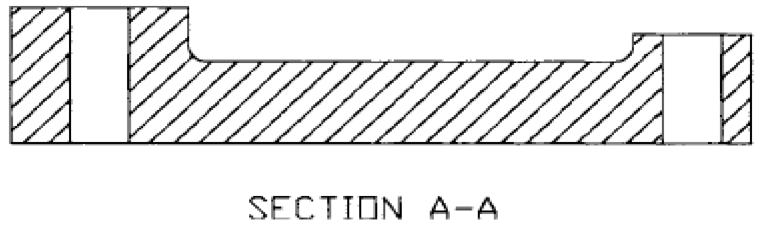


Figure 3.12 *(a) First angle projection symbol. (b) Third angle projection symbol*

Hidden details are by using broken lines.

Surface that has been cut is shown using evenly spaced lines at 45° known as hatching.



Example of a sectional view

3.4 Identifying useful supplementary information

Various supplementary information are recorded on the drawing sheet, most of which will be textual information:

material and specification;

surface finish;

tolerances;

equivalent parts;

screw thread forms;

tool;

gauge;

quantity to be produced;

parts lists (in the case of assembly drawings).

3.5 Equivalent parts

Modern manufacturing is based on three major concepts:

mass manufacture,

interchangeability and

standardization.

Of these concepts, both interchangeability and standardization influence the specification of equivalent parts.

3.5 Equivalent parts

Interchangeability:

mating parts are manufactured in a manner that allows any one of a batch of parts to be used with any other appropriate mating part in a sub-assembly or assembly.

Standardization:

to pursue the goal of interchangeable manufacture, standardization of parts is most required one.

3.6 Screw thread forms

Many parts will be joined by means of mechanical fasteners such as screws and/or nuts and bolts a sub-assembly or assembly.

most commonly used is ISO metric screw thread.

usually represented on an engineering drawing with an M prefix followed by a value indicating the external diameter in mm.

Example:

if a screw thread is designated as M5, it is a coarse pitch thread of 5 mm diameter.

if a screw is designated as M5 x 0.5, it is a fine pitch thread.

the M and associated diameter value will be followed by the pitch.

3.7 DIMENSIONAL TOLERANCES

What is Tolerance?

minimum and maximum size of a dimension

Why Tolerance?

To achieve an exact dimension in manufacturing of an item.

tolerances ± 0.5

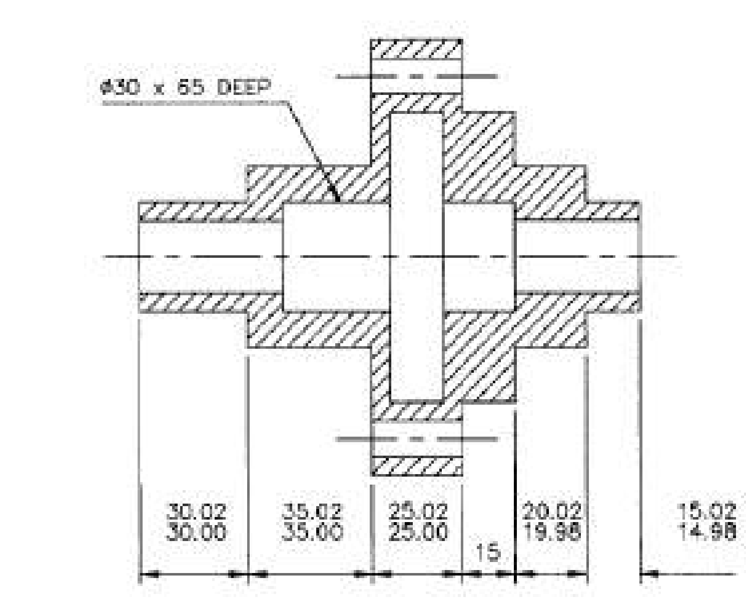


Figure 3.14 *Dimensional tolerances with limits directly stated*

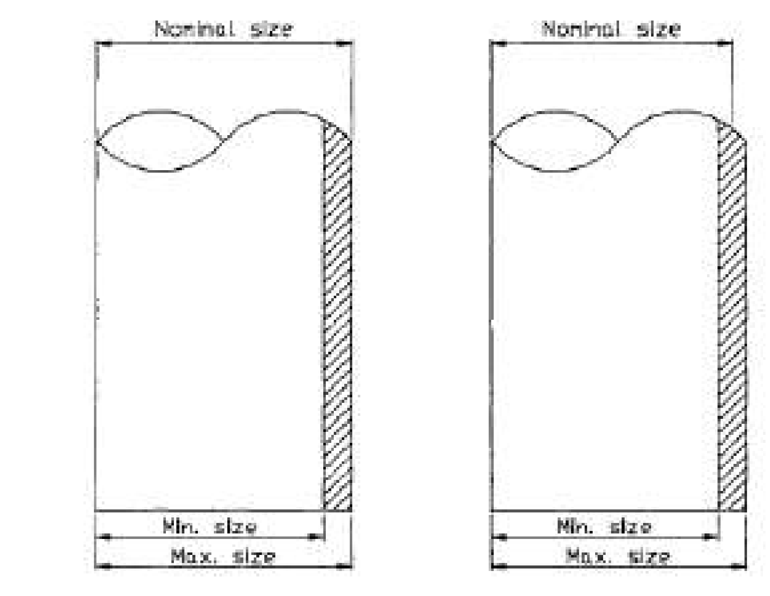


Figure 3.16 *Bilateral and unilateral dimensional tolerances*

3.8 LIMITS AND FITS

two bases for systems of limits and fits and these are:

Hole Basis	Shaft Basis
shaft must fit the hole	hole must fit the shaft
hole size remains constant	shaft size remains constant
shaft size varies according to	hole size varies according to the type of fit

hole-based system (i.e. the shaft fits the hole) is more commonly used, there are three basic types of fit.

3.8 LIMITS AND FITS

Clearance fit:

shaft is made smaller than the hole, (i.e upper size of shaft is smaller than lower size of the hole). It allows to rotate within the hole.

Ex: shaft bearings

Interference fit:

shaft is made larger than the hole, (i.e lower size of the shaft is larger than upper size of the hole). Pressure / heat will be used to mate the parts.

Ex: permanent assembly, bushes and couplings.

Transition fit:

a light interference fit is often used and the parts can be assembled and unassembled with the minimum of pressure.

Ex: fasteners such as keys, pins and parts fitted together.

3.8 LIMITS AND FITS

Example: A *hole is* *dimensioned as Ø50 H8/f 7. Determine the upper and lower limits, the extremes of fit and thus the type of fit for this combination of shaft and hole.*

H8 indicates that this is a hole-based system (i.e the shaft must fit the hole; hole size remains constant while the shaft size varies).

Upper and lower limits for Hole H8:

upper deviation = 0.046 mm .'. upper limit = 50.046 mm
lower deviation = 0 mm .'. lower limit = 50 mm

Upper and lower limits for Shaft f7:

upper deviation = -0.03 mm .'. upper limit = 49.97 mm
lower deviation = -0.06 mm .'. lower limit = 49.94 mm

Material Evaluation and Process selection

1. 4.2 Aim / Objective:
2. 4.3 Basic classification of materials for manufacture:
3. 4.4 Basic material properties:
4. 4.5 Metals:
5. 4.6 Ceramics:
6. 4.7 Polymers:
7. 4.8 Composites and semiconductors:
8. 4.9 Material selection process and methods:
9. 4.10 Material evaluation method:
10. 4.11 Manufacturing processes:
11. 4.12 Process selection:
12. 4.13 Process and operations sequencing:
13. 4.14 Summary

Material Evaluation and Process selection

selection of a specific material for a particular part or product is an important part of the design and manufacture cycle.

Aim / Objective:

To identify common materials used for manufacture;
To identify main properties of materials;
To identify material selection processes
To identify common processes used for manufacture;
To select suitable processes for a given part/product.

Material Evaluation and Process selection

Basic classification of materials for manufacture:

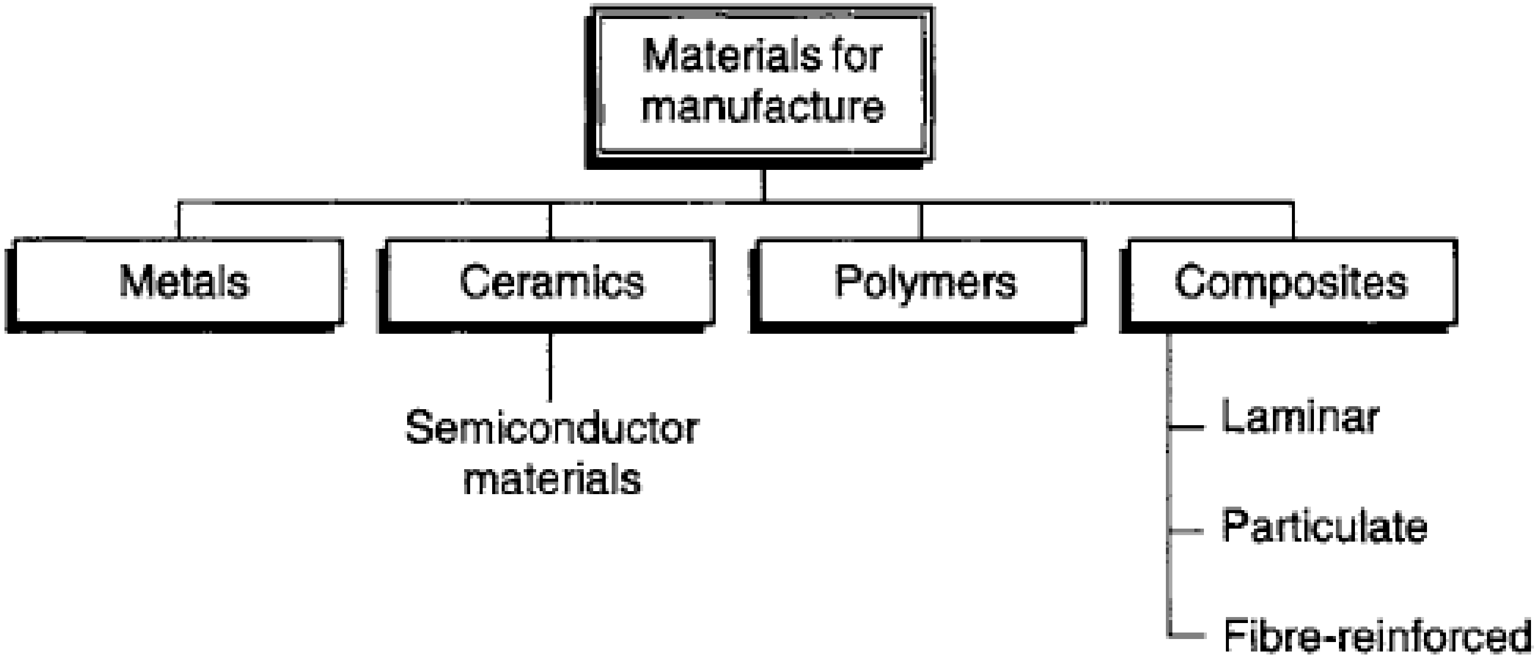


Figure 4.1 *General classification of materials for manufacture*

Material Evaluation and Process selection

Basic material properties:

Mechanical properties describe how a material reacts under applied loads.

Physical properties describe density and melting point.

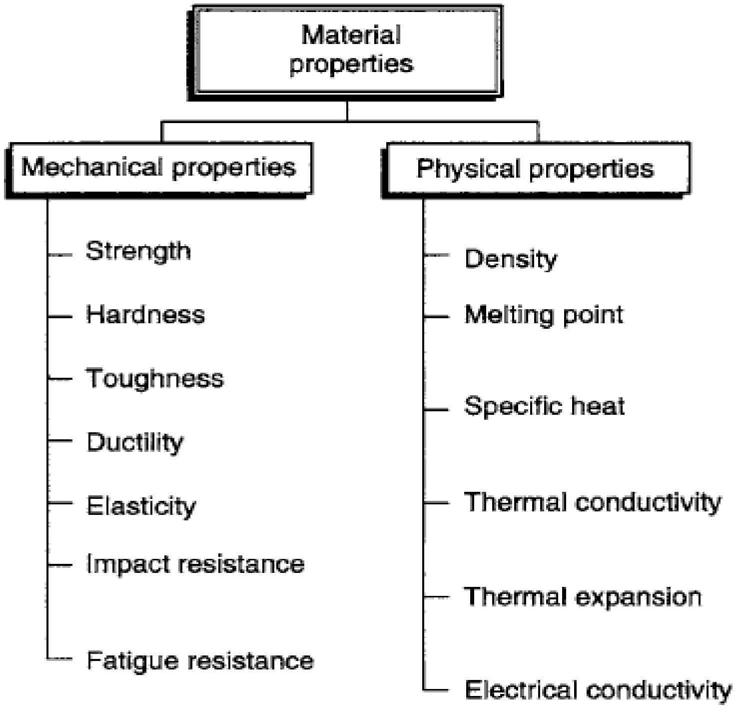


Figure 4.2 *General mechanical and physical material properties*

Material Evaluation and Process selection

Basic material properties:

Mechanical properties describe how a material reacts under applied loads.

Physical properties describe density and melting point.

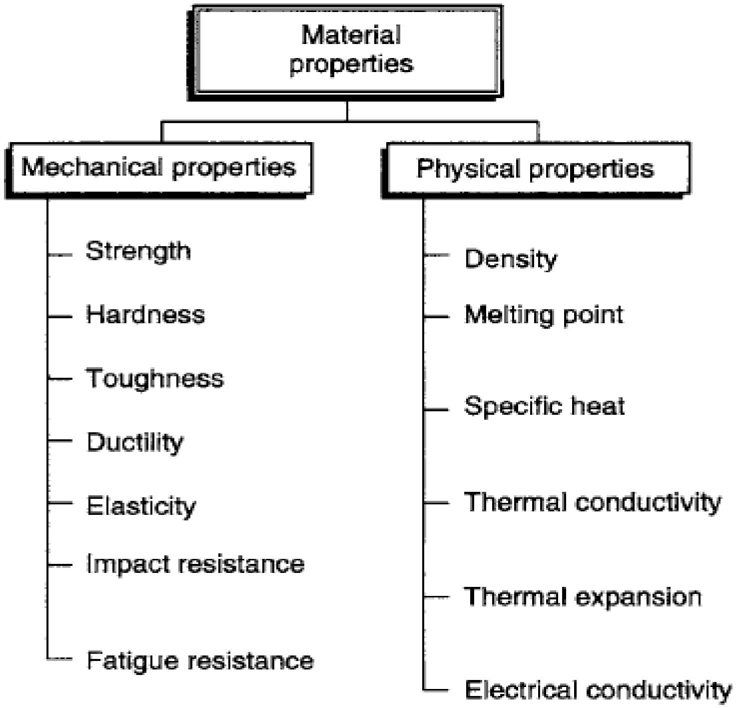


Figure 4.2 *General mechanical and physical material properties*

Production equipment and tooling selection

5.1 Introduction

5.2 Aims and objectives

5.3 Production equipment for specific processes

5.4 Factors in equipment selection

5.5 Machine selection method

5.6 Tooling for specific production equipment

5.7 Factors in tooling selection

5.8 Tooling selection method

5.9 Summary

Production equipment

manufacturing processes:

casting,
shaping/forming,
machining,
joining and
surface processes.

Production equipment for specific processes:

Casting : expendable / permanent mould

Shaping/forming : bulk forming, sheet forming and powder processing.

Machining: all conventional, unconventional, CNC, etc.

Production equipment

Factors in equipment selection:

Technical factors

- *Physical size*
- *Machine accuracy*
- *Surface finish*
- *Cutting forces*
- *Power*

Operational factors

- *Batch size*
- *Capacity*
- *Availability*

Machine selection method:

- **First cut selection**
- **Power/force analysis**
- **Capability analysis**
- **Operational analysis**
- **Final selection**

Tooling selection

Tooling for specific production equipment:

- Tooling for casting, shaping and forming (Mould / Die)
- Tooling for machining (Work holding)

Factors in tooling selection:

There are six constraints must be considered in tool selection.

- Manufacturing practice (continuous or intermittent cutting)
- Manufacturing process
- Machine tool characteristics
- Capability
- Processing time
- Cutting tool availability

Tooling selection

Operating requirements for tool selection:

Workpiece material
Operation
Part geometry
Tooling data

Factors affecting tooling performance:

Cutting tool materials
Cutting tool geometry
Cutting fluids

Tooling selection method

1. Evaluation of process and machine selections-
   the range of tools that can be used
2. Analysis of machining operations-
   analysis enables identification of specific tool types for specific operations.
3. Analysis of workpiece characteristics –
   analysis of the first two enables suitable tool materials and geometry (in terms of size and shape).
   third allows the tool type and geometry to be refined further to suit the operations.
4. Tooling analysis-
   Using the tooling data available, will obviously reflect whatever tooling is actually available for the operations required.
5. Selection of tooling –

clamping system	toolholder type and size;
insert shape	insert size
tool edge radius	insert type
tool material.	

ME 16006

Process Planning and Cost Estimation

ME 16006 PP and CE

UNIT I	INTRODUCTION TO PROCESS PLANNING
UNIT II	PROCESS PLANNING ACTIVITIES
UNIT III	COSTING AND ESTIMATION
UNIT IV	PRODUCTION COST ESTIMATION
UNIT V	MACHINING COST ESTIMATION

UNIT 2 PROCESS PLANNING ACTIVITIES

Process parameters: Cutting speed, spindle speed, number of strokes, feed rate, depth of cut, machining time for various production processes. Basic work holding devices, jigs and fixtures, principles of locating and clamping – Case study.

UNIT 2 PROCESS PLANNING ACTIVITIES

Sl. No	Topics	Slide Nos.
1	Process parameters	
2	Production processes	
3	Machining time for various production processes	
4	Basic work holding devices	
5	Selection jigs and fixtures	
6	Principles of locating clamping	
7	Case study – 1	
8	Case study – 2	

6. Process Parameters

1. Introduction
2. Aims and objectives
3. Factors affecting speeds, feeds and depth of cut
4. Surface cutting speeds
5. Spindle speeds and number of strokes
6. Feed rates
7. Speeds and feeds for NC machines
8. Depth of cut
9. Machining times
10. Summary

6.1 Introduction & 6.2 Objectives

Setting of appropriate process parameters for a

– given machine tool, production equipment

– for a given component.

only three parameters influence the machining process:

- cutting speed, feed rate and depth of cut.

Learning objectives:

- To identify factors for selection of process parameters;
- To calculate appropriate speeds and feeds;
- To calculate machining times.

6.3 Factors to be considered

Following factors are influencing when setting all the three process parameters speed, feed and depth of cut:

- work piece material and geometry;
- tool material and geometry;
- processing time available as specified by production planning.

6.3 Cutting speed for machining operation

- speed at which the cutting edge of the tool passes over the surface of the workpiece

turning, boring, milling and drilling

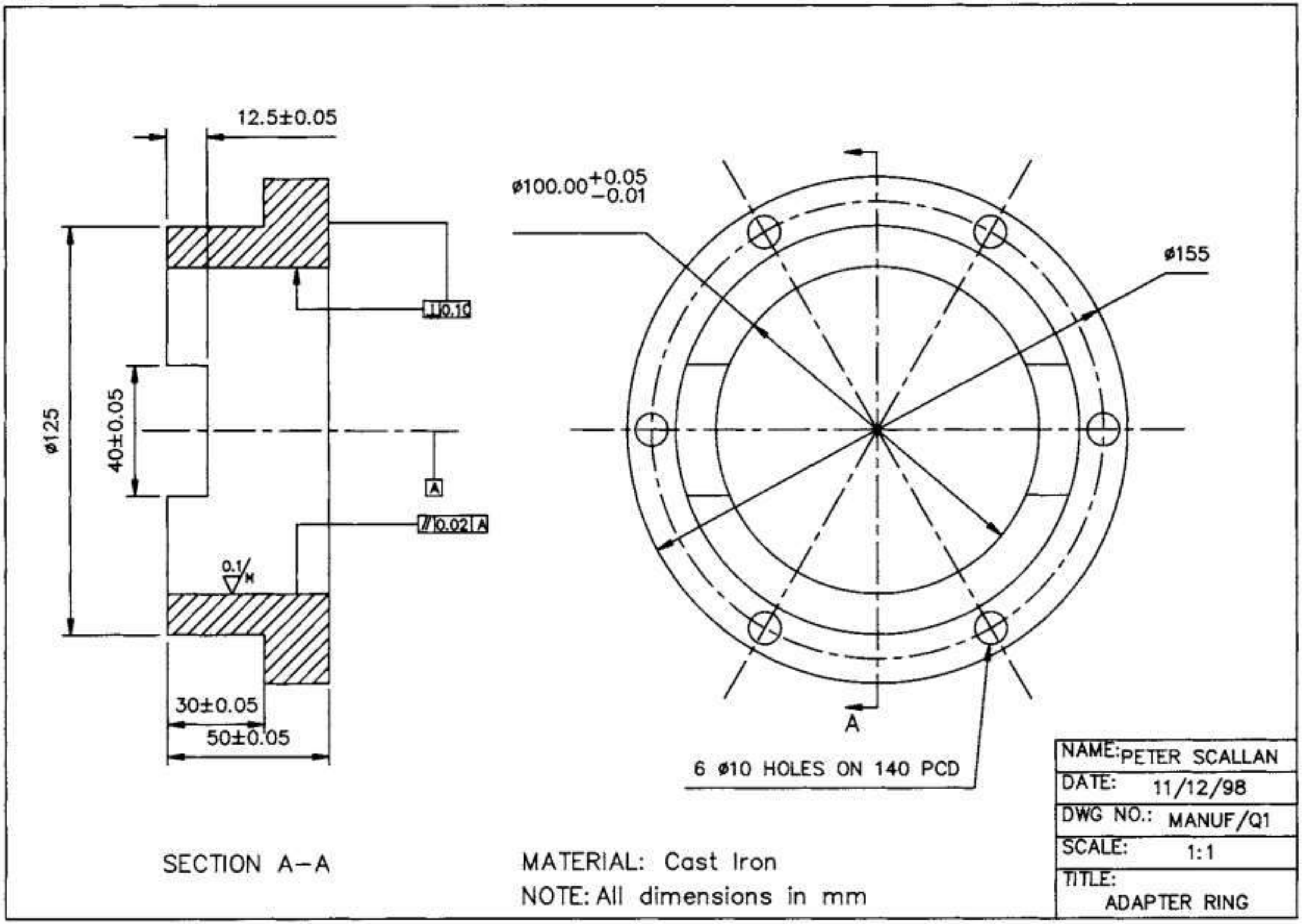
Broaching

shaping and planing

grinding

Drawing Interpretation

1. Study the drawing and identify the useful information included on it.
2. What important information is missing from the drawing?
3. What do you notice about the general surface finish specified?
4. Study the drawing thoroughly, interpreting all dimensional and geometrical information, and identify the critical processing factors.
5. Based on the type of manufacturing environment, what sort of process planning documentation would you expect to see in a company like this?



ure 3.24 *Adapter ring for case study*

5. Developing a manufacturing strategy

Manufacturing strategy can be defined as a long range plan to use the resources of the manufacturing system to support the business strategy and in turn meet the business objectives.

Capacity decision

Process decision

Facility decision

Make or buy decision

Infrastructure decision

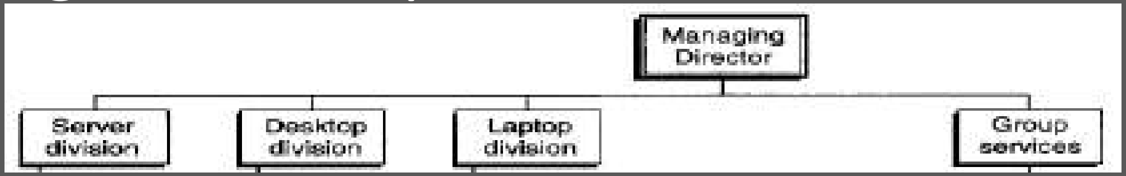
HR decision

Figure 1.4 *Developing a manufacturing strategy*

6. Manufacturing organizational structures

functional structure: departments around the functions within the organization.

product structure: organizations produce a diverse range of products.



matrix structure: an attempt to obtain the benefits of both functional and product structures.

7. Categories of MS

There are two basic categories of manufacturing system:

- discrete parts manufacturing;
  - project manufacture;
  - batch manufacture;
  - mass/flow manufacture
  - jobbing shop manufacture

- continuous process manufacturing;

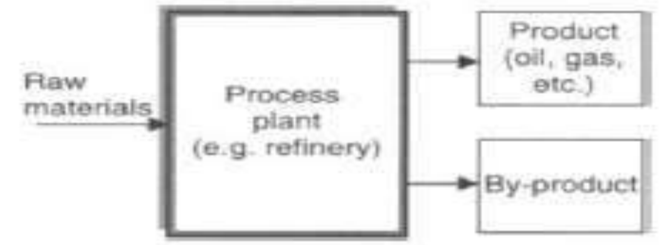


Figure 1.8 *Continuous manufacture*

8. Processing strategies

The process decision is further linked to four distinct strategies within manufacturing,

– make to stock (MTS);

– assemble to order (ATO);

– make to order (MTO);

– engineer to order (ETO).

9. Plant Layout

What is plant layout?

physical arrangements of departments, workgroups within departments, workstations, machines and stock-holding points within a manufacturing facility.

Plant facility systems design:

structural systems, heating, ventilation and air conditioning (HVAC) and general services, that is, water, electrics, lighting, etc.

Plant layout design:

equipment and machinery within the production area, all production related areas and often personnel areas within the facility.

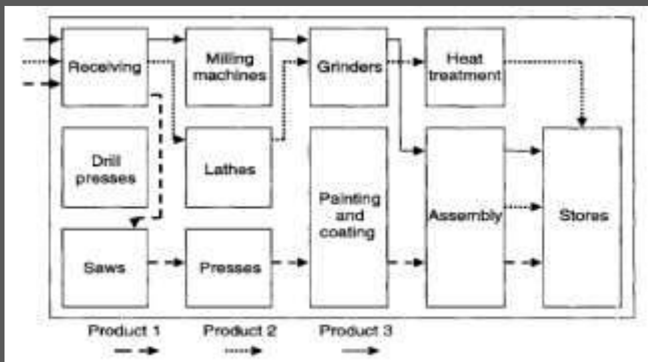
Material handling systems design:

materials, personnel and equipment handling systems required to support production.

9. Plant Layout

Four types of plant layout:

- fixed position layout
- process layout
- product layouts
- cellular layout (or) hybrid layout



igure 1.12 *Process-focused layout*

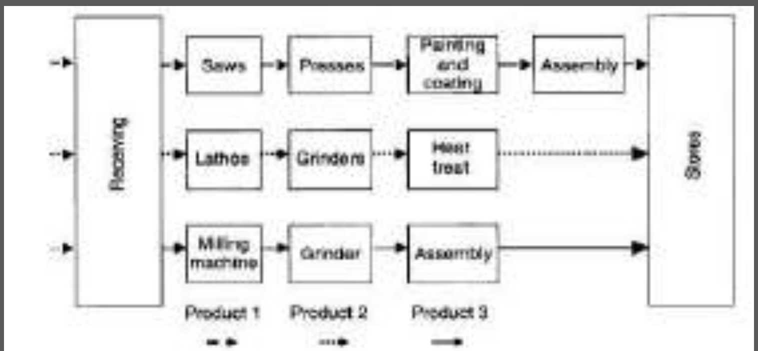


Figure 1.13 *Product-focused layout*

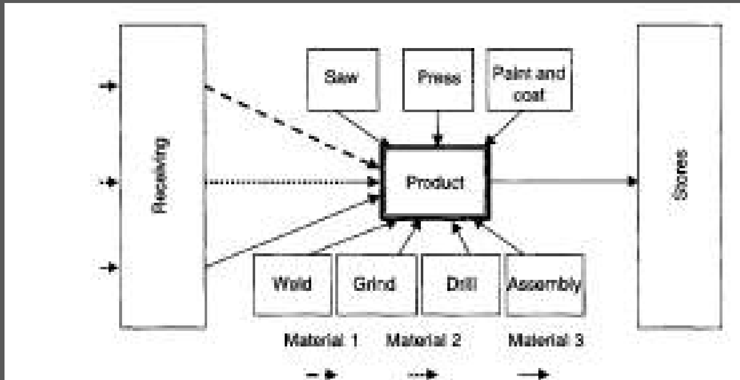


Figure 1.14 *Fixed position layout*

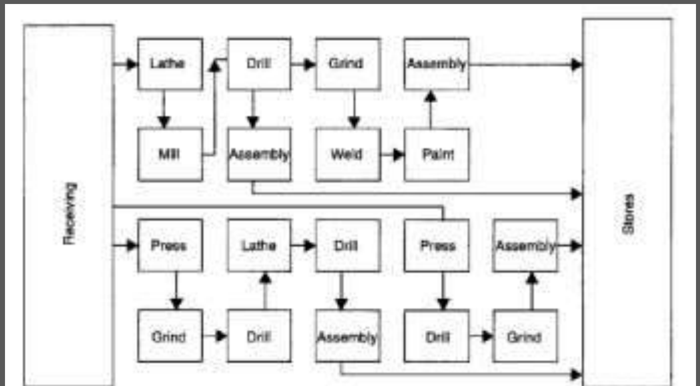


Figure 1.15 *Hybrid layout*

9. Plant Layout

The major influence in determining / selecting the most suitable Plant layout:

volume and variety of product to be manufactured.

Other criteria include

cost of the layout,

materials handling requirements,

flexibility of the layout,

stock requirements and

ease of maintenance.

10. Manufacturing Engineering

two distinct engineering functions with direct responsibility for the manufacture of a product:

- industrial engineering
- manufacturing engineering

Industrial engineering, whose main responsibility is usually to support manufacturing engineering.

Therefore, industrial engineering is involved in:

Methods analysis

Work measurement

Plant layout

Material handling

Plant maintenance

Manufacturing engineering, responsible for all phases of product manufacture, with the exception of product design. There are four specific areas:

Manufacturing systems development

Process development

Process evaluation

Process planning

PROCESS

What do you mean by PROCESS?

- Conversion of a work-piece from its initial form to a final form predetermined (usually by a design engineer)
- Group of action to achieve the output in accordance with a specified measure of effectiveness.

Various manufacturing processes:

Casting :	Establishing
Forming:	Moving of material
Machining:	Subtractive / Removing Technique
Fabrication / Welding:	Additive / Joining Technique
Finishing Process:	Final / aesthetic aspects

PROCESS PLANNING

What do you mean by PROCESS PLANNING?

- Systematic determination of the processes and its sequence by which the product is to be manufactured economically and competitively within the limits of design specifications.

- It consists of devising, selecting and specifying

  processes,
  machineries and equipment,
  tools

  to transform the raw material into finished product as per the specifications.

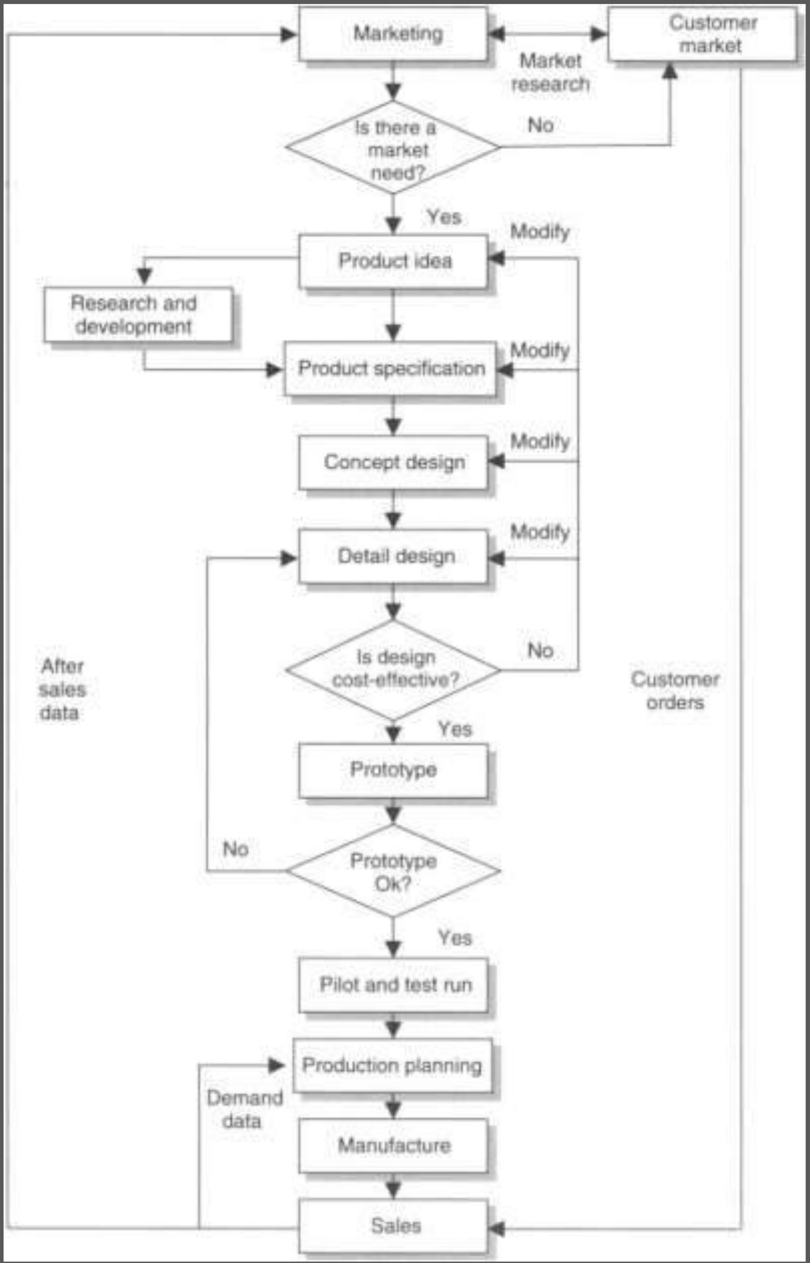
- Intermediate stage between design & manufacturing

Designing → **PROCESS PLANNING** → Manufacturing

PROCESS PLANNING: Aims & Objectives

- To identify functions involved in design and manufacture;
- To define the process planning activity;
- To identify and describe the main tasks undertaken during process planning;
- To identify and describe the various data used in process planning;
- To identify and describe the main process planning documentation;
- To identify and describe the relationship between process planning and other manufacturing functions.

Process Planning: Design & Manufacture Cycle



Marketing:

Promotion - exist

Market research - new

R & D:

Concept design

Detail design

Prototype

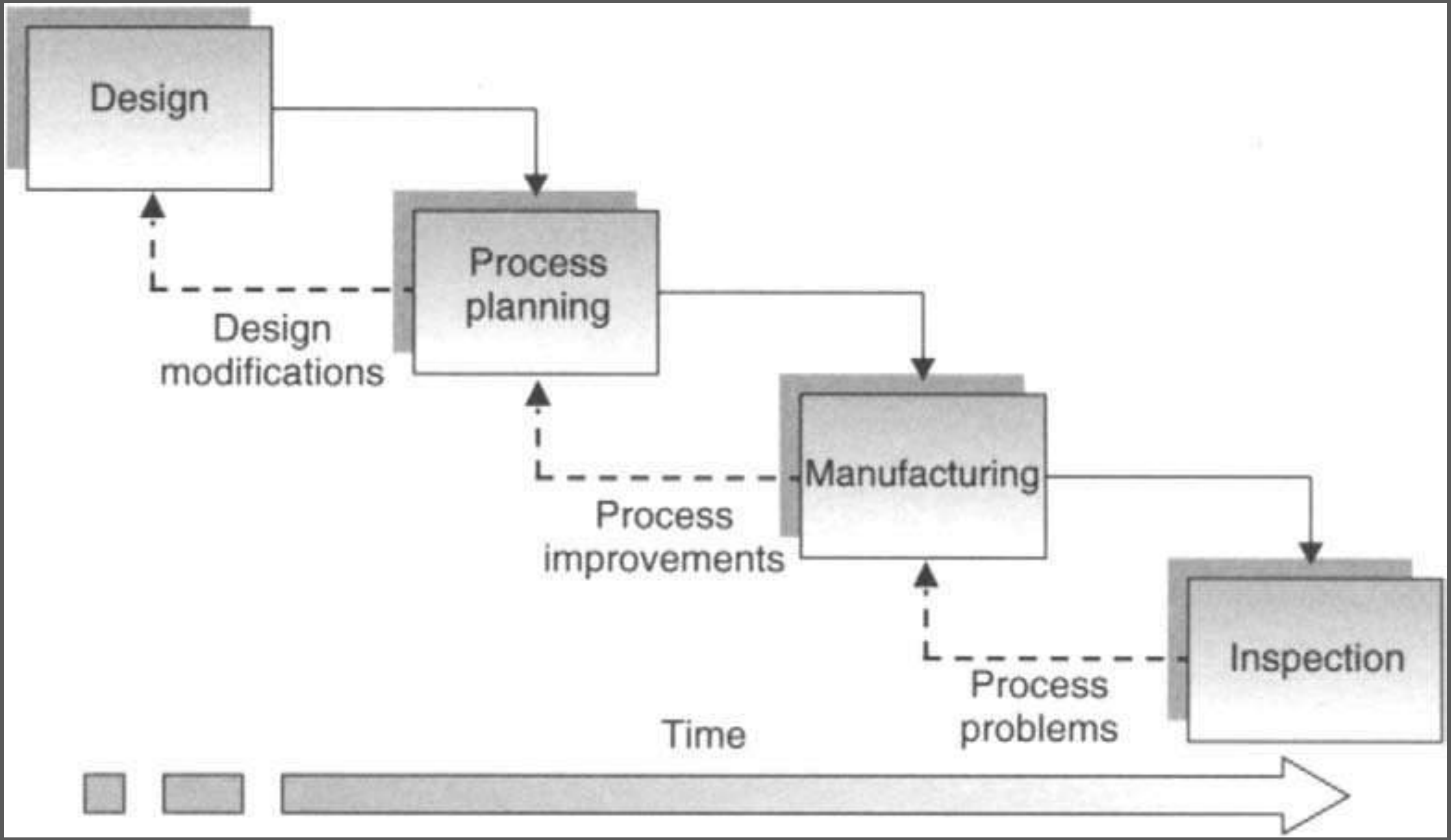
Trial

Pilot batch

Manufacture

Sales

Process Planning: Design & Manufacture interface



Process Planning Activities

Preparing the process plan includes

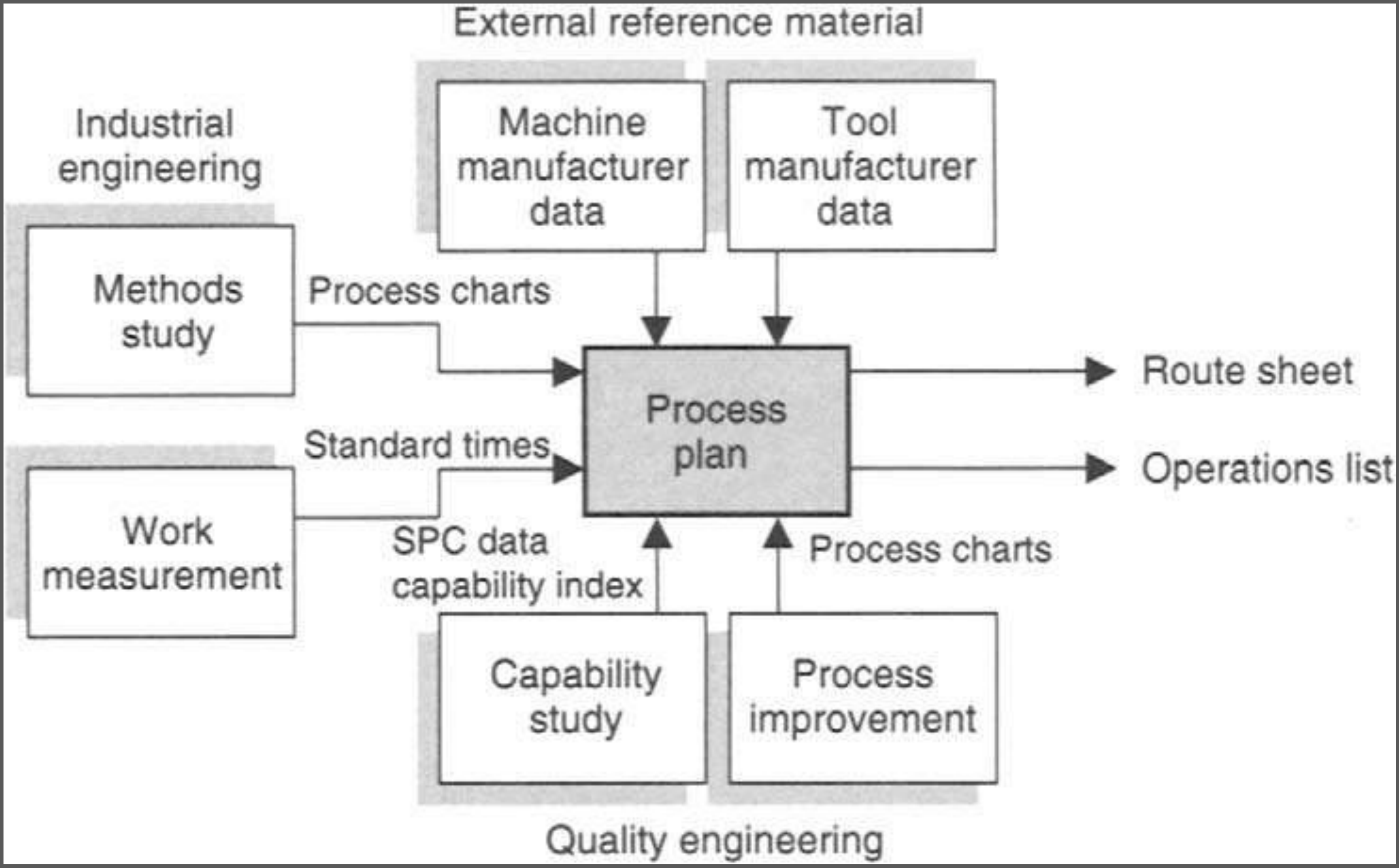
- Drawing Interpretation
- Material evaluation and process selection
- Machines and tool selection
- Setting process parameters
- Workholding devices
- Selecting quality assurance methods
- Costing
- Documentation: Routing sheet, Operations List, etc.

An engineer should have

- knowledge of materials for manufacture;
- knowledge of manufacturing processes;
- knowledge of jigs and fixtures;
- an ability to use reference material, Ex: m/c data
- knowledge of the relative costs of materials, tooling;
- an ability to calculate manufacturing parameters and costs;
- knowledge of inspection/QA procedures and specifications.

Process Planning and Industrial Engineering

main o/p of process planning: Routing sheet and Operations sheet.



Process Planning and Quality Assurance

seven wastes in production:

overproduction,

waiting,

transporting,

inappropriate processing,

unnecessary inventory,

unnecessary motion and

defects.

Process Planner & Quality Inspector:

Process Planning and Production Planning

process planning & production planning are separate functions.

process planner is to determine how a job is to be done and how long it will take. Therefore, the process planner is not concerned with resources of the shopfloor.

outputs of the process planning are the main inputs to the production planning.

Process Planning Methods

two basic methods employed in process planning:

manual process planning and

computer-aided process planning (CAPP)

Manual process planning can be broken down further into two distinct approaches:

- traditional approach
- workbook approach

CAPP methods can be categorized further as

- variant CAPP
- generative CAPP

Process Planning Methods: Traditional

Process Planner's activities are outlined in three stages:

1. He looks drawing and uses his experience of manufacturing methods, combined with knowledge of the types of resource available, to decide how the component or assembly should be made.

2. He refers manuals to ascertain the company's recommended tools, feeds and speeds for the particular material on the selected machine.
3. Documents in routing sheet, which lists all the operations.

Process Planning Methods: Workbook

1. It is a derivative of the traditional approach.

2. This is considered a more efficient approach.

3. It involves developing workbooks of pre-determined sequences of operations for given types of workpieces.

4. The pre-determined sequence of operations are selected from the workbook and incorporated into the process plan.

General guidelines for manual process planning

1. establishing one datum and using this as a reference for all subsequent operations;

2. creating as many surfaces as possible at the same setting (i.e. without clamping and unclamping) to maximize dimensional accuracy;

3. avoid the use of secondary surface data as much as possible;

4. precision operations (ex: producing high-quality surface finishes) should be carried out last to reduce the possibility of damage;

5. inspection operations should be included at appropriate intervals to minimize scrap and rework.

Advantages & disadvantages of manual process planning

Advantage of manual process planning:

it is a low-cost task and is flexible, i.e. system can be changed easily.

Disadvantages of manual process planning:

1. Excessive clerical content: more paperwork, labour intensive
2. Lack of consistency in planning: due to different planners,
3. Late design modifications: design changes,required at later stage,
4. Changing technology: rapid change in manufacturing environment, new processes, tooling and materials, etc.

Computer aided process planning

Advantage of CAPP:

- less time spent on process planning;
- less reliance on the knowledge and experience of the process planner;
- more efficient use of manufacturing resources leading to improvements in costs;
- improved productivity;
- improved accuracy and consistency of process plans.

Computer aided process planning

Computer Aided Process Planning (CAPP) can be categorized in two major areas:

(1) Variant or Retrieval method of process planning.
(2) Generative method of process planning.

Variant process planning, where library retrieval procedures are applied to find standard plans for similar components.

Generative process planning, where plans are generated automatically for new components without reference to existing plans.

The latter system is most desirable but also the most difficult way of performing CAPP.

Variant Method of Process Planning (Retrieval CAPP System)

computer makes a search of its storage or a data base or a no. of standard or completed process plans that have been previously developed by the company's process planners.

The development of the data base of these process plans requires substantial knowledge of machining, time and efforts.

Using the current design data supplied by the CAD system, (after a component has been designed and dimensioned), it searches for a process plan that was based on a part of similar design. (This search can make effective use of GT, Group Technology, design coding to simplify the search for similar part design).

The process plan retrieved is then modified or suitably varied (i.e., altered) by the process planner, to suit the exact requirements of the current part design.

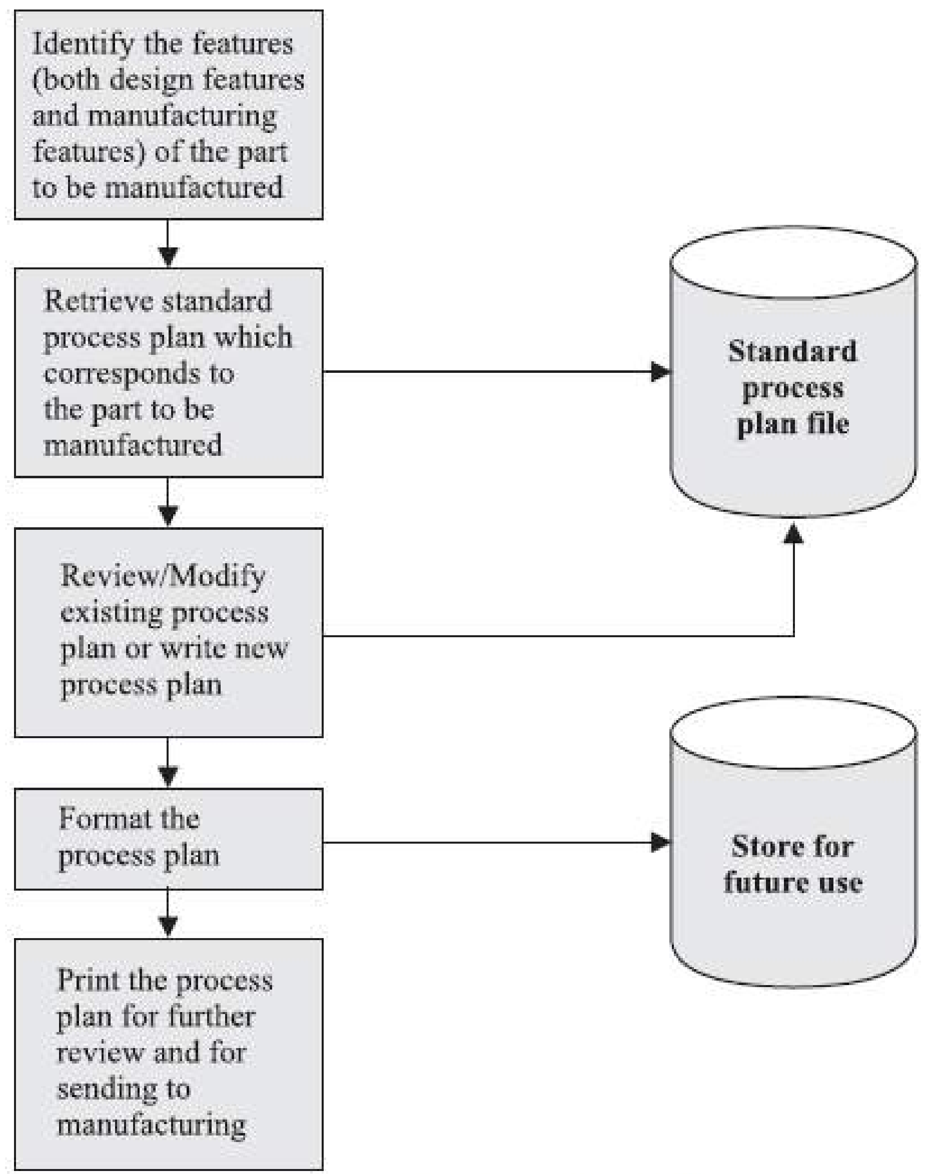
Variant Method of Process Planning (Retrieval CAPP System)

The use of Computer and Group Procedure for developing the Retrieval type Technology (GT) to search for the most appropriate or similar part design, and to retrieve the process plan for that design, significantly reduces the work required of the process planners.

This approach of process planning is also known as Retrieval CAPP system. This is based on the principles of Group Technology and parts classification and coding.

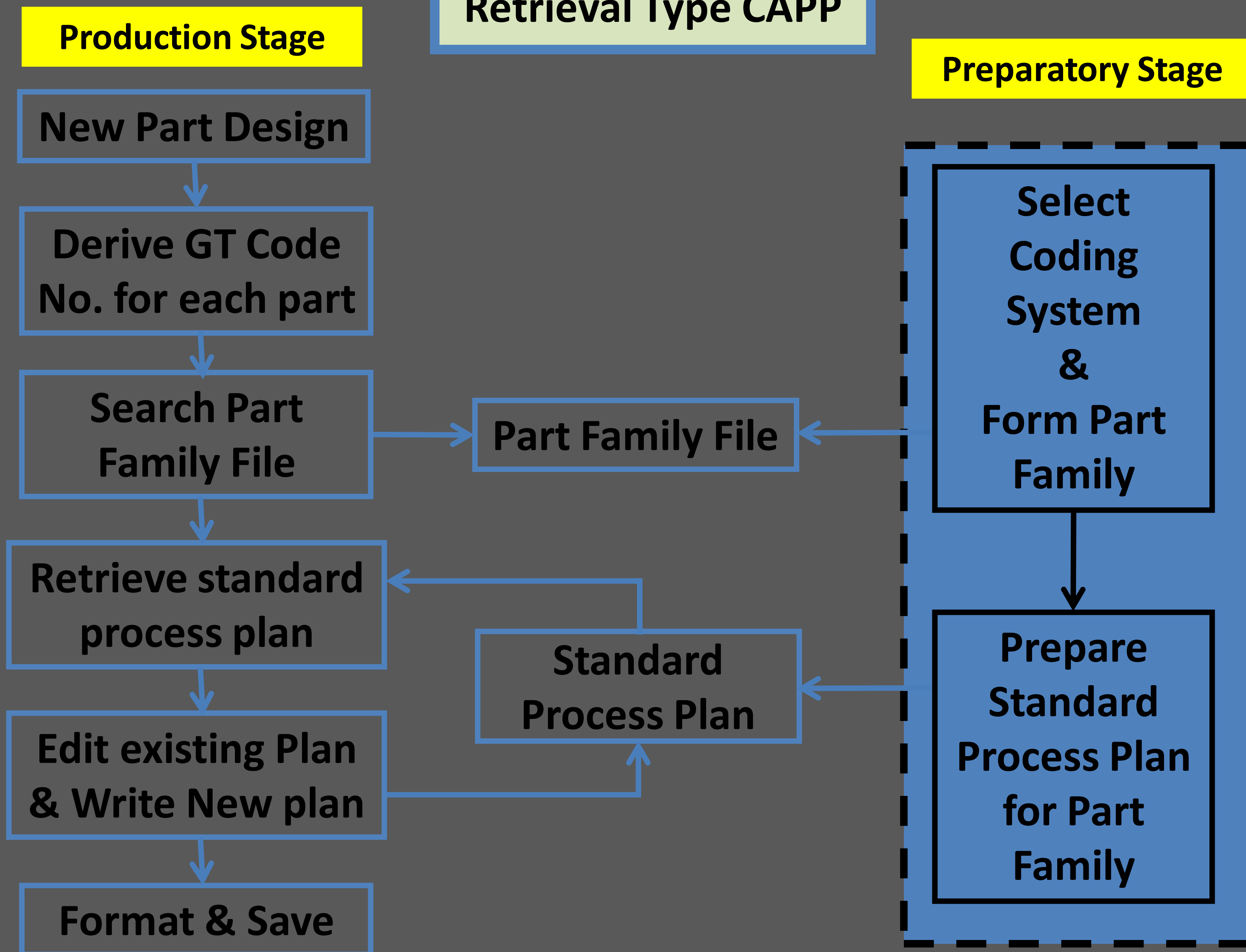
One of the pre-requisites for implementation of this method is that the industries must develop and maintain a large computer data base of standard completed process plans. In addition, the part designs are to be developed using CAD systems.

Variant Method of Process Planning (Retrieval CAPP System)



Procedure for developing the Retrieval type Computer—Aided Process Planning (CAPP) system

Retrieval Type CAPP



Advantages of Retrieval CAPP System

1. Once a standard plan has been written, a variety of components can be planned.
2. Programming is simple.
3. The system is understandable, and the planner has control of the final plan.
4. It is easy to use by small & medium scale companies, where product variety is not so high.

Disadvantages of Retrieval CAPP System

1. The components are limited to previously planned similar components.
2. Experienced process planners are still required to modify the standard plan for the specific component.
3. Details of the plan cannot be generated.
4. Variant planning cannot be used in an entirely automated manufacturing system, without additional process planning.

Generative Method of Process Planning
(Generative CAPP System)

A process plan is created from scratch without human intervention.

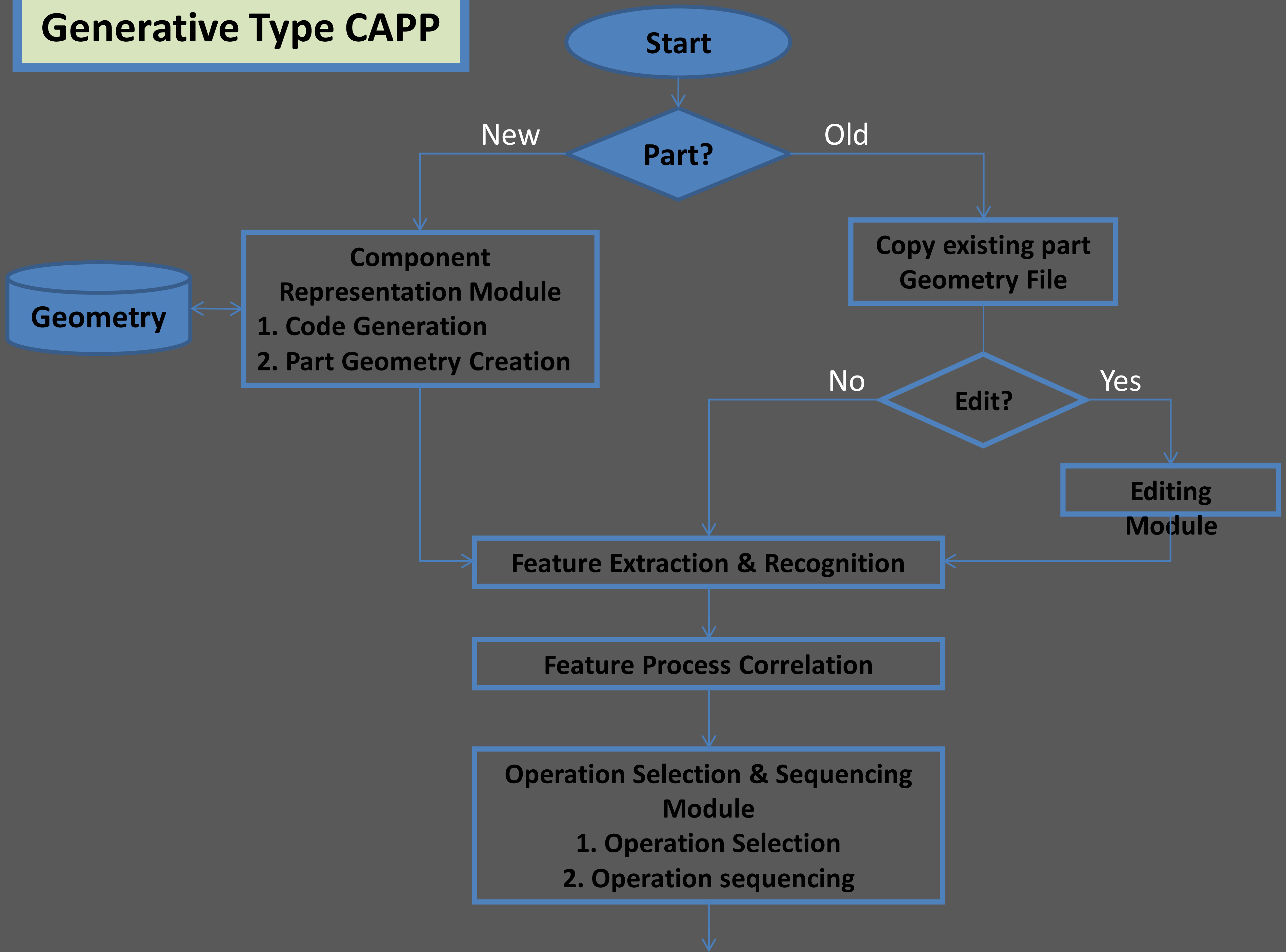
computer uses the stored data (manufacturing and design) to generate process plan that could be used to manufacture the current part.

It searches this list for the one which optimizes the cost function. This method always yields the optimum process plan for manufacturing a particular part.

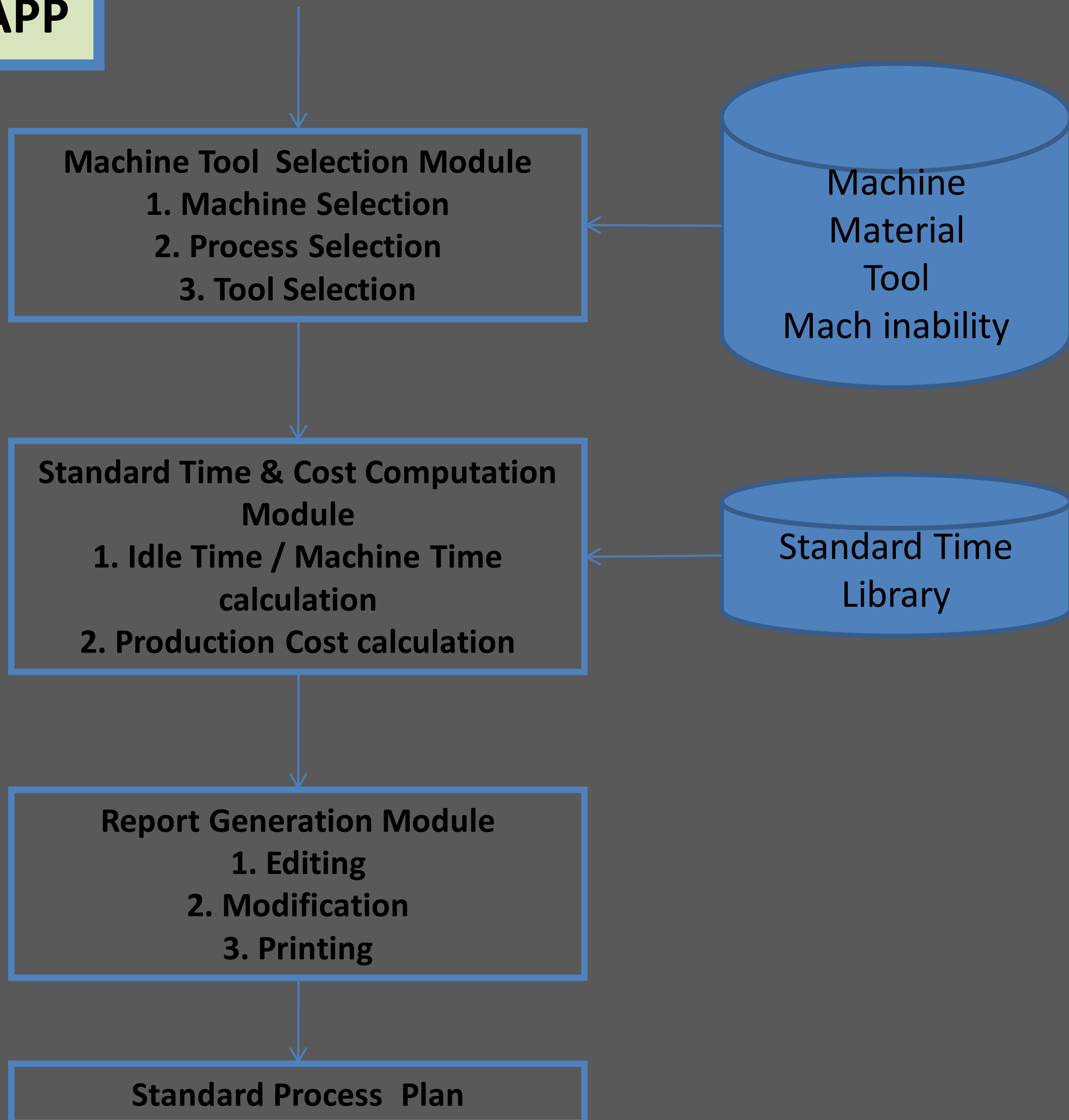
However, it has a very high cost in terms of time and computer processing expenses.

To repeat this for every feasible process plan or a part can become very costly.

Generative Type CAPP



Generative Type CAPP



Advantages of Generative CAPP System

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

Process Planning: Basic terminology

The three basic terms employed in process planning:

1. Process: It is the basic unit for compiling a process plan. An operator machines a workpiece on a machine. Ex: rough turning on a lathe, drilling a hole on a drilling machine

2. Operation: It is the sub-unit of a process. A process will consist of a number of operations. The operations are carded out in a desired order known as operations sequencing.

3. Cut: It is the sub-unit of an operation. Cutting tool passes-over the workpiece surface. Some operations may require several cuts, or only one cut.

CHAPTER 3: DRAWING INTERPRETATION

3.1 INTRODUCTION

1. the main i/p to the process planning activity is product design.

2. So, the manufacturing engineer is to deal with engg. drawings.

3. Drawing interpretation requires knowledge on standards and symbols used for both dimensional and geometric tolerances.

3.2 AIMS and OBJECTIVES

1. to interpret dimensional information from the drawing;

2. to interpret geometric information from the drawing;

3. to identify the critical processing factors from the dimensional and geometric information.

3.3 ENGINEERING COMMUNICATION

1. The detail design is a complete description of the product in written and/or graphical form.

2. The main thrust of this output will be the engineering drawings.

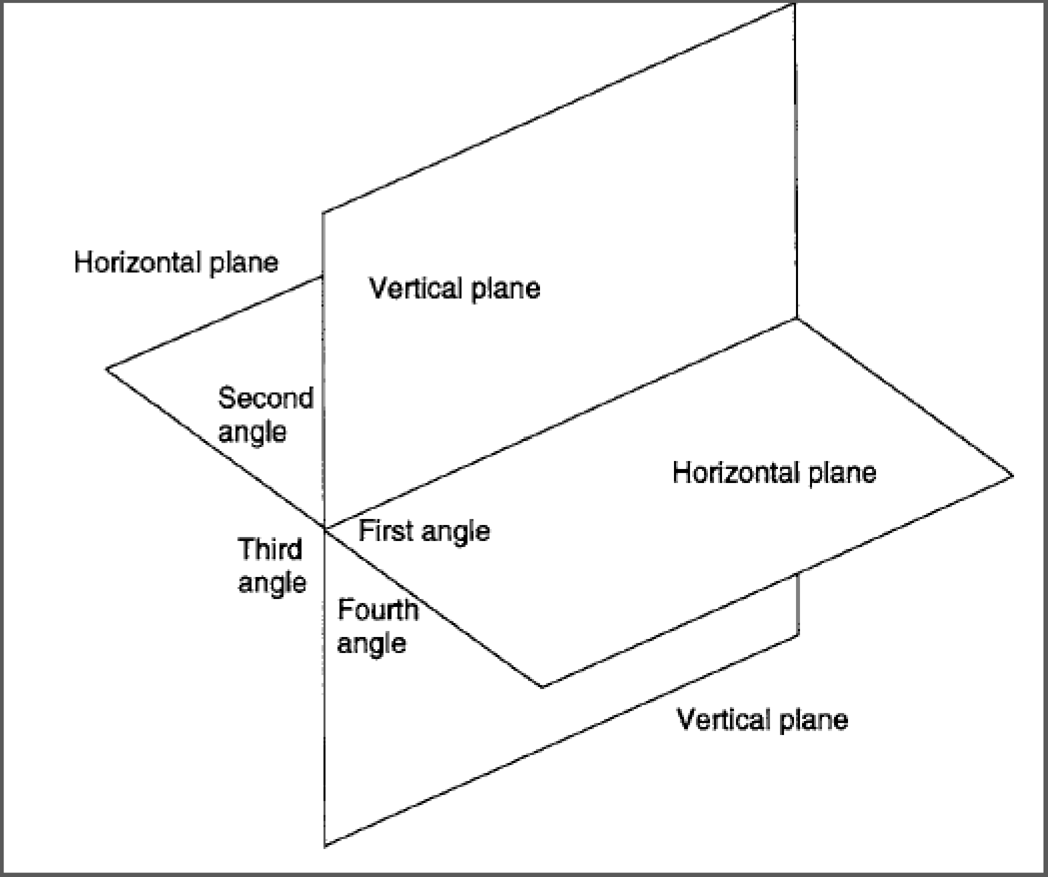
3. It should contain all the information, required for Process Planning.

different types of engineering drawings used in manufacturing:

1. detail drawings: contains all information required to manufacture i.e. dimensions, tolerances, surface finish specifications, material specifications, etc.
2. assembly drawings: contain all the information required to assemble two or more parts together
3. combined drawings: shows an assembly with parts list and the details of these parts on one drawing

3.3 ENGINEERING COMMUNICATION

1. Orthographic projection:
   method of detailing a three-dimensional object on paper, into a two-dimensional plane surface with the views of front (a front elevation), the top (a plan) and the side (a side elevation)



3.3 ENGINEERING COMMUNICATION

All engineering drawings will normally be in either first or third angle orthographic projection.

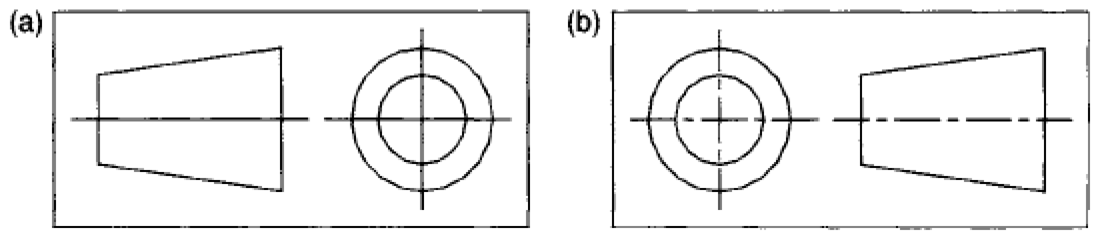
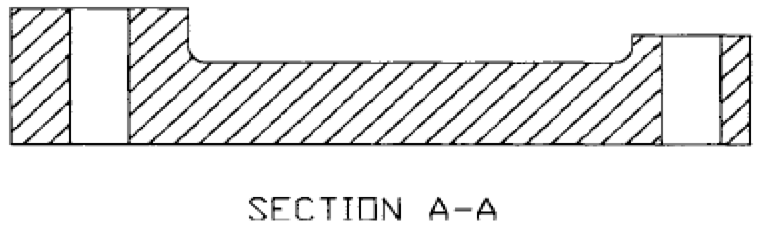


Figure 3.12 *(a) First angle projection symbol. (b) Third angle projection symbol*

Hidden details are by using broken lines.

Surface that has been cut is shown using evenly spaced lines at 45° known as hatching.



Example of a sectional view

3.4 Identifying useful supplementary information

Various supplementary information are recorded on the drawing sheet, most of which will be textual information:

material and specification;

surface finish;

tolerances;

equivalent parts;

screw thread forms;

tool;

gauge;

quantity to be produced;

parts lists (in the case of assembly drawings).

3.5 Equivalent parts

Modern manufacturing is based on three major concepts:

mass manufacture,

interchangeability and

standardization.

Of these concepts, both interchangeability and standardization influence the specification of equivalent parts.

3.5 Equivalent parts

Interchangeability:

mating parts are manufactured in a manner that allows any one of a batch of parts to be used with any other appropriate mating part in a sub-assembly or assembly.

Standardization:

to pursue the goal of interchangeable manufacture, standardization of parts is most required one.

3.6 Screw thread forms

Many parts will be joined by means of mechanical fasteners such as screws and/or nuts and bolts a sub-assembly or assembly.

most commonly used is ISO metric screw thread.

usually represented on an engineering drawing with an M prefix followed by a value indicating the external diameter in mm.

Example:

if a screw thread is designated as M5, it is a coarse pitch thread of 5 mm diameter.

if a screw is designated as M5 x 0.5, it is a fine pitch thread.

the M and associated diameter value will be followed by the pitch.

3.7 DIMENSIONAL TOLERANCES

What is Tolerance?

minimum and maximum size of a dimension

Why Tolerance?

To achieve an exact dimension in manufacturing of an item.

tolerances ± 0.5

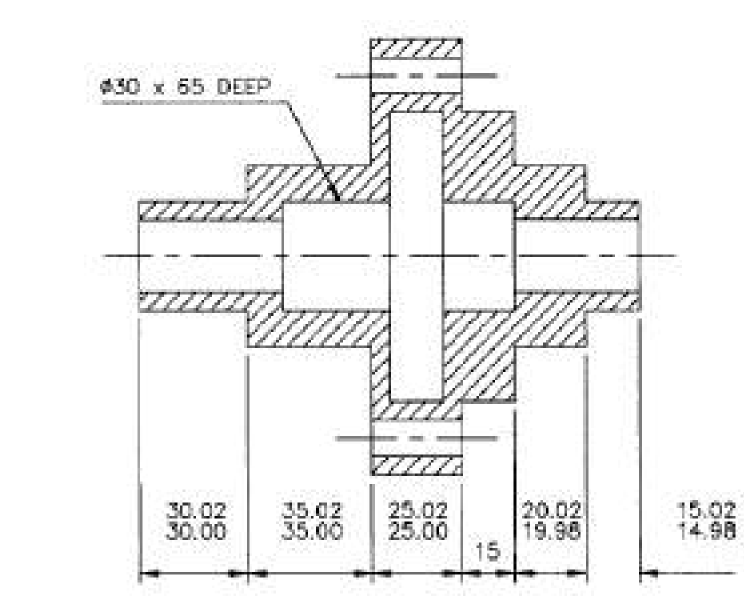


Figure 3.14 *Dimensional tolerances with limits directly stated*

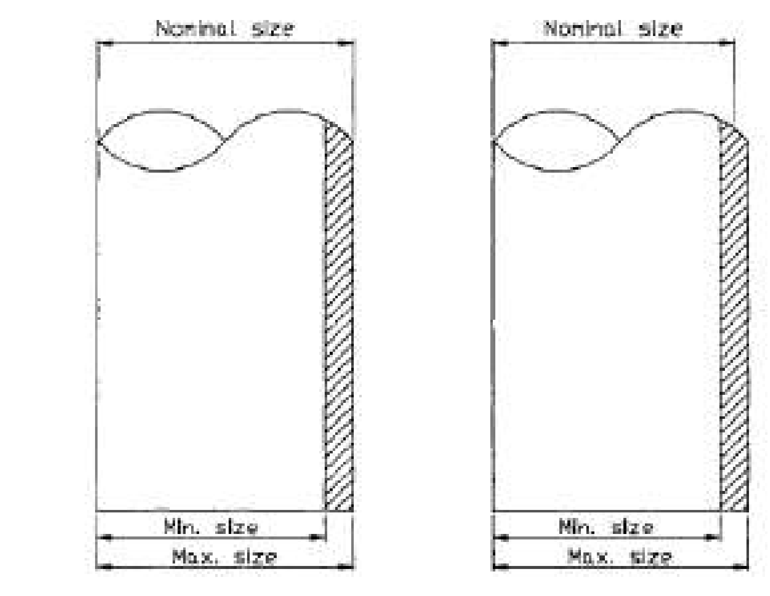


Figure 3.16 *Bilateral and unilateral dimensional tolerances*

3.8 LIMITS AND FITS

two bases for systems of limits and fits and these are:

Hole Basis	Shaft Basis
shaft must fit the hole	hole must fit the shaft
hole size remains constant	shaft size remains constant
shaft size varies according to	hole size varies according to the type of fit

hole-based system (i.e. the shaft fits the hole) is more commonly used, there are three basic types of fit.

3.8 LIMITS AND FITS

Clearance fit:

shaft is made smaller than the hole, (i.e upper size of shaft is smaller than lower size of the hole). It allows to rotate within the hole.

Ex: shaft bearings

Interference fit:

shaft is made larger than the hole, (i.e lower size of the shaft is larger than upper size of the hole). Pressure / heat will be used to mate the parts.

Ex: permanent assembly, bushes and couplings.

Transition fit:

a light interference fit is often used and the parts can be assembled and unassembled with the minimum of pressure.

Ex: fasteners such as keys, pins and parts fitted together.

3.8 LIMITS AND FITS

Example: A *hole is* *dimensioned as Ø50 H8/f 7. Determine the upper and lower limits, the extremes of fit and thus the type of fit for this combination of shaft and hole.*

H8 indicates that this is a hole-based system (i.e the shaft must fit the hole; hole size remains constant while the shaft size varies).

Upper and lower limits for Hole H8:

upper deviation = 0.046 mm .'. upper limit = 50.046 mm
lower deviation = 0 mm .'. lower limit = 50 mm

Upper and lower limits for Shaft f7:

upper deviation = -0.03 mm .'. upper limit = 49.97 mm
lower deviation = -0.06 mm .'. lower limit = 49.94 mm

Material Evaluation and Process selection

1. 4.2 Aim / Objective:
2. 4.3 Basic classification of materials for manufacture:
3. 4.4 Basic material properties:
4. 4.5 Metals:
5. 4.6 Ceramics:
6. 4.7 Polymers:
7. 4.8 Composites and semiconductors:
8. 4.9 Material selection process and methods:
9. 4.10 Material evaluation method:
10. 4.11 Manufacturing processes:
11. 4.12 Process selection:
12. 4.13 Process and operations sequencing:
13. 4.14 Summary

Material Evaluation and Process selection

selection of a specific material for a particular part or product is an important part of the design and manufacture cycle.

Aim / Objective:

To identify common materials used for manufacture;
To identify main properties of materials;
To identify material selection processes
To identify common processes used for manufacture;
To select suitable processes for a given part/product.

Material Evaluation and Process selection

Basic classification of materials for manufacture:

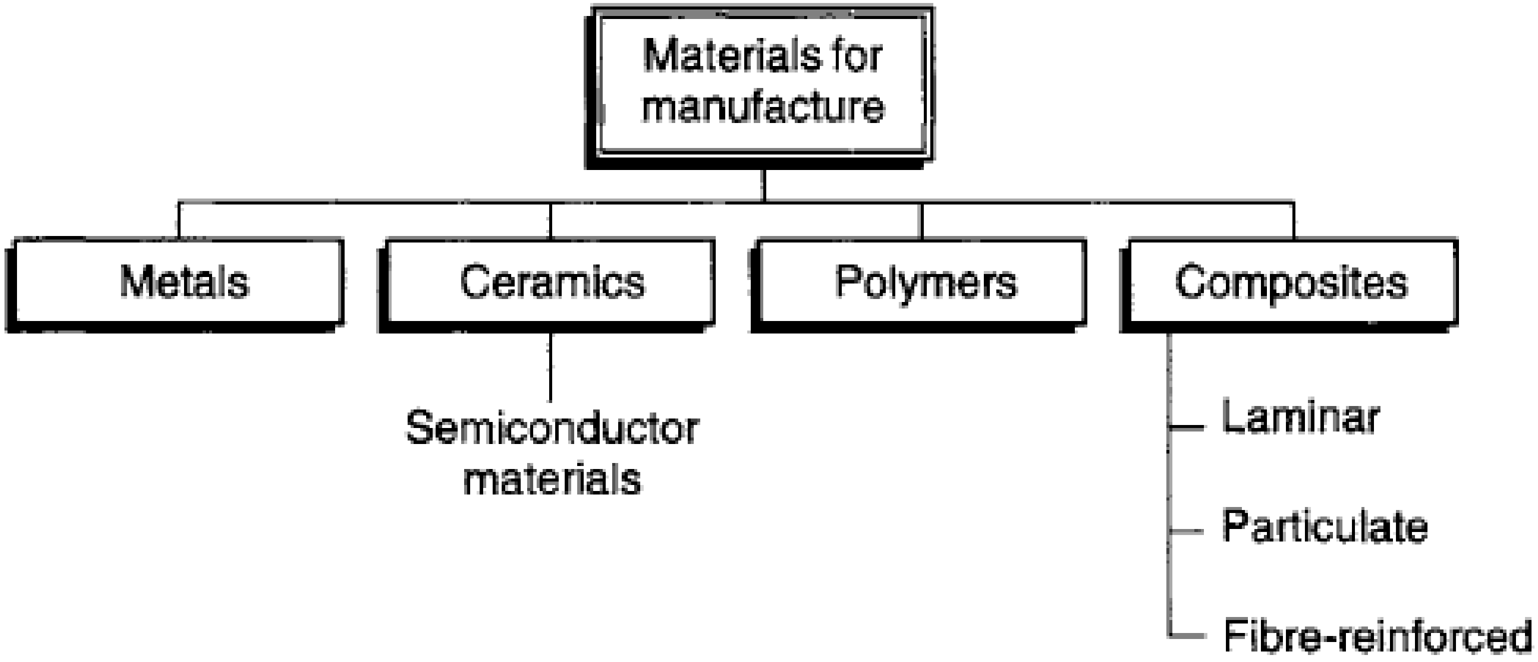


Figure 4.1 *General classification of materials for manufacture*

Material Evaluation and Process selection

Basic material properties:

Mechanical properties describe how a material reacts under applied loads.

Physical properties describe density and melting point.

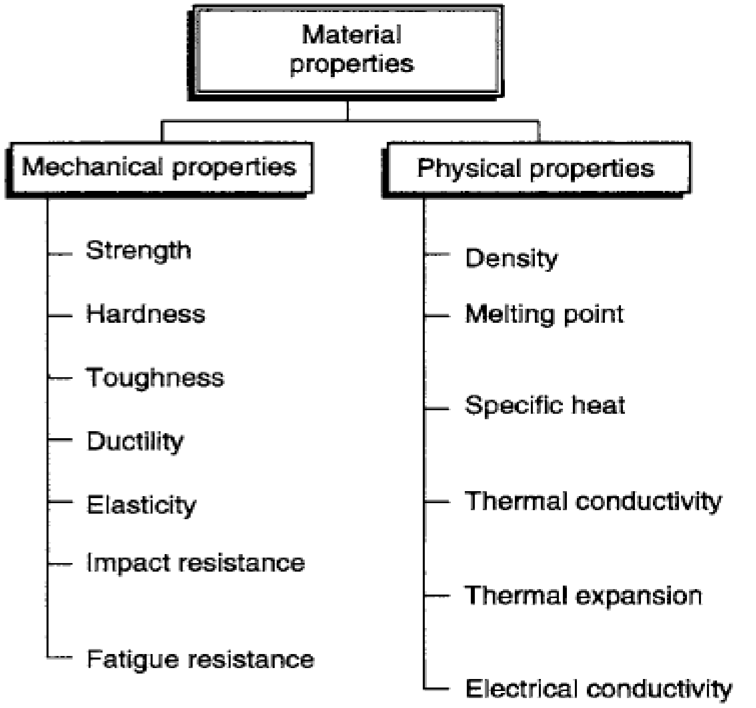


Figure 4.2 *General mechanical and physical material properties*

Material Evaluation and Process selection

Basic material properties:

Mechanical properties describe how a material reacts under applied loads.

Physical properties describe density and melting point.

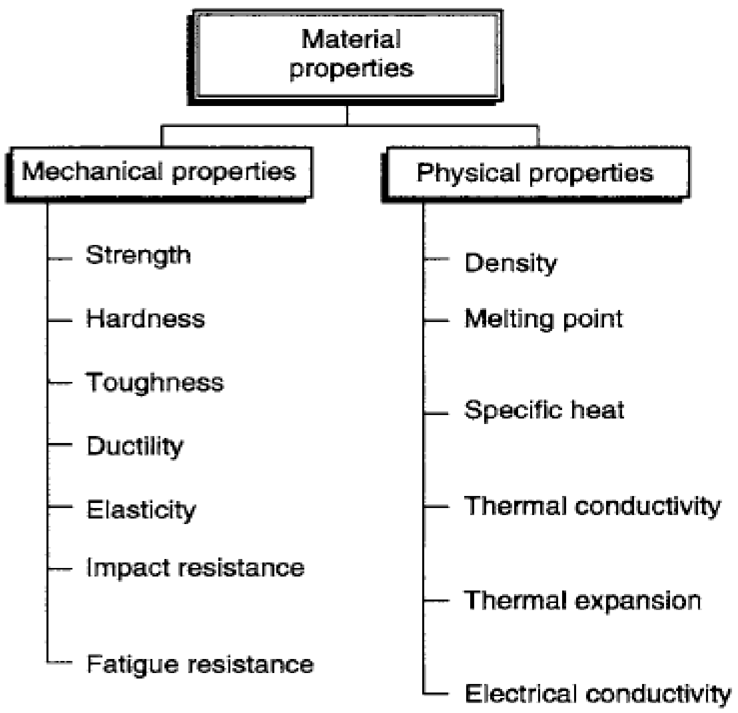


Figure 4.2 *General mechanical and physical material properties*

Production equipment and tooling selection

5.1 Introduction

5.2 Aims and objectives

5.3 Production equipment for specific processes

5.4 Factors in equipment selection

5.5 Machine selection method

5.6 Tooling for specific production equipment

5.7 **Factors in tooling selection**

5.8 Tooling selection method

5.9 Summary

Production equipment

manufacturing processes:

- **casting,**
- **shaping/forming,**
- **machining,**
- **joining and**
- **surface processes.**

Production equipment for specific processes:

Casting : expendable / permanent mould

Shaping/forming : bulk forming, sheet forming and powder processing.

Machining: all conventional, unconventional, CNC, etc.

Production equipment

Factors in equipment selection:

Technical factors
- *Physical size*
- *Machine accuracy*
- *Surface finish*
- *Cutting forces*
- *Power*

Operational factors
- *Batch size*
- *Capacity*
- *Availability*

Machine selection method:

- **First cut selection**
- **Power/force analysis**
- **Capability analysis**
- **Operational analysis**
- **Final selection**

Tooling selection

Tooling for specific production equipment:

- Tooling for casting, shaping and forming (Mould / Die)
- Tooling for machining (Work holding)

Factors in tooling selection:

There are six constraints must be considered in tool selection.

- Manufacturing practice (continuous or intermittent cutting)
- Manufacturing process
- Machine tool characteristics
- Capability
- Processing time
- Cutting tool availability

Tooling selection

Operating requirements for tool selection:

Workpiece material
Operation
Part geometry
Tooling data

Factors affecting tooling performance:

Cutting tool materials
Cutting tool geometry
Cutting fluids

Tooling selection method

1. Evaluation of process and machine selections-
   the range of tools that can be used
2. Analysis of machining operations-
   analysis enables identification of specific tool types for specific operations.
3. Analysis of workpiece characteristics –
   analysis of the first two enables suitable tool materials and geometry (in terms of size and shape).
   third allows the tool type and geometry to be refined further to suit the operations.
4. Tooling analysis-
   Using the tooling data available, will obviously reflect whatever tooling is actually available for the operations required.
5. Selection of tooling –
   clamping system toolholder type and size;
   insert shape insert size
   tool edge radius insert type
   tool material.

ME 16006

Process Planning and Cost Estimation

Course Outcome

CO1	The students can compare the various elements of cost and will be able to group those costs under various heads viz. Material Cost, Labour cost, Expenses and Overheads.
CO2	Given the product diagram or problem statement, the students can identify the elements of cost involved and can quote the manufacturing price of a product, thereby developing entrepreneur skills with himself.
CO3	The students can determine the machining time for any given components and for any machine tool.
CO4	The students can select the manufacturing process and develop the process planning sheet for any given product.

ME 16006 PP and CE

UNIT I	INTRODUCTION TO PROCESS PLANNING
UNIT II	PROCESS PLANNING ACTIVITIES
UNIT III	COSTING AND ESTIMATION
UNIT IV	PRODUCTION COST ESTIMATION
UNIT V	MACHINING COST ESTIMATION

UNIT 3 INTRODUCTION TO COST ESTIMATION

Syllabus:

Difference between costing and estimation – components of cost – elements of cost – Cost ladder – Types of estimates – Methods of Estimation – Computing labor cost, material cost and Product Price – allocation of over head charges – Calculation of depreciation – Break Even Analysis for optimum process selection.

Objective:

- To discuss about the various elements of cost, associated in manufacturing a component.
- To determine selling price of a component.

INTRODUCTION TO COST ESTIMATION

- Cost estimation : Definition, Importance, Objectives, Functions
- Qualities of Cost Estimator
- Cost Estimation Procedure
- Data required for cost estimation
- Elements / Constituents of Cost
- Components of Cost
- Allocation of Overheads – Methods
- Depreciation – Definition, causes, methods for calculation
- Break-even Analysis

- **ESTIMATION**

  computation of some quantity;

  the exact magnitude can not be determined.

- **COST ESTIMATION**

  estimation of the expected cost of producing a job before the actual production is taken up.

- **Importance**

  to compete in market

  whether profit or not

  over-estimating - increase cost

  under-estimate - heavy loss

COST ESTIMATION - Objectives

- to decide manufacturing / selling policy
- to submit tender
- to decide overheads amount
- to fix wage / salary
- to decide material purchase

COST ESTIMATION - Functions

- material cost
- labour cost
- tool / equipment cost
- overhead charge
- selling price
- conducting time / motion study
- selecting modern method / equipment
- recording for future reference

COST ESTIMATOR - Qualities

- to read & under stand drawings
- knowledge on m/c operations
- familiarize with tools, jigs, fixtures, etc.
- awareness on material and market price
- wage rates
- allowance
- cutting speed, feed, depth of cut
- Procedure to conduct time study / motion study

COST ESTIMATION - Procedure

1. decide requirement & specifications
2. plot drawings, decide Machine, Method
3. decide accuracy, finish required
4. prepare list of components of product
5. make or buy decision
6. determine material cost
7. determine time required
8. determine labour cost
9. determine prime cost (6 + 8)

COST ESTIMATION - Procedure

10. Determine Factory overhead (includes depreciation, maintenance)
11. determine administrative overhead
12. packing and delivery
13. Total cost
14. decide profit
15. Fix selling price

COST ACCOUNTING (or) COSTING

Systematic procedure of recording accurately every item of expenditure incurred on the manufacture of a product

Expenditure incurred on material, labour, machinery, production, inspection, etc.

Expenditures are recorded and summed-up to find the cost.

It differs from estimation. How?

COST ACCOUNTING	COST ESTIMATION
determination of **actual** cost of the product.	Calculation of **probable** cost of the product.
require account knowledge i.e **accountant**.	requires technical knowledge i.e **engineer**.
after the manufacture.	**before** the manufacture i.e forecast.
It tells about the profitability of a product after its manufacture.	It tells, whether is it profitable to produce or not.

Methods of Costing

1. Process Costing:

Standard product is being made / processed.

It involves many distinct processes.

Ex: processing industries (Oil, chemical, cement, flour, milk, paper, etc.)

Trace & record cost at each stage of processing / operation.

Methods of Costing

2. Job Costing:

Finding the cost of each individual job

Each job has to be planned & costed separately.

Ex: Ship building, house construction, rocket launching, road laying

3. Batch Costing:

A batch consist of many products / units.

Costing of a batch is calculated. Then, unit price will be ascertained by dividing no. of units.

TYPES OF COST ESTIMATES

1. Conceptual design
2. Factor method of Cost Estimation
3. Material Cost Method of Estimation
4. Function Method of Cost Estimation

TYPES OF COST ESTIMATES

1. Conceptual design:

only the functional requirements are considered by the designer using techniques such as solid modelling

rough magnitude of estimate can be obtained.

Geometry of parts and materials are not known at this stage.

accuracy of estimates are approximately – 30% to + 50%.

TYPES OF COST ESTIMATES

2. Factor method of Cost Estimation:

Estimated Cost

= Factor for total cost estimate x amount of major cost item

Ex: cost of road laying per km

cost of house construction per square

TYPES OF COST ESTIMATES

3. Material Cost Method of Estimation:

Predicts the total cost of the product based on the ratio of the material cost of the product to the material cost share of the total cost.

Estimated cost = (Material cost of the item) ÷ (Material cost share of item)

Ex: Material cost contribute 65% of car cost

If material cost is Rs.2.5lakhs,

cost of car = 2.5lakhs ÷ 0.65

= Rs.3.85lakhs

TYPES OF COST ESTIMATES

4. Function Method of Cost Estimation:

- more variables are used.
- Uses mathematical expression with constants and parameters
- Estimated cost of an item = $(G \times a) + (R \times c)$

  where G = Weight of the item, kg

  a = Material cost per kg

  R = Weight of material Removed, kg

  c = Cost per kg of material removed

Principal constituents of Cost

1. Design Cost: time taken to design x designer salary
2. Drafting Cost: drafting time x remuneration of draftsmen
3. R & D Cost: time and expenditure spent on experiments
4. Materials Cost: part weight x material price
5. Labour Cost: labour time required to produce x standard man-hour cost
6. Inspection Cost: expenditure spent on inspection equipments, quality person, etc.
7. Cost of Tools, Jigs & Fixtures
8. Overhead Cost

Elements of Cost

Cost of a product may be divided into three principal elements:

1. Materials: cost material for making a product

2. Labour: cost of remuneration of the employe

(wages, salary, commission, bonus)

3. Expenses: cost of services provided

Elements of Cost

1. Materials
    a. Direct Material: H.S.S bit for making turning tool
    b. In-direct Material: cotton waste, oil, grease, etc.

2. Labour
    a. Direct Labour
    b. In-direct Labour

3. Expenses
    a. Direct Expenses
    b. In-direct Expenses

Material Cost

Direct Material

Becomes a part of the product.

Consumed in the manufacturing

Can be charged directly.

Ex:

Purchased for a particular product

Material intended for further treatment

Packing materials

In-direct Material

Cannot be traced as part of product.

Required for maintaining & operating plant, equipment

Can not be a part of product.

Ex:

Lubricant

Cotton waste

Coolant

Determination of Material Cost

1. Study the drawing carefully and break-up the component into simple geometrical shapes. (Cube, Prism, Cylinder, etc.)

2. Add the necessary machining allowances on all sides which are to be machined.

3. Determine the volume of each part by applying the formulae.

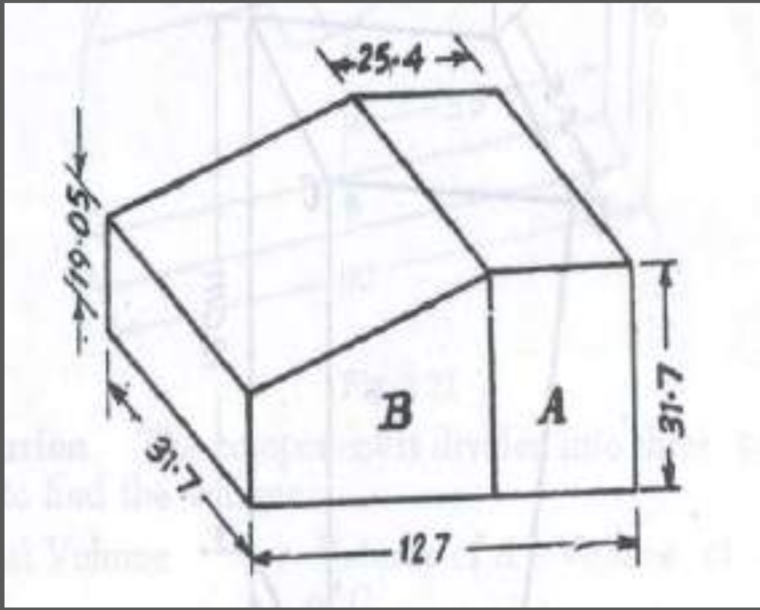
4. Add the volumes of all the simple components to get the total volume of the product.

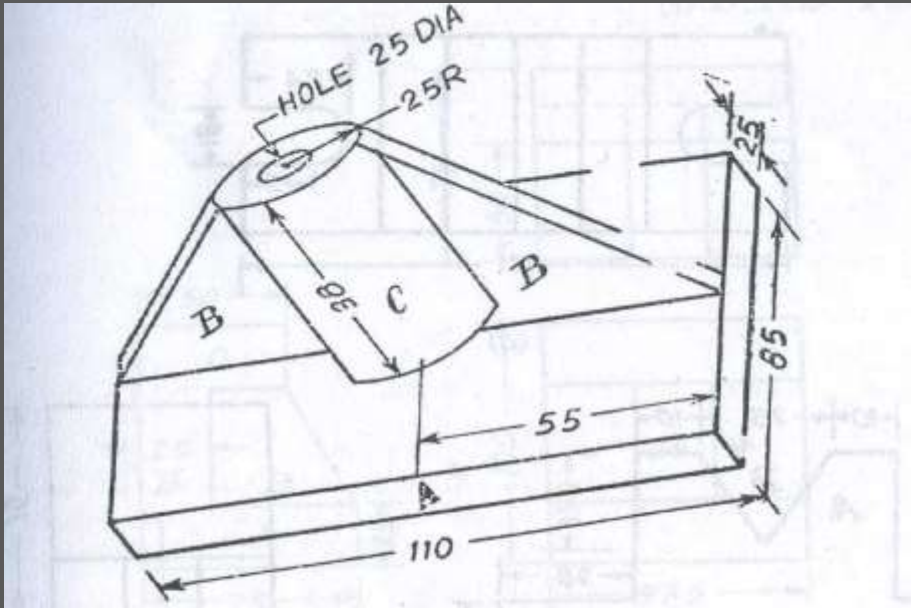
5. Multiply the total volume of the product by the density of the material to get the weight of the material.

6. Multiply the material cost per unit weight by the total weight of the component to find out the cost of the component

Determination of Material Cost

1. The wedge is to be made of 38.1mm dia. bar stock by forging. Calculate what length of bar shall be required if the volume of the material remains unchanged.

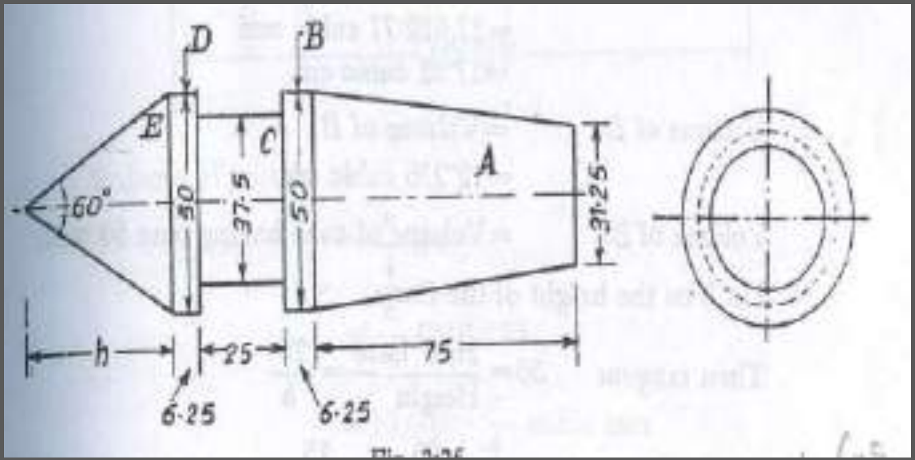


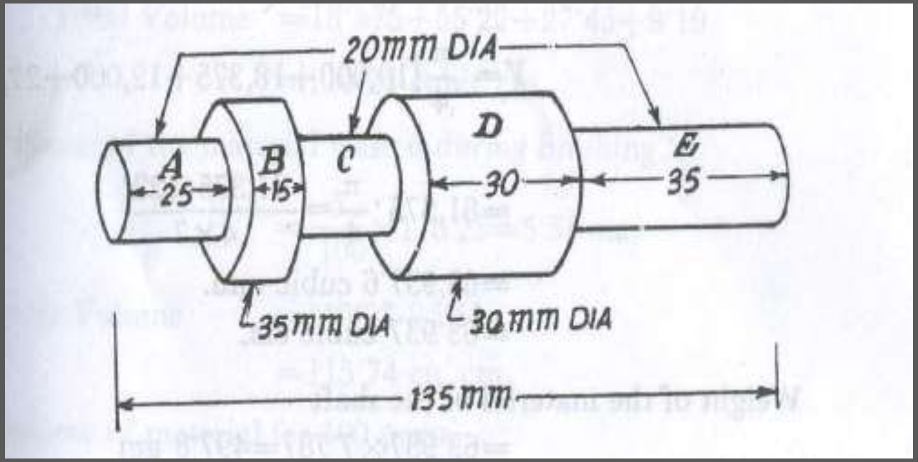


2. Find the material cost for finished component. The density is 8gm/cc and cost of material is Rs.24/kg.

Determination of Material Cost

3. Estimate the weight and cost of lathe centre if the density is 7.787gm/cc and the material cost is Rs.3.50/kg.



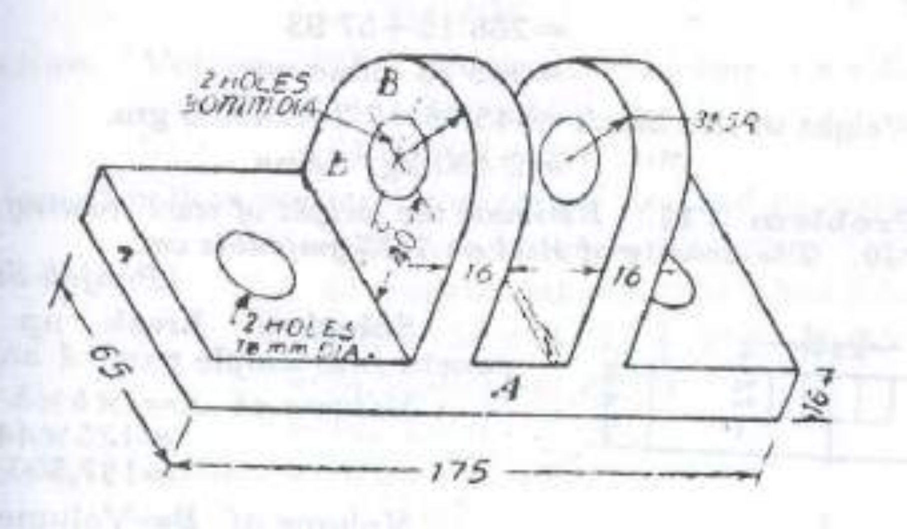


4. Estimate the weight of the shaft, if its density is 7.87gm/cc.

Determination of Material Cost

5. Calculate the volume and weight if the density is 7.2gm/cc.

   20% of the finished component required for the job is lost in various machining process.



Labour Cost

Direct Labour

Directly employed in manufacturing operation.

Wages charged directly to the job.

Ex:

welder,

turner,

electrician, etc.

In-direct Labour

Non-productive staff engaged upon general services connected with the running of a factory as a whole.

Labour who helps the productive labours in performing their duties.

Ex:

Foreman

Supervisor

Store-keeper, drivers, etc.

Determination of Labour Cost

1. To find out the labour cost, one must have the knowledge on
    1. Operation time calculation
    2. Rate per hour of different operation

To calculate the operation time, consider

1. Set-up time: time required for setting-up & fixing job, tool, equipment, etc.
2. Operation time: time necessary to perform all the operation. It includes all physical movements.
3. Tear down time: time taken to remove job, tools, other accessories from the m/c. (<= set-up time).
4. Allowances: Time required by the operator to take rest, tool sharpening, inspection, personal need, etc.

Expenses

Direct Expenses

Except direct material & labour cost, all other expenditures.

Can be charged directly to job.

Ex:

- Jigs & Fixtures
- Pattern
- Design & drawing
- Mould, die

In-direct Expenses

Overhead charges, burden or on-cost.

Can not be charges directly to job cost unit.

Sum of indirect material, indirect labour, other expenses.

Ex:

- Factory expenses
- Administrative expenses
- Selling expenses
- Distribution expenses

In-direct Expenses

1. Factory Expenses

(Factory on-cost / production overhead / factory overhead / works on-cost / works overhead)

Rent, insurance for building

Supervisor, manager salary

Consumables like grease, oil.

Depreciation: plant, m/c

Power: steam, gas, etc.

2. Administrative Expenses

Managerial & administrative related expenditure.

Director salary

Office staff salary

Amenities like phone, printer.

Meeting, travelling expenses

Electrical consumption

Stationery

Office building insurance

In-direct Expenses

3. Selling Expenses

Expenditure spent towards securing orders, retaining market.

Advertising, publicity

Sales manager, staff salary

Sales person travelling

Tender preparation

Sales stock

Broucher / posters

4. Distribution Expenses

Expenses paid for distribution of product.

Finished stock storage

Packing charges

Loading / unloading

Freight charges

Vehicle, transport charges

Dispatch person salary

Components of Cost

Prime Cost = Direct Material Cost + Direct Labour Cost + Direct Expenses

Factory Cost = Prime Cost + Factory on-cost

Production Cost = Factory Cost + Administrative Expenses

Total Cost = Production Cost + Selling Expenses + DistributionExpense

Selling Price = Total Cost + Profit

Market (or) Catalogue Price = Selling Price + Discount given to distributors

Example 2 : From the following data, find out prime cost, Works/factory cost, production cost, total cost and selling price. Assume a net profit of Rs.10,000.

1. Value of stock of material as on 1-04-2003	60,000
2. New Material purchased	2,50,000
3. Director's Fee	3,500
4. Advertising	12,000
5. Depreciation on sales dept. car	1,200
6. Printing and stationery charges	300
7. Depreciation on plant equipment	5,000
8. Wages of direct workers	70,000
9. Wages of in-direct workers	10,000
10. Rent for factory building	5,000
11. Postage, telephone	200
12. Water, electricity for factory	1,000
13. Office salaries	2,000
14. Rent of the Office	500
15. Rent of the show room	1,500
16. Salesman commission	2,500
17. Sales dept. car expenses	1,500
18. Material in hand (March 31, 2004)	50,000
19. Variable direct expenses	750
20. Plant repair and maintenance	3,000
21. Lighting for office use	2,500
22. Cost of distributing goods	2,000

Example 2 : From the following data, find out prime cost, Works/factory cost, production cost, total cost and selling price. Assume a net profit of Rs.10,000.

1. Value of stock of material as on 1-04-2003	op. stock
2. New Material purchased	
3. Director's Fee	Admin Overhead
4. Advertising	Selling overhead
5. Depreciation on sales dept. car	Selling overhead
6. Printing and stationery charges	admin overhead
7. Depreciation on plant equipment	Fact overhead
8. Wages of direct workers	
9. Wages of in-direct workers	Fact overhead
10. Rent for factory building	Fact overhead
11. Postage, telephone	admin overhead
12. Water, electricity for factory	Fact overhead
13. Office salaries	admin overhead
14. Rent of the Office	admin overhead
15. Rent of the show room	selling overhead
16. Salesman commission	selling overhead
17. Sales dept. car expenses	selling overhead
18. Material in hand (March 31, 2004)	
19. Variable direct expenses	
20. Plant repair and maintenance	fact. overhead
21. Lighting for office use	admin overhead
22. Cost of distributing goods	selling overhead

Material Cost = 60,000 - 50,000 + 2,50,000
2,60,000

Prime Cost = 2,60,000 + 70,000 + 750
= 3,30,750

Factory Cost = 3,30,750 + 5,000 + 10,000 + 5,000 +
1,000 + 3,000 = 3,54,750

Production Cost = 3,54,750 + 3,500 + 300 + 200 +
500 + 2,500 = 3,63,750

Total Cost = 3,63,750 + 12,000 + 1,200 + 1,500 +
2,500 + 1,500 + 2,000 = 3,84,450

Selling Price = 3,84,450 + 10,000 = 3,94,450

Example 3 : Calculate the selling price per unit.

Direct material cost	= Rs. 8,000
Direct labour cost	= 60 % of direct material cost
Direct expenses	= 5 % of direct labour cost
Factory expenses	= 120% of direct labour cost
Administrative expenses	= 80% of direct labour cost
Sales & distribution expenses	= 10% of direct labour cost
Profit	= 8 % of total cost
No. of pieces produced	= 200

Example 4 :

A factory is producing 1000 fasteners/hour on a machine.

material cost =	Rs. 375
labour cost =	Rs. 245
direct expense =	Rs. 80.
factory on-cost =	150% of the total labour cost
office on-cost =	30 % of the factory cost.

selling price of each fastener is Rs. 1.30

calculate whether there is loss or gain and by what amount ?

Example 5 :

A certain product is manufactured in batches of 100.

direct material cost =		Rs. 50
direct labour cost =		Rs. 80
factory overhead charges =		Rs. 65.
selling expenses	=	45 % of factory cost

what should be selling price of each product so that the profit is 10 % of the total cost ?

Example 6 :

A factory owner employed 50 workers during the month of November 2004.

(i) Material cost =	Rs. 30,000
(ii) Worker wage rate =	Rs. 6 per hour
(iii) Duration of work =	8 hours per day
(iv) No. of holidays/month =	5
(v) Total overhead expenses =	Rs. 15,000

If the workers were paid over time of 400 hours at the rate of Rs. 12 per hour, calculate

(a) Total cost, and

(b) Man hour rate of overheads.

Example 7 :

catalogue price = Rs. 1,050

Distributor’s discount = 20 percent.

Data collected shows that the selling price and factory cost are equal.

The relation between material cost, labour cost and factory on-cost are in the ratio 1 : 2 : 3.

If the labour cost is Rs. 200, what profit is being made on the gadget ?

Allocation of Overhead

It is defined as Cost of

- Indirect Material, Indirect Labour & Indirect Expenses

- operating cost of a business which cannot be traced directly to a particular unit of output.

Methods for allocating overheads:

1. Percentage of DLC
2. Percentage of DMC
3. Percentage on Prime Cost
4. Man-Hour Rate
5. Machine-Hour Rate
6. Production Unit Rate method
7. Combination of Man-hour and Machine hour Rate

Methods of allocation of Overhead

1. Percentage of DLC = $\dfrac{\text{Total overheads}}{\text{DLC}} \times 100$

2. Percentage of DMC = $\dfrac{\text{Total overheads}}{\text{DMC}} \times 100$

3. Percentage of PC = $\dfrac{\text{Total overheads}}{\text{PC}} \times 100$

1. Percentage on Direct Labour Cost

Factory overheads of a certain concern were Rs.8.0 lacs and total direct wages paid to the labour during the above period were Rs.32.0 lacs, find out the percentage on-cost by percentage on direct labour cost method.

$$\text{Percentage of DLC} = \frac{\text{Total overheads}}{\text{DLC}} \times 100$$

2. Percentage on Direct Material Cost

A foundry department producing water meter body had Rs.5.0 lacs as total overheads while the material cost was Rs.25.0 lacs. Calculate the percentage on-cost.

$$\text{Percentage on-cost} = \frac{\text{Total overheads}}{\text{DMC}} \times 100$$

3. Percentage on Prime Cost

A factory has total overheads of Rs.6 lacs, while the prime cost is Rs.10.0 lacs. Find out the on-cost of twp products by percentage on prime cost method.

If product first has Rs.100 as direct material and Rs.200 as direct labour cost, while product second has Rs.150 as direct labour and Rs.150 as direct material cost.

$$\text{Percentage on-cost} = \frac{\text{Total overheads}}{\text{PC}} \times 100$$

Methods of allocation of Overhead

4. Man-hour rate = $\dfrac{\text{Total overheads}}{\text{Total man-hour spent}} \times 100$

5. Machine-hour rate = $\dfrac{\text{Total overheads}}{\text{Total productive m/c hr}} \times 100$

6. Overheads/unit = $\dfrac{\text{Total overheads}}{\text{Total production qty}} \times 100$

4. Man-hour rate method

Example 3.4. *A factory produces two components A and B. Component A requires 20 hours and is manufactured by the workers paid at the rate of Rs. 10.00 per hour, while component B also requires 20 hours but the workers producing it are paid at the rate of Rs. 7.5 per hour. Find out the on-cost of each component, if (i) it is 40% of the direct labour cost, (ii) Rs. 2.00 per man hour.*

$$\text{Man-hour rate} = \frac{\text{Total overheads}}{\text{Total man-hour spent}} \times 100$$

5. Machine-hour rate method

Example 3.5. *A factory has 15 lathes of same make and capacity and 5 shapers of same make and capacity. Lathes occupy 30 m^2 area while shapers occupy 15 m^2 area. During one calender year, factory expenses for this section are as follows :*

			Rs.
(i)	*Building rent and depreciation*		5,000
(ii)	*Indirect labour and material*		15,000
(iii)	*Insurance*		2,000
(iv)	*Depreciation charges of lathes*	5,000	
(v)	*Depreciation charges of shapers*		3,000
(vi)	*Power consumption for the lathes*		2,000
(vii)	*Power consumption for the shapers*		1,000

Find out the machine hour rate for lathe and shapers, if all the lathes and shapers work for 25,000 hours and 8,000 hours respectively.

$$\text{Machine-hour rate} = \frac{\text{Total overheads}}{\text{Total productive m/c hr}} \times 100$$

6. Unit Rate Method

A manufacturing concern produces 5000 machines per year, if the overheads during that year are Rs.800,000 calculate the overhead cost on each machine.

$$\text{Overheads/unit} = \frac{\text{Total overheads}}{\text{Total production qty}} \times 100$$

Depreciation

Definition & concept

Causes of Depreciation

- Physical causes
- Usage
- Abnormal occurrences
- Technological changes

Depreciation

Methods of calculating Depreciation

1. Straight line method
2. Reducing balance method
3. Unit production method
4. Annuity method
5. Sinking fund method
6. Sum of the digits method

Depreciation - Straight line method

Let

C = Total original cost (original cost + installation / erection cost)

S = Scrap / salvage / residual value at the end of life

N = no. of years , assumed useful life

$$\text{Depreciation fund at the end of every year (D)} = \frac{C - S}{N}$$

Note: This method does not take into account the maintenance / repair charges which gradually increase.

Depreciation – 1. Straight line method

A m/c was purchased for Rs.20, 000. The assumed scrap value at the end of 15 years of assumed useful life of the m/c was Rs.8,000. Determine the depreciation fund accrued at the end of 4 years of its useful service.

C = Total original cost (original cost + installation / erection cost)

S = Scrap / salvage / residual value at the end of life

N = no. of years , assumed useful life

$$\text{Depreciation fund at the end of every year (D)} = \frac{C - S}{N}$$

Depreciation fund accrued at the end 4th year (D_4) = D x 4

Depreciation – 2. Reducing balance method

Depreciation is fixed as percentage rate of book value at the beginning of the year.

Cost of the asset = Rs.20,000

Book value of the asset at beginning of 1st year = Rs.20,000

depreciation rate (X) = 10%

depreciation fund at the end of 1st year = Rs.2,000

Book value of the asset at beginning of 2nd year = Rs.18,000

depreciation fund at the end of 2nd year = 10% of Rs.18,000

= Rs.1,800

Fixed percentage by which the value of the machine is reducing every year $X = 1 - \left(\frac{S}{C}\right)^{1/N}$

Depreciation – 3. Diminishing Balance method

A milling m/c is purchased for Rs.12,000 and the expenses incurred on its installation are Rs.500. The assumed serviceable period and salvage value are 12 years and Rs.2,000 respectively.

By diminishing balance method, determine the fixed percentage by which the cost of the m/c is reducing every year.

Also, determine the depreciation fund after 2years 6months.

14.16%

D1= Rs.1,770

D2,6= Rs.3,289.37

Depreciation – 4. Sum of Years' Digits method

Depreciation fund is written off every year in reduced amounts.

$$\text{Fraction} = \frac{\text{numerator}}{\text{denominator}} = \frac{\text{effective life of an asset taken in reverse order}}{\text{sum of the years of the effective life of the asset}}$$

Depreciation fund = (Total depreciation fund) x (Fraction)

Depreciation – Sum of Years' Digits method

Example:

A machine is purchased for Rs.10,000 and its scrap value is estimated as Rs.2,000 after 6 years of useful service. Determine the depreciation fund, in reverse, at the end of the 4^{th} year based on the sum of years' digits method.

Depreciation – 5. Sinking Fund method

Company's annual profit is invested aside in readily saleable securities. When the life of the asset expires, securities are sold and new asset is purchased.

Securities earn some interest.

C = Total original cost (original cost + installation / erection cost)

S = Scrap / salvage / residual value at the end of life

N = no. of years , assumed useful life

R = rate of interest on accumulating fund

Depreciation fund to be set aside (D) at the end of every year

$$D = \frac{(C - S)\,R}{(1 + R)^N - 1}$$

Depreciation – Sinking Fund method

Example:

A machine is purchased for Rs.49,000 and its erection and installation expenses are Rs.1,000. The effective life of the m/c is estimated as 15 years and its salvage value as Rs.15,000.

If the rate of interest on the invested depreciation fund is 5%, compute the rate of depreciation by sinking method.

Break-even Analysis

Break Even Point (BEP):

- It represents the production quantity for which the total cost of producing the goods equals the total sales price.
- At break-even point there will be neither any profit nor any loss to the manufacturer.

Q = Quantity at BEP

F = Fixed costs

V = Variable cost per unit produced

S = Selling price per unit

Then $F + (Q \times V) = S \times Q$

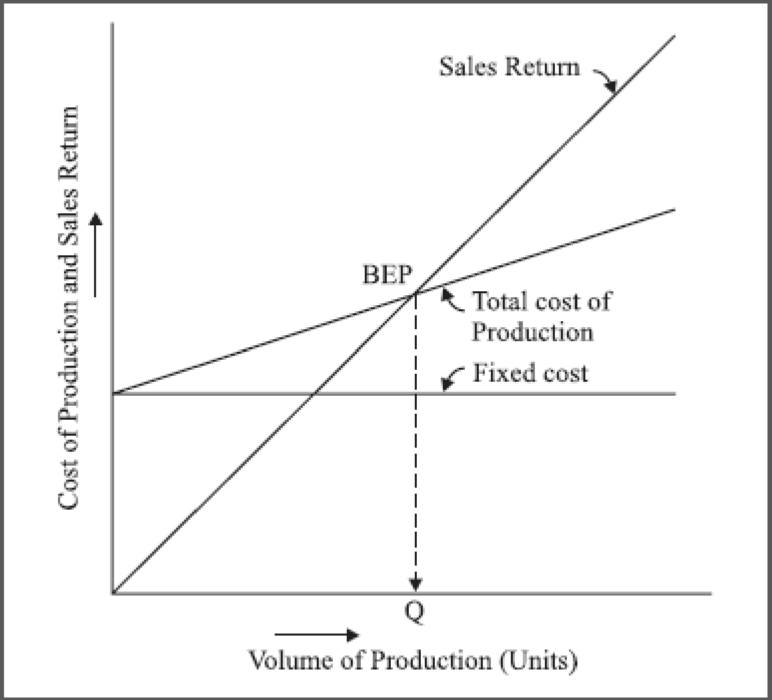
$$Q = \frac{F}{S - V}$$

Break-even Analysis

Break-even chart is a graphical representation of inter-relationship between quantity produced, cost of producing and sales return.

The total cost of production (fixed cost + variable cost) and total sales return are plotted against quantity produced.

The intersection of the total cost and total sales return lines gives the break-even point.



Break-even Point

Break Even Point:

Total sales revenue = Total expenses

Point at which no profit, no loss occurs.

In Graphical representation,

the intersection point of Total sales revenue line & Total cost line

Breakeven Chart

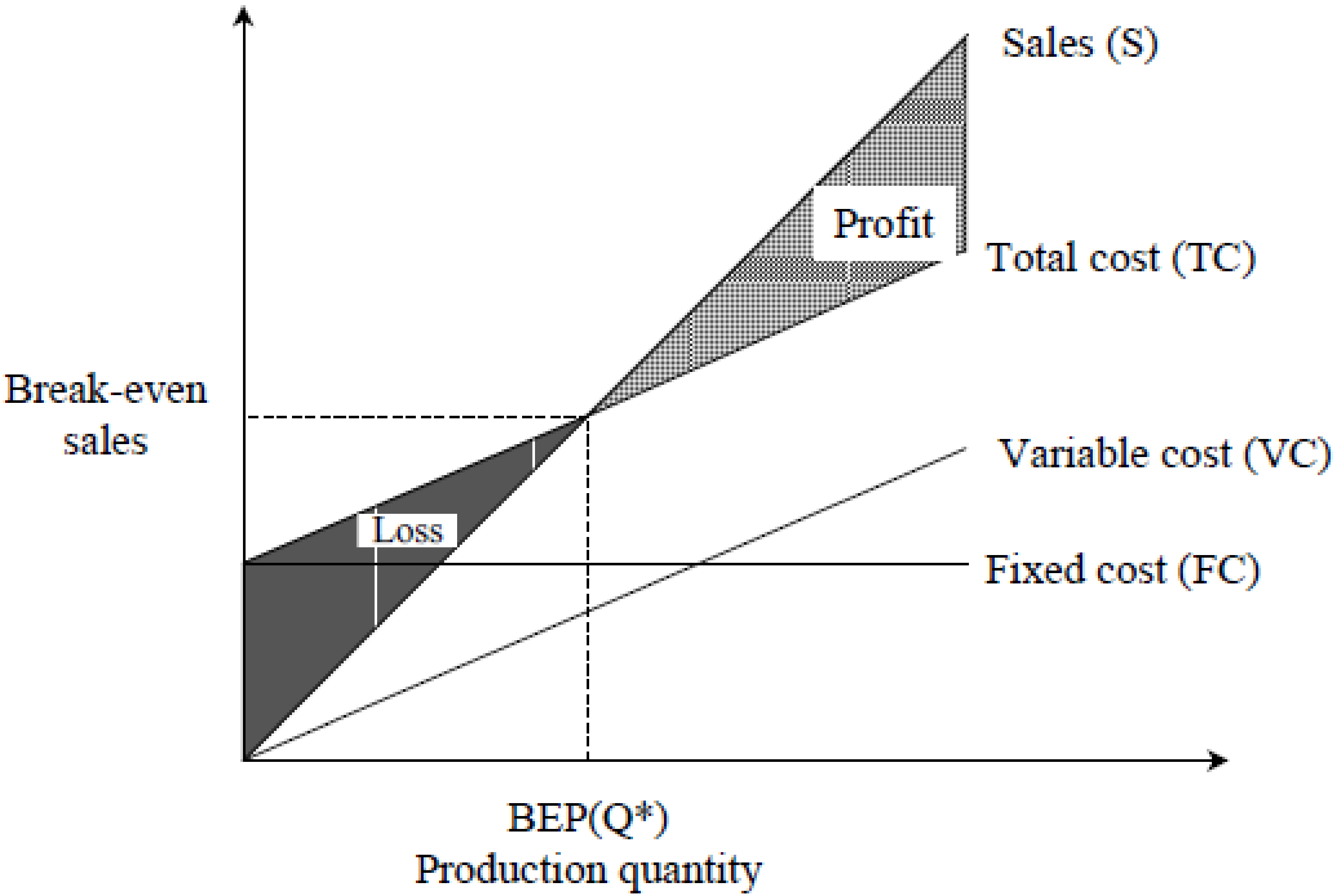


Fig. 1.3 Break-even chart.

Break-even Point

- If the production qty < the break-even qty:

  Total expense is more than total revenue. Hence, the firm will be making **LOSS**.

- If the prodn. qty is more than the break-even qty:

  Total revenue is more than total expenses. Hence, the firm will be making **PROFIT**.

Breakeven Chart

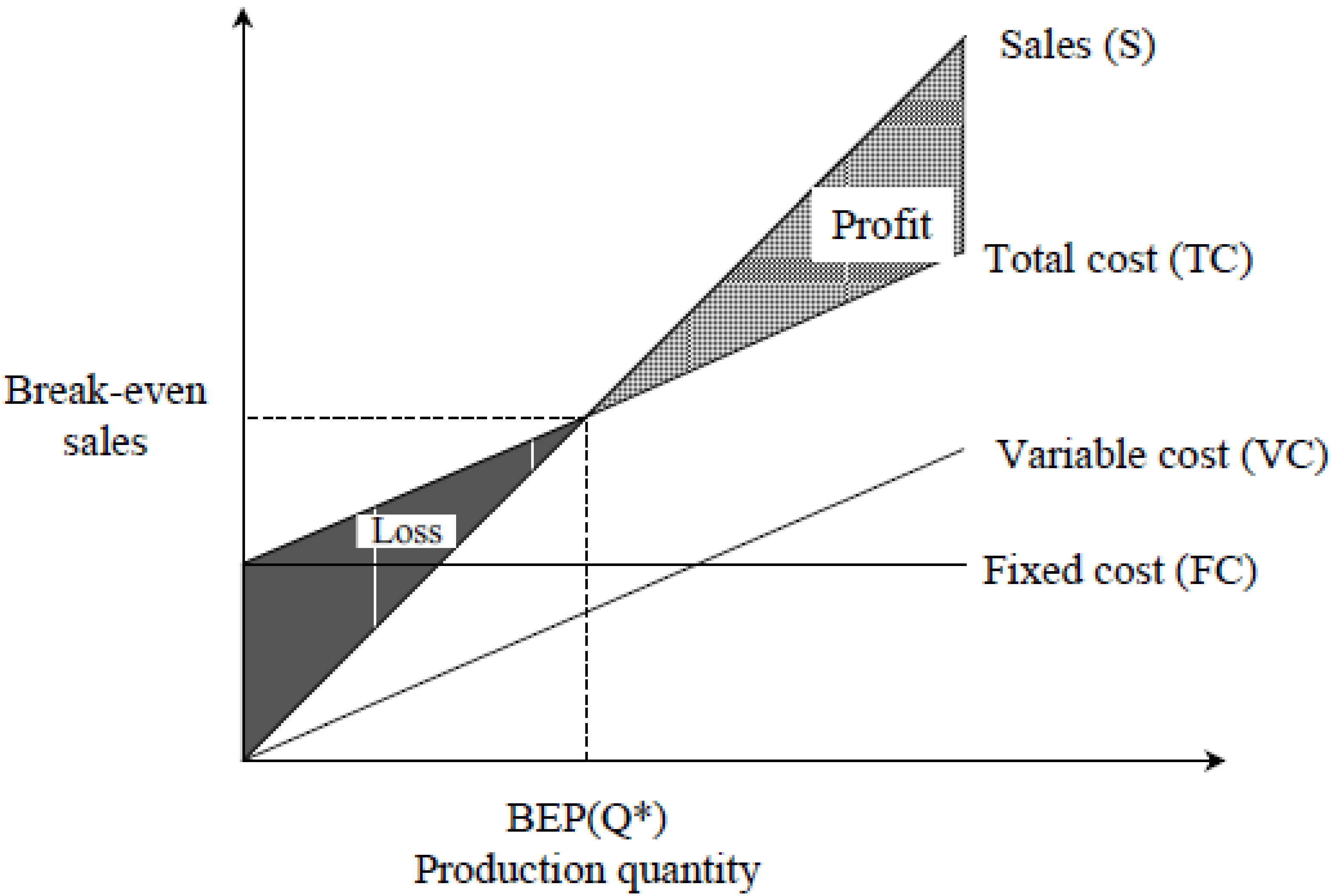


Fig. 1.3 Break-even chart.

Break-even Analysis

Let s = selling price per unit; v = variable cost per unit

FC = fixed cost per period; Q = volume of production

1. Total sales revenue (S) = s x Q

2. Total cost (TC) = Total variable cost + Fixed Cost

   = (v x Q) + FC

3. Profit = Total Sales Revenue – Total Cost

   = *s x Q – (FC + v x Q)*

4. Break-even quantity (BEQ) =

$$\frac{\text{Fixed cost (FC)}}{\text{Selling price/unit (s)} - \text{Variable cost/unit (v)}}$$

5. Break-even sales = BEQ x Selling price/unit

6. Contribution = Sales – Variable costs

7. Margin of Safety = Actual sales – Break-even sales

$$= \frac{\text{Profit}}{\text{Contribution}} \times \text{sales}$$

Break Even Analysis: Problem 1

Alpha Associates has the following details:

Fixed cost	= Rs. 20,00,000
Variable cost per unit	= Rs. 100
Selling price per unit	= Rs. 200

Find

(a) The break-even sales quantity,

(b) The break-even sales

(c) If the actual production quantity is 60,000, find

(i) contribution; and

(ii) margin of safety by all methods.

Break Even Analysis: Solution for Q1

$$\text{(a) Break-even quantity} = \frac{FC}{s - v} = \frac{20{,}000{,}00}{200 - 100}$$

$$= 20{,}00{,}000/100$$

$$= 20{,}000 \text{ units}$$

$$\text{(b) Break-even sales} = \frac{FC}{s - v} \times s = \frac{20{,}000{,}00}{200 - 100} \times \text{Rs.}200$$

$$= 40{,}000{,}000$$

Break Even Analysis: Solution for Q1

(c) (i) Contribution = Sales – Variable cost
= (*s x Q) – (v x Q)*
= (200 x 60,000) – (100 x 60,000)
= 1,20,00,000 – 60,00,000
= Rs. 60,00,000

(c) (ii) Margin of Safety = Sales – Break-even sales
= (200 x 60,000) – (200 x 20,000)
= 1,20,00,000 – 40,00,000
= Rs. 80,00,000

ME 16006

Process Planning and Cost Estimation

Course Outcome

CO1	The students can compare the various elements of cost and will be able to group those costs under various heads viz. Material Cost, Labour cost, Expenses and Overheads.
CO2	Given the product diagram or problem statement, the students can identify the elements of cost involved and can quote the manufacturing price of a product, thereby developing entrepreneur skills with himself.
CO3	The students can determine the machining time for any given components and for any machine tool.
CO4	The students can select the manufacturing process and develop the process planning sheet for any given product.

ME 16006 PP and CE

UNIT I	INTRODUCTION TO PROCESS PLANNING
UNIT II	PROCESS PLANNING ACTIVITIES
UNIT III	INTRODUCTION TO COST ESTIMATION
UNIT IV	PRODUCTION COST ESTIMATION
UNIT V	MACHINING TIME CALCULATION

UNIT 4 PRODUCTION COST ESTIMATION

Syllabus:

Losses in forging, Estimation of Forging Cost – Estimation of cost for Gas cutting, Arc Welding and Gas Welding – Estimation in Foundry Shop, pattern cost, casting cost - Estimation in sheet metal shop.

UNIT 4 PRODUCTION COST ESTIMATION

After studying this unit, the student should be able to

1. know how cost estimation is done in respect of forging, welding, casting and sheet metal work.

2. List the various sections in forging shop, foundry shop, welding shop and sheet metal ahop.

3. List the various elements of cost involved in respect of a forged, cast, welded and fabricated component.

4. List the various losses that occur in the material during forging process.

Forging

- Introduction
- Process of Forging
- Forging Operations
- Forging Losses

Process of Forging

- Change the shape of solid metal into desired mechanical component by taking advantage of some mechanical properties like ductility, plasticity, etc.
- Ductility: ability to drawn out
- Plasticity: ability to deform in all direction
- Size of the stock can be brought to desired shape by manually or hammer or press. This method is forging.
- The place in which it is performed is forging shop.

Methods of Forging

1. Smith forging :

component is made by hammering the heated material on an anvil. The hammering may be done by hand or machine.

2. Drop forging :

impressions on a pair of die blocks. The upper half of t he die is raised and allowed to drop on the heated metal placed over the lower half of the die. The metal is thus squeezed into required shape.

3. Press forging :

metal is squeezed into desired shape in dies using presses. Instead of rapid impact blows of hammer, pressure is applied slowly. This method is used for producing accurate forgings.

Methods of Forging

4. Machine forging or Upset forging :

the metal is shaped by making it to flow at right angles to the normal axis. The heated bar stock is held between two dies and the protruding end is hammered using another die. In upset forging the cross-section of the metal is increased with a corresponding reduction in its length.

5. Roll forging :

Roll forging is used to draw out sections of bar stock, *i.e., reducing the* cross-section and increasing the length. Special roll forging machines, with dies of decreasing cross-section are used for roll forging.

Forging Operations

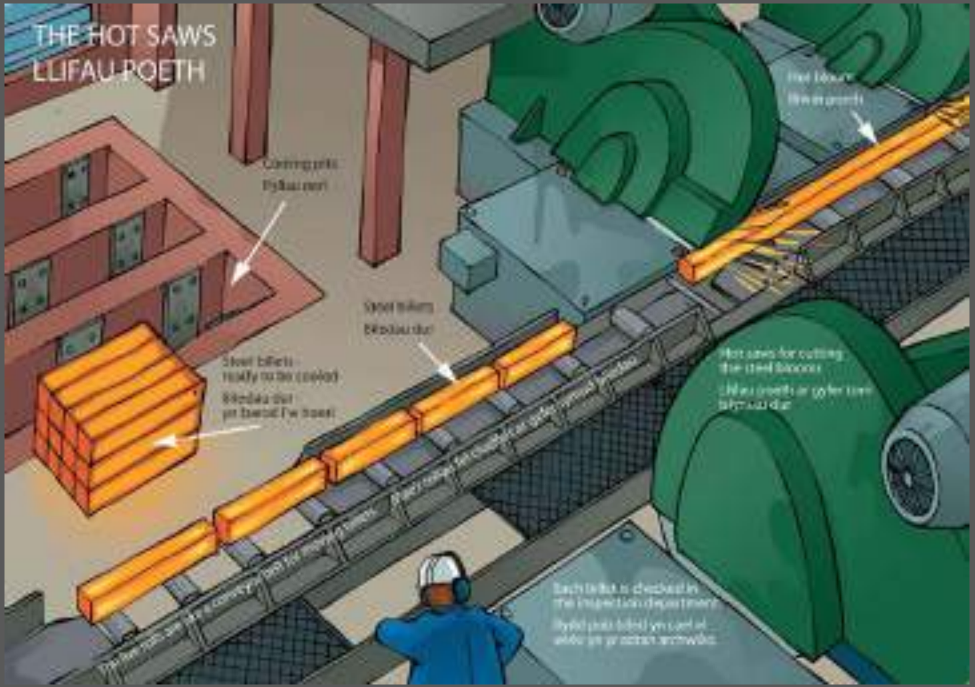
- **Upsetting:** heating bar & apply pressure axially, at the two ends (cross section increases)
- **Drawing-out:** heating bar & apply pressure in transverse direction (length increases)
- **Setting-down:** process of forming a neck (thinning down)
- **Bending:** holding between two fixtures and striking with hammer (bend)
- **Punching:** producing holes with punch
- **Drifting:** increasing dia of punched hole with drift
- **Squeezing:** bringing in desired shape in dies.

Losses in Forging

1. Shear loss :

Blanks are cut from billets or long bars.

Material equal to the product of thickness of sawing blade and cross-section of bar is lost for each cut.



Small piece left-out at the end also going as waste.

Shear loss is generally taken as **5 percent of net weight.**

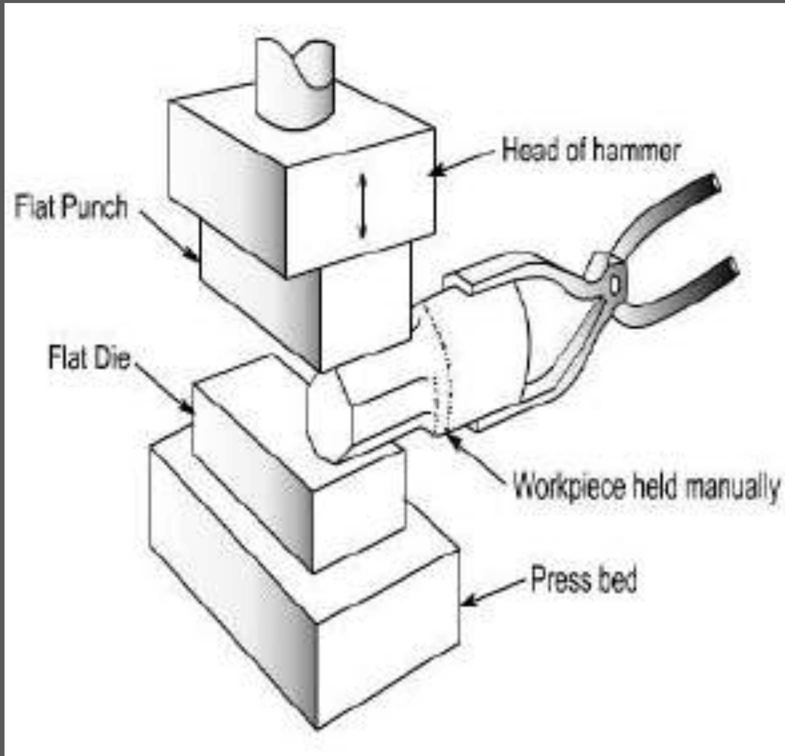
Losses in Forging

2. Tonghold loss :

Drop forging operations are performed by holding the stock at one end with the help of tongs.

A small length, about 2.0 – 2.5 cm and equal to diameter of stock is added to the stock for holding.

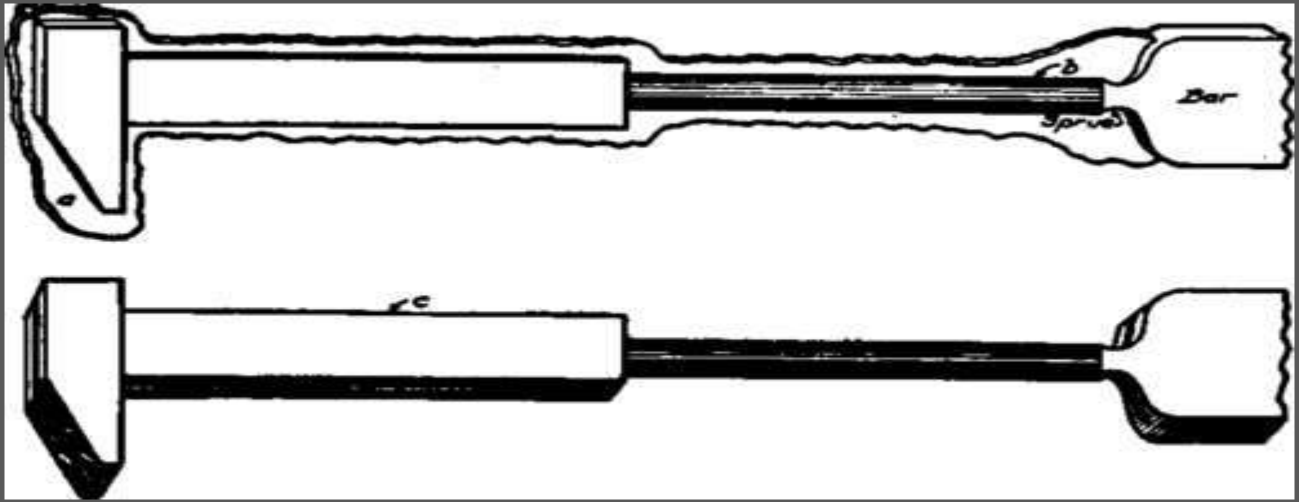
Tonghold loss
= Area of X-section of bar × Length of tonghold



Losses in Forging

3. Scale loss :

As the forging process is performed at very high temperature, the Oxygen from air forms iron oxide by reacting with hot surface.
This iron oxide forms a thin film called scale, and falls off from surface at each stroke of hammer.
Scale loss is taken as **6 percent of net weight.**



Losses in Forging

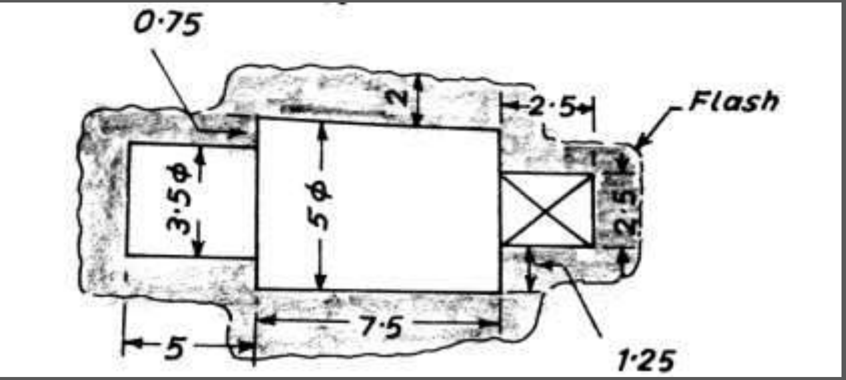
4. Flash loss :

some metal comes out of the die at the parting line of the top and bottom halves of the die. This extra metal is called flash.

Flash = 20 mm wide x 3 mm thick.

Volume of flash = Circumference of component at parting line x cross-sectional area of flash

Weight of flash loss = volume of flash x density of the material



Losses in Forging

5. Sprue loss :

When the component is forged by holding the stock with tongs, the tonghold and metal in the die are connected by a portion of metal called the sprue or runner.

This is cut off when product is completed.

Sprue loss is taken as **7 percent of net weight.**

Introduction - Forging

Estimation of forging time is divided into two category:

1. time taken for heating the job upto required temp.

2. time taken for performing forging opeartion to get required shape.

Estimation of Cost of Forgings

The cost of a forged component consists of following elements :

1. Cost of direct materials.

2. Cost of direct labour.

3. Direct expenses such as cost of die, cost of press.

4. Overheads.

Estimation of Cost of Forgings

1. Cost of Direct Material:

a. Calculate the net weight of forged component

Net weight = Volume of forging × Density of material

b. Calculate the gross weight

Gross weight = Net weigt + Material loss in the process

c. Diameter and length of stock

$$\text{Length of stock} = \frac{\text{Gross weight}}{\text{Cross sectional area of stock} \times \text{Density of material}}$$

Direct material cost = Gross weight × Price per kg

Estimation of Cost of Forgings

2. Cost of Direct Labour:

Direct labour cost = *t* × *l*

t = time for forging per piece (in hours)
l = labour rate / hour

3. Direct Expenses:

It includes the expenditure incurred on

- dies and other equipment,
- utilisation of machines,
- consumables

which can be directly identified with a particular product.

Estimation of Cost of Forgings

4. Overheads:

It includes

- supervisory charges,
- depreciation of plant and machinery,
- consumables,
- power and lighting charges,
- office expenses etc.

The overheads are generally expressed as percentage of direct labour cost.

Total cost of forging = 1 + 2 + 3 + 4

Forging Cost Calculation – Problem-1

Two hundred pieces of the bolt are to be made by upsetting from 25mm diameter.

What is the length of each bolt before upsetting?

What length of the rod is required if 3.5% of the length goes as scrap?

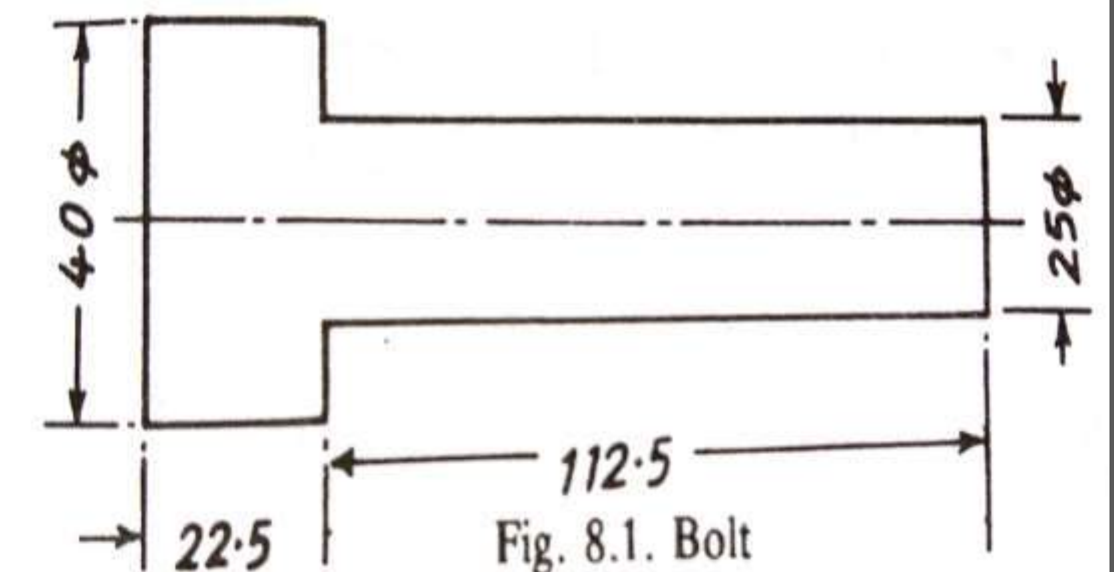


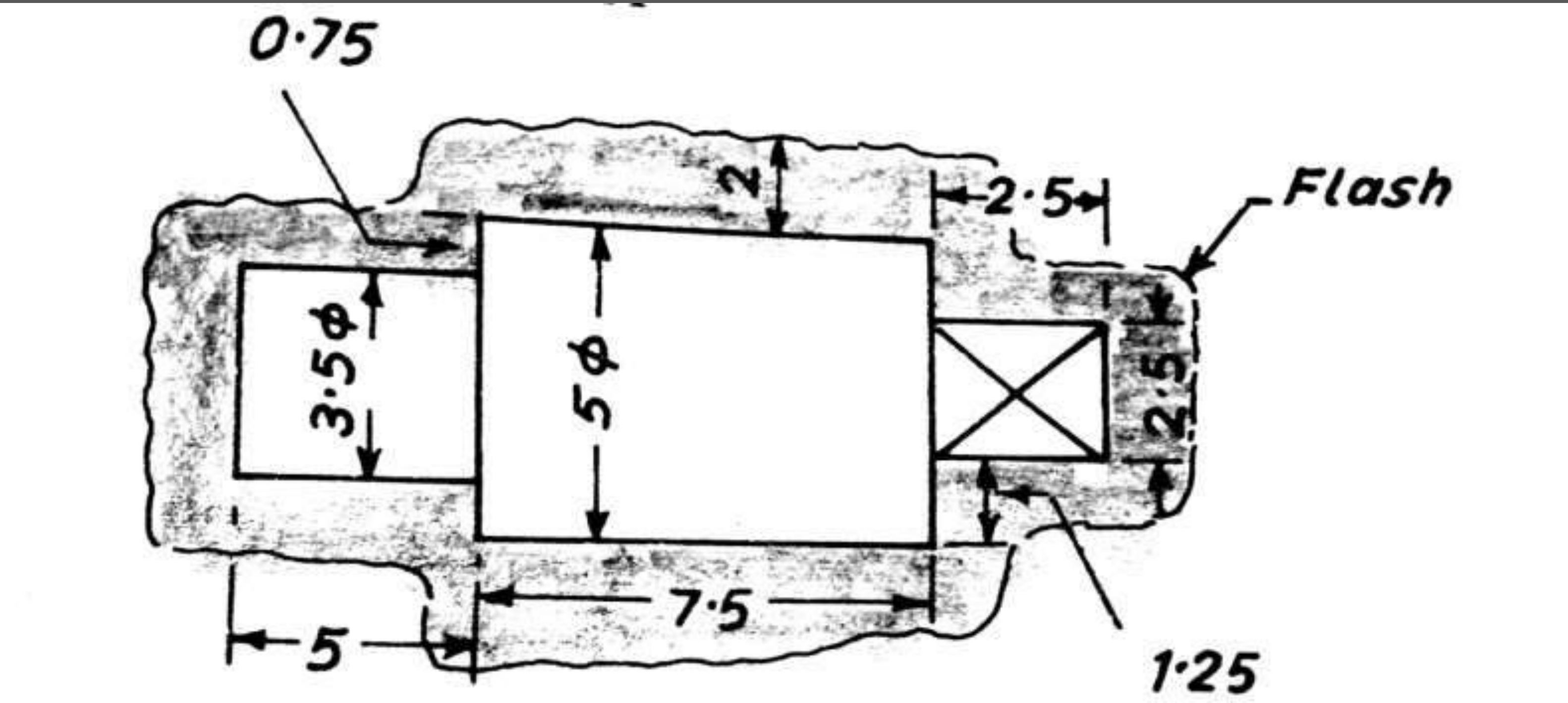
Fig. 8.1. Bolt
(All dimensions are in mm)

Forging Cost Calculation – Problem-1

1. Volume of the head:	$= (\pi/4) * D^2 * L$
2. Length of the bar needed for making the head	= (Volume / Area of raw stock) $= 1 / (\pi/4) * d^2$
3. Total length needed for one bolt	= 2 + shank length
4. Length required for making 200 bolts	= (3 * 200)
5. Consider loss as 3.5%	= 4 * 3.5%
6. Total length required	= 4 + 5

Forging Cost Calculation – Problem-2

Calculate the cost of drop forging 100 components from a 5cm diameter bar. Take material cost as Rs.200 per meter, forging rates Rs.0.10 per cm^2 of the surface area and on-cost as 10% material cost.



Forging Cost Calculation – Problem-2

1. Volume of the component:	= {(π/4) * D^2 * L }of 3 portions
2. Shear loss:	= 5% of the volume = 0.05 * 1
3. Scale loss:	= 6% of the volume = 0.06 * 1
4. Sprue loss:	= 7% of the volume = 0.07 * 1
5. Tanghold loss: Take length as 20mm & dia as raw-stock dia	= volume of tong
6. Flash loss:	= flash width * flash thick * periphery of forging
7. Total losses:	= 2 + 3 + 4 + 5 + 6

Forging Cost Calculation – Problem-2

8. Total volume of material required for one component:	= 1 + 7
9. Total Volume of material required for 100 components:	= 100 * 8
10. Length of the bar required:	= (Volume / Area of raw stock)
11. Cost of the material:	= 10 * Raw material Rate
12. Surface area:	= Area of all the seven surfaces
13. Forging charge per piece:	= 12 * forging rate/component
14. Forging charges for 100 components:	= 13 * 100
15. On-cost:	= 10% of material cost = 0.10*11
16. Total cost of making 100 forgings:	= 11 + 14 + 15

Forging Cost Calculation – Problem-3

Calculate for the component shown in Fig. (all dimensions are in mm):

(i) net weight and gross weight

(ii) Length of 14 mm dia bar required to forge one component.

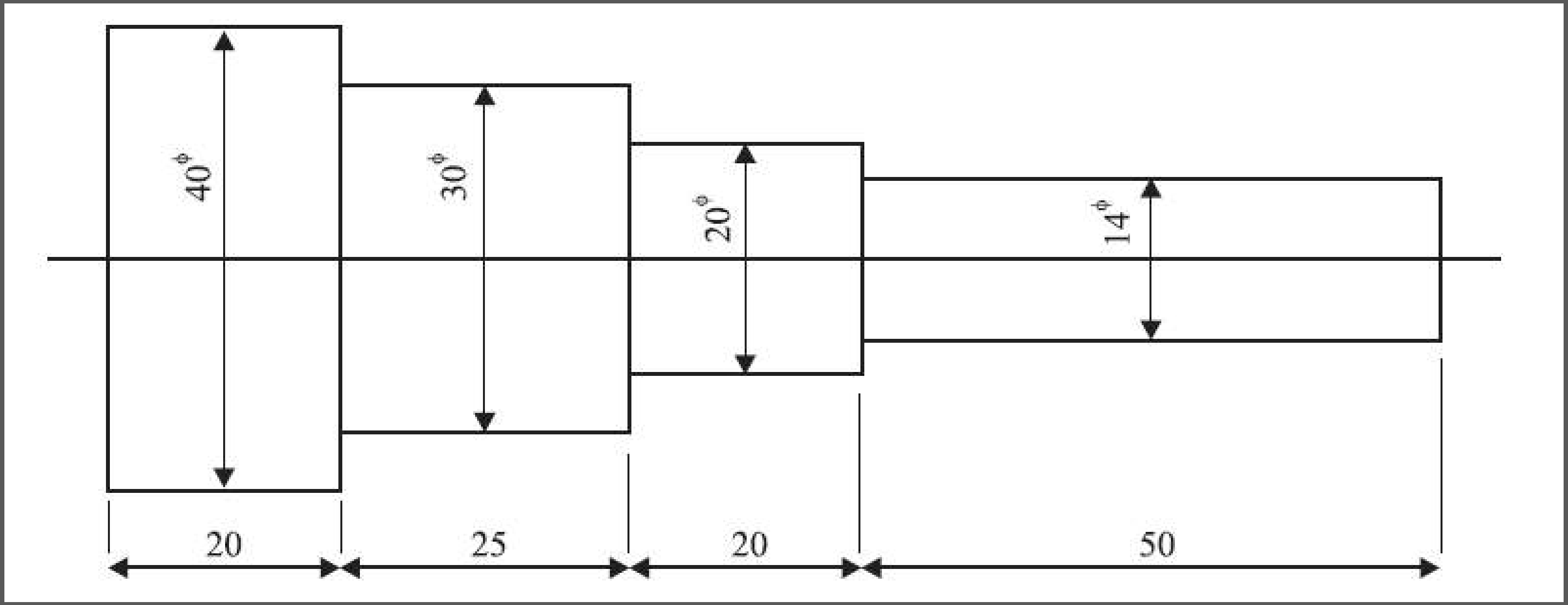
(iii) Cost of forging/piece if :

Density of material used is 7.86 gm/cc.

Material cost = Rs. 80 per kg

Labour cost = Rs. 5 per piece

Overheads = 150 percent of labour cost.



Forging Cost Calculation – Problem-3

1. Volume of the component:	= {(π/4) * D^2 * L }of 4 portions
2. Net weight of the component:	= 1 * 7.86gm/cc
a. Shear loss:	= 5% of the net weight
	=
b. Scale loss:	= 6% of the net weight
	=
c. Sprue loss:	= 7% of the net weight
	=
d. Tanghold loss: Take length as 20mm & dia as raw-stock dia	= volume of tong * density
e. Flash loss:	= (flash width * flash thick * periphery of forging)*density
3. Total losses:	= a + b + c + d + e

Forging Cost Calculation – Problem-3

4. Gross weight of the component:	= 1 + 3
5. Length of the bar required:	= Volume / Area of raw stock
6. Direct Cost of the material:	= Rs.80/kg * 4 =
7. Forging charge per piece:	= Rs.5 / piece
8. On-cost:	= 150% of labour charges = 0.15 * 7
9. Total cost of forging / piece:	= 6 + 7 + 8

COST ESTIMATION IN FOUNDRY SHOP

Foundry:

1. metal casting process
2. metal is melted and poured into the moulds to get the components in desired shape and size.
3. Castings are obtained from a foundry shop.

Foundry shop has the following sections :

1. Pattern Making Section

2. Sand-mixing Section

3. Core-making Section

4. Mould Making Section

5. Melting Section

6. Fettling Section

7. Inspection Section

ESTIMATION OF COST OF CASTINGS

The total cost of manufacturing a component consists of following elements :

1. Material cost.

2. Labour cost.

3. Direct other expenses.

4. Overhead expenses

1. Material cost is calculated as follows:

Calculate volume of material required for casting.

Add the weight of process scrap.

Add the allowance for metal loss.

Multiply the total weight by cost per unit weight of the material.

Subtract the value of scarp.

ESTIMATION OF COST OF CASTINGS

The total cost of manufacturing a component consists of following elements :

1. Material cost.

2. Labour cost.

3. Direct other expenses.

4. Overhead expenses

2. Labour cost is calculated as follows:

The cost of labour involved in making cores and moulds.
(based on the time taken for making)

The cost of labour involved in melting and pouring of the metal.
(basis of per kg of cast weight)

ESTIMATION OF COST OF CASTINGS

The total cost of manufacturing a component consists of following elements :

1. Material cost.

2. Labour cost.

3. Direct expenses.

4. Overhead expenses

3. Direct Expenses:
expenditure incurred on patterns, core boxes, cost of using machines, etc.

4. Overhead Expenses:
salary and wages of supervisors, pattern shop staff and inspection staff, administrative expenses, water and electricity charges etc.
Expressed as percentage of labour charges.

Cost Estimation in Foundry Shop– Problem 4

Calculate the total cost of CI (Cast Iron) cap shown in Fig. 5.1, from the following data :

Cost of molten iron at cupola spout = Rs. 30 per kg

Process scrap = 17 percent of net wt. of casting

Process scrap return value = Rs. 5 per kg

Administrative overhead charges = Rs. 2 per kg of metal poured.

Density of material used = 7.2 gms/cc

The other expenditure details are :

Process	***Time per piece***	***Labour charges per hr***	***Shop overheads per hr***
Moulding and pouring	10 min	Rs. 30	Rs. 30
Casting removal, gate cutting etc.	4 min	Rs. 10	Rs. 30
Fettling and inspection	6 min	Rs. 10	Rs. 30

Cost Estimation in Foundry Shop– Problem 4

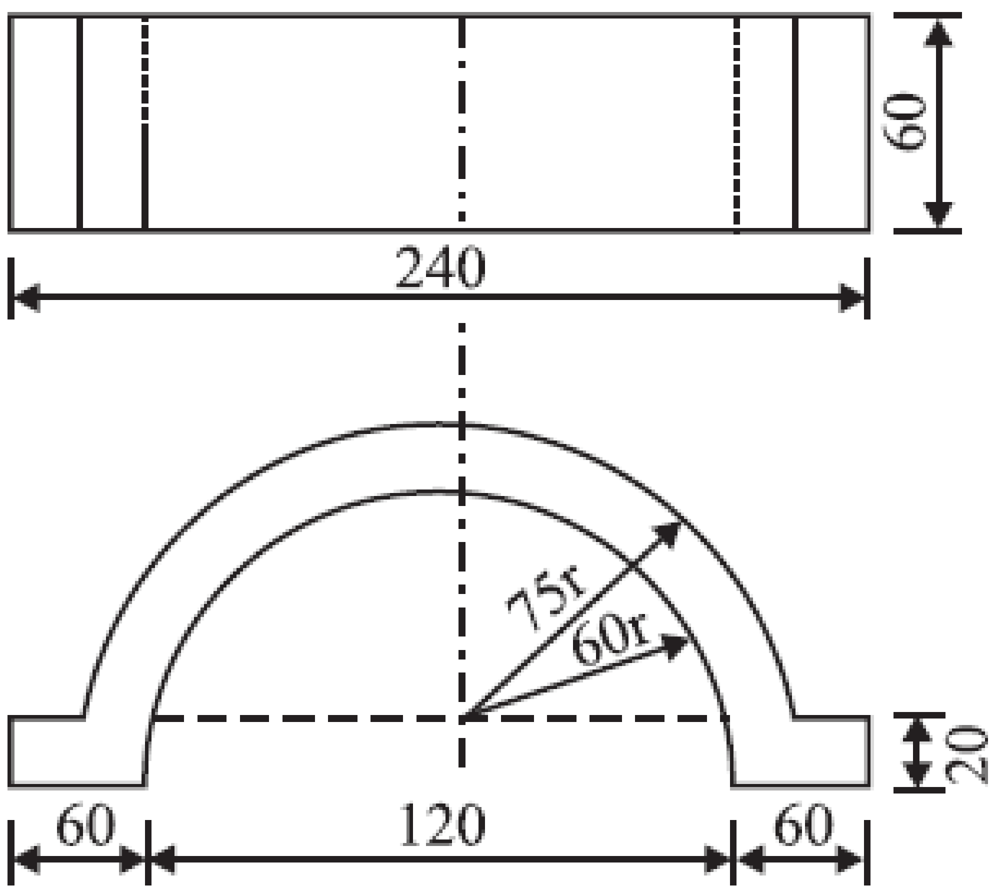


Fig. 5.1. All dimensions are in mm.

Cost Estimation in Welding Shop

Gas welding :

Most commonly used gas welding is oxy-acetylene welding. Temperature required for welding is obtained by the application of a flame from mixture of oxygen and acetylene gas. Filler material is used to fill the gap between the parts to be welded.

Technique used:

Leftward welding :
Welding is started from right hand side of the joint and proceeds towards left. This method is used for welding plates upto 5 mm thick. No edge preparation is required in case of the plates of thickness upto 3 mm.

Rightward welding :
This method is adopted for welding thicker plates. Welding proceeds from left to right. The flame is directed towards the deposited metal and rate of cooling is very slow.

Cost Estimation in Welding Shop

Cost of welding depends on

welding process used,
type of joint,
materials,
labour employed in making and inspecting the joint.

Estimation of Cost in Welding

Total cost of welding consists of :

1. Direct material cost.
2. Direct labour cost.
3. Direct Expenses.
4. Overheads.

Cost Estimation in Welding Shop

Direct Material Cost

1. Cost of base materials to be welded i.e., sheet, plate, rolled section, casting or forging.

2. Cost of electrodes / filler material used.

Direct Material Cost = 1 + 2

Direct Labour Cost:

1. cost of labour for preparation, welding and finishing operations.

Direct Labour Coat = Preparation cost + Welding Cost + Finishing cost

Cost Estimation in Welding Shop

Direct Expenses:

cost of power consumed, cost of fixtures used for a particular job etc.

$$\text{Power cost} = \frac{V \times A}{1{,}000} \times \frac{t}{60} \times \frac{1}{E} \times \frac{1}{r} \times C$$

where,

V = Voltage (volt)

A = Current (Ampere)

t = Welding time (minutes)

E = Efficiency of the welding machine (0.6 for welding transformer, 0.25 for welding generator)

r = Ratio of operating time to connecting time taken by the operator

C = Cost of electricity per kWhr (i.e., Unit.) in Rupees

Cost Estimation in Welding Shop– Problem 1

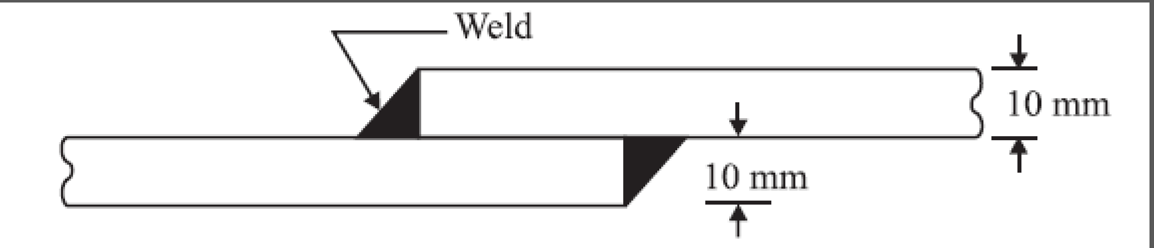


Fig. 5.4. Lap joint

Estimate the cost of weld from the following data :

1. Thickness of plate	=	10 mm
2. Electrode diameter	=	6 mm
3. Minimum arc voltage	=	30 Volts
4. Current used	=	250 Amperes
5. Welding speed	=	10 meters/hour
6. Electrode used per meter of weld		= 0.350 kgs
7. Labour rate	=	Rs. 40 per hour
8. Power rate	=	Rs. 3 per kWh
9. Electrode rate	=	Rs. 8.00 per kg
10. Efficiency of welding m/c	=	50 percent
11. Connecting ratio	=	0.4
12. Overhead charges	=	80 percent of direct charges
13. Labour accomplishment factor		= 60 percent

Cost Estimation in Welding Shop– Problem 1

1. Power cost = $\dfrac{V \times A}{1{,}000} \times \dfrac{t}{60} \times \dfrac{1}{E} \times \dfrac{1}{r} \times C$

2. Cost of labour per meter= $\dfrac{\text{Cost of labour / hr}}{\text{Welding speed in m/hr}} \times \dfrac{1}{\text{Labour accomplishment factor}}$

3. Cost of electrode per meter of welding =

4. Total direct cost per meter of welding = 1 + 2 + 3

5. Overhead charges per meter of welding = 80% of 4

6. Total charges for welding of meter of length= 4 + 5

7. Double lap fillet welding = Total weld length x 2 times

8. Total charges = 7 x 6

Cost Estimation in Welding Shop– Problem 1

Welding speed = 10 meters/hour (Given)
10 meters = 1 hour
10 meters = 60 minutes
1 meter = 6 minute

$$\text{1. Power cost} = \frac{30 \times 250}{1{,}000} \times \frac{6}{60} \times \frac{1}{50\%} \times \frac{1}{0.4} \times \text{Rs. 3 per kWh}$$

= Rs.11.25

$$\text{2. Cost of labour per meter} = \frac{\text{Cost of labour / hr}}{\text{Welding speed in m/hr}} \times \frac{1}{\text{Labour accomplishment factor}}$$

$$= \frac{\text{Rs. 40 per hour}}{\text{10 meters/hour}} \times \frac{1}{60\%} = \text{Rs. 6.66/meter weld length}$$

3. Cost of electrode per meter of welding = 0.350 kgs x Rs. 8.00 per kg
= Rs.2.80

Cost Estimation in Welding Shop– Problem 1

4. Total direct cost per meter of welding

= Power cost + Cost of labour per meter + Cost of electrode per meter

= Rs.11.25 + Rs. 6.66 + Rs. 2.80

= Rs. 20.71

5. Overhead charges per meter of welding = 80% of Total direct cost

= 0.80 x Rs.20.71 = Rs. 16.60

6. Total charges for welding of meter of length= Rs. 20.71+ Rs. 16.60 = Rs. 37.31

7. Double lap fillet welding = Total weld length x 2 times

= 1.5 meters x 2 times

= 3 meters

8. Total charges = 3 meters x Rs. 37.31

= Rs.112

Cost Estimation in Welding Shop– Problem 2

A container open on one side of size 0.5 m × 0.5 m × 1 m is to be fabricated from 6mm thick plates.

The plate metal weighs 8 gms/cc. If the joints are to be welded, make calculations for the cost of container.

Cost of plate = Rs. 10 per kg

Sheet metal scarp (wastage) = 5 % of material

Cost of labour = 10 % of sheet metal cost

Cost of welding material = Rs. 20 per meter of weld.

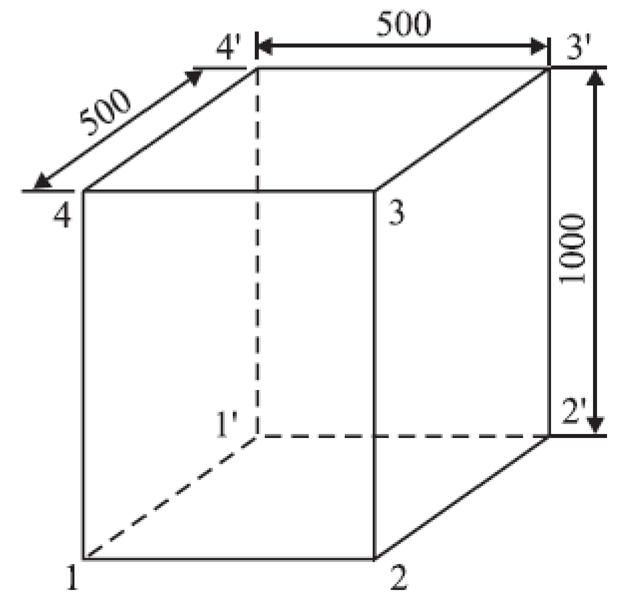


Fig. 5.5. Welded water tank

Cost Estimation in Welding Shop– Problem 2

A. Material cost:

Net volume = 4 x (50x100x0.6)cm^3 + (50x50x0.6)cm^3 = 13,500cm3

Net weight = Net volume x density

= 13,500 cm^3 x 8gm/cc = 1,08,000gm = 108kgs

Scrap = 5% of net weight = 108kgs x 5% = 5.40kgs

Total weight of sheet required for fabrication of one container = 113.40kgs

Cost of sheet metal per container = 113.4kgs x Rs.10/kg = Rs.1134.00

B. Labour charges= 10% of the sheet metal cost

= Rs.113.40

C. Welding material Cost:

Welding length = (4 x 50cm) + (4 x 100cm)

= 600cm = 6meter

Welding material cost = Rs.20/meter x 6meter

= Rs.120

D. Cost of container = A + B + C

= 1134.00 + 113.40 + 120.00

= Rs.1,367.40

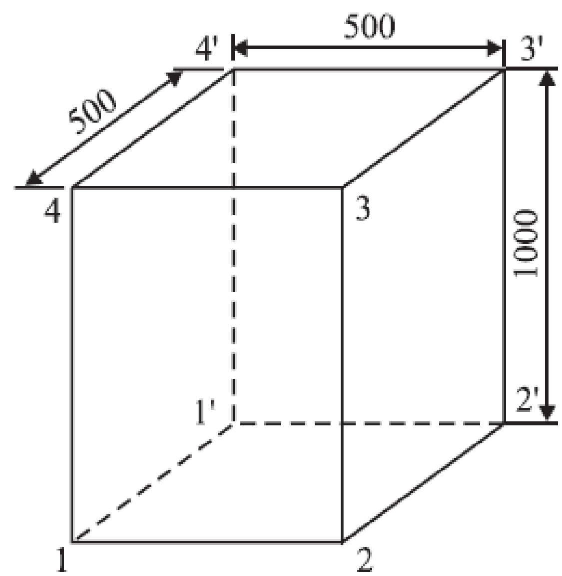


Fig. 5.5. Welded water tank

Cost Estimation in Welding Shop– Problem 3

Calculate the cost of welding two pieces of mild steel sheets 1 meter long and 7 mm thick. A 60° V is prepared by means of gas cutting before welding is to the commenced. The cost of Oxygen is Rs. 7/cu meter and of acetylene is Rs. 4/cu meter. The filler metal costs Rs. 20 per kg. The following data is also available :

For gas cutting (For 10 mm thick plate)

Cutting speed = 20 m/hr
Consumption of Oxygen = 2 cu meter/hr
Consumption of acetylene = 0.2 cu meter/hr

Data for Rightward Welding (For 7 mm thick plate)

Consumption of Oxygen = 0.8 cu meter/hr
Consumption of acetylene = 0.8 cu meter/hr
Dia of filler rod used = 3.5 mm
Filler rod used per meter of weld = 3.4 meters
Rate of welding = 3 meters/hr
Density of filler metal = 8 gm/cc

Cost Estimation in Welding Shop– Problem 3

A. GAS CUTTING:

Cutting speed: 20meter/hour i.e. 20met = 1hr, so, 1met = 1/20hr

Time taken for edge preparation of two plates:

= 2plates x 1/20hr = 1/10hr = 0.1hr

1. Consumption of O_2 and its cost:
    1. consumption of O_2 = 2 m^3/hr x 0.1hr = 0.2m^3
    2. Cost of O_2 = 0.2m^3 x Rs.7/ m^3 = Rs.1.4
2. Consumption of C_2H_2 and its cost
    1. Consumption of C_2H_2 = 0.2m^3/hr x 0.1hr = 0.02m^3
    2. Cost of C_2H_2 = 0.02m^3 x Rs.4/m^3 = Rs.0.08
3. Cost of (O_2 + C_2H_2) for cutting = Rs.1.40 + Rs.0.08 = Rs.1.48

B. GAS WELDING:

1. Filler Rod

    1. Weld length = 1met
    2. Filler rod length = 3.4met x 1met= 3.4met = 340cm
    3. Filler rod weight = 3.14 x $(0.35cm)^2$ /4 x 340cm x 8gm/cc
       = 261.8gm = 0.262kg
    4. Filler rod cost = 0.262kg x Rs.20/kg = Rs.5.24

Cost Estimation in Welding Shop– Problem 3

2. Gases

Rate of welding = 3meters/hr i.e. 3meters = 1hr, so, time taken for 1met welding =1/3 hr

1. Volume of O_2 = $0.8m^3$/hr x 1/3hr = $0.26m^3$

2. Cost of O_2 = $0.26m^3$ x Rs.7/m^3 = Rs.1.82

3. Volume of C_2H_2 = $0.8m^3$/hr x 1/3hr = $0.26m^3$

4. Cost of C_2H_2 = $0.26m^3$ x Rs.4/m^3 = Rs.1.04

5. Cost of (O_2 +C_2H_2) = Rs.1.82 + Rs.1.04 = Rs.2.86

C. Total cost of making the weld:

= Cost of (O_2 + C_2H_2) for cutting + Cost of Filler rod + Cost of (O_2 +C_2H_2) welding

= Rs.1.48 + Rs.5.24 + Rs.2.86

= Rs. 9.58

Cost Estimation in Welding Shop– Problem 4

Calculate the cost of welding two plates 200 mm × 100 mm × 8 mm thick to obtain a piece 200 mm × 200 mm × 8 mm approximately using rightward welding technique. The following data is available :

Cost of filler material	= Rs. 60 per kg
Cost of oxygen	= Rs. 700 per 100 cu meters
Cost of acetylene	= Rs. 700 per 100 cu meters
Consumption of oxygen	= 0.70 cu m/hr
Consumption of acetylene	= 0.70 cu m/hr
Diameter of filler rod	= 4 mm
Density of filler material	= 7.2 gms/cc
Filler rod used per meter of weld	= 340 cms
Speed of welding	= 2.4 meter/hr

ME 16006

Process Planning and Cost Estimation

ME 6005 PPCE

UNIT I	INTRODUCTION TO PROCESS PLANNING
UNIT II	PROCESS PLANNING ACTIVITIES
UNIT III	INTRODUCTION TO COST ESTIMATION
UNIT IV	PRODUCTION COST ESTIMATION
UNIT V	MACHINING TIME CALCULATION

UNIT 5 MACHINING TIME CALCULATION SYLLABUS

Estimation of Machining time –

Importance of Machine time calculation –

Calculation of machining time for
different lathe operations, drilling and boring –

Machining time calculation for
milling, shaping, planning and slotting

Machining time calculation for
grinding.

UNIT 5 OBJECTIVE

To explain how machining time is estimated in respect of machined components.

To state the various components of total time required to perform a machining operation.

To calculate the time required for various machining operations like Turning, Facing, External relief, Undercutting, Chamfering, Knurling, Boring, Drilling, Threading, Tapping, shaping, planning, slotting, Milling and Grinding.

To calculate the total time required to machine a component given all the machining parameters.

INTRODUCTION

Product Cost = Material + Labour + Manufacturing cost.

To know manufacturing cost i.e. Machining cost, it is necessary to compute machining time.

The total time required to perform a machining operation consists of following elements :

Set-up time,
Handling time,
Machining time,
Tear down time,
Down time and
Allowances.

- **Set-up Time:** Time required to
  - Study the component drawing.
  - Draw tools from tool crib,
  - Install and adjust the tools, jigs and fixtures on the machine.
- **Handling Time:** Time required to
  - Prepare a part for machining
  - Dispose the part after operation has been completed.
  - Load and unload the component on the machine
  - Make measurements on parts during machining, etc.
- **Machining Time:**
  - time for which the machine works on the component, i.e. time between tool touches and leaves the w/p
  - machining time depends on material, speed, feed, depth of cut and number of cuts required.

- **Tear-down Time:** Time required to

  remove the tools, jigs and fixtures from the machine

  clean the machine and tools after the operation on last part

  The tear down time occurs only once for a complete lot.

- **Down Time:** time wasted by the operator due to

  breakdowns,

  non-availability or delay in supply of tools and materials.

- **Allowances:**

  time for personal needs of the operator,

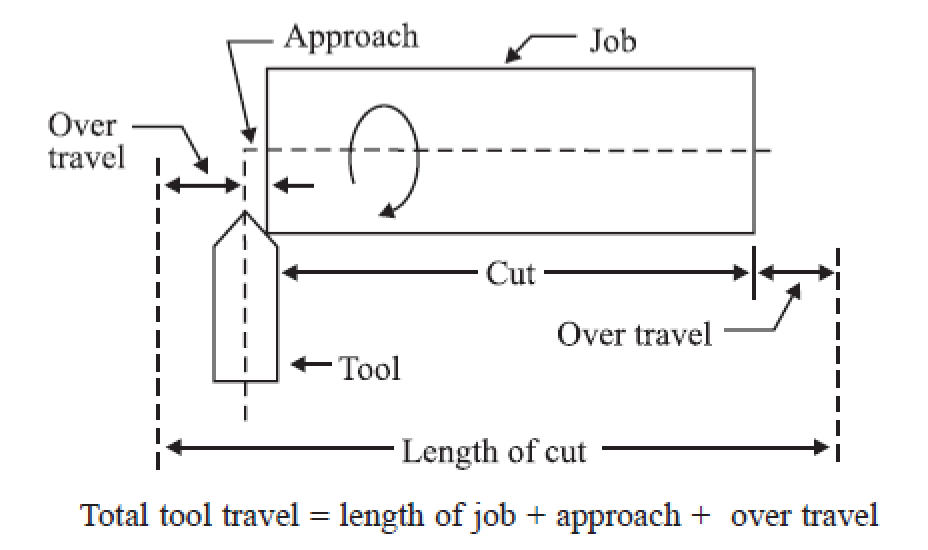
  time for checking,

  time for tool sharpening etc.

Terms used in cutting time formula

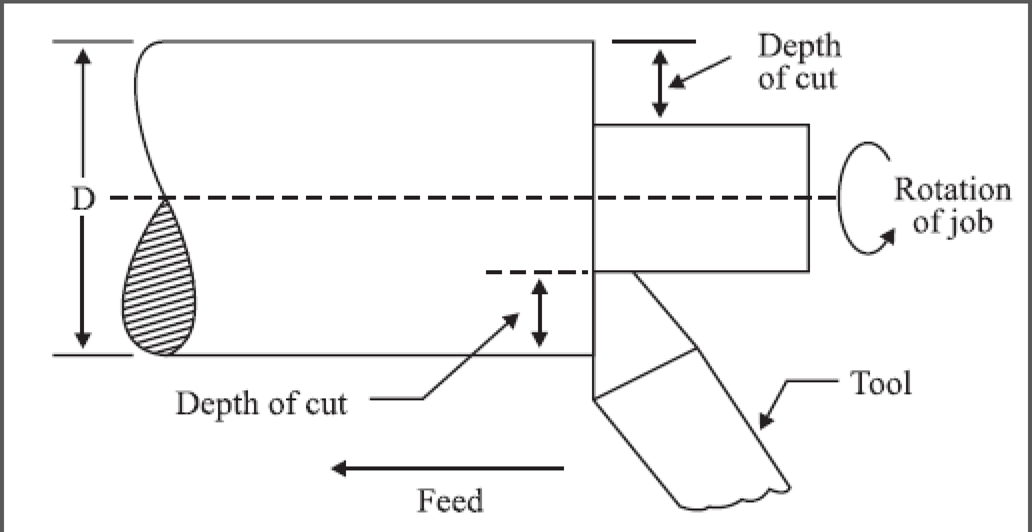
Length of cut (L): distance travelled by the tool to machine the work piece

Length of cut (L) = Approach length + Length of work piece to be machined + Over travel



Terms used in cutting time formula

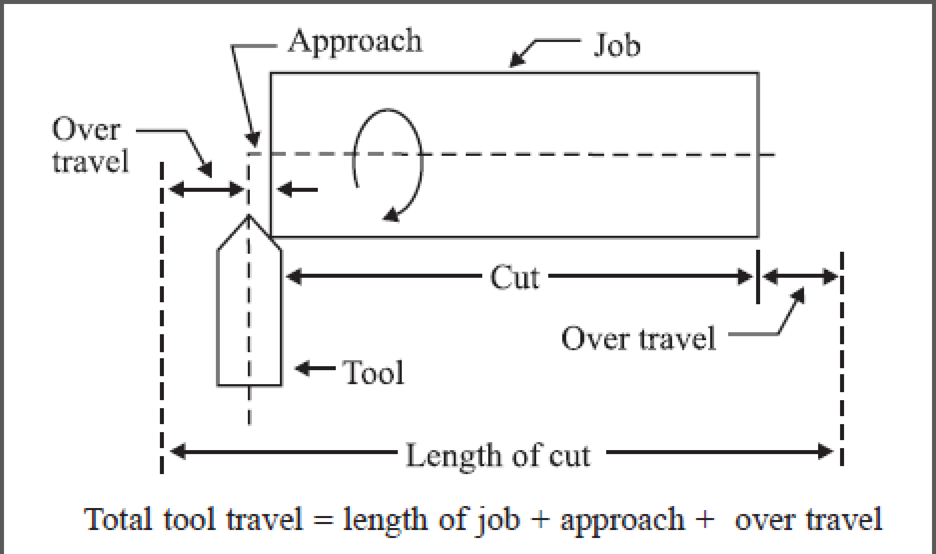
Feed (F): distance that a tool travels along the work w.r.t. the tool for each revolution of the work-piece.



Terms used in cutting time formula

Depth of cut: difference between unfinished dimension and finished dimension of the job.

Example: in turning, depth of cut is the difference between radius of the bar before and after taking the cut.



Terms used in cutting time formula

Cutting speed: speed at which the cutting edge of tool passes over the job and it is usually expressed in meters per minute.

$$S = \frac{\pi \times D \times N}{1000} \quad \text{(or)} \quad N = \frac{1000 \times S}{\pi D}$$

where
S = Surface cutting speed in meters per minute
D = Diameter of the job in mm
N = r.p.m. of machine/job.

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

Turning : removal of excess material form the work piece by means of a pointed tool, to produce a cylindrical or cone shaped surface.

From cutting speed, r.p.m. of job is calculated by using the formula.

$$N = \frac{1000\,S}{\pi \times D}$$

N = r.p.m. of job

S = Surface cutting speed in meters/minute

D = Diameter of the stock to be turned (in mm)

Time required for turning (in minutes) $T = \frac{L}{f \times N}$

f = Feed per revolution (in mm)

L = Length of stock to be turned (in mm)

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

If it is not possible to obtain the required dimensions in single cut, more than one cut may be required. In such cases, the r.p.m. (N) is determined by using mean diameter of the job.

$$N = \frac{1000 \times S}{\pi \times D_{average}}$$

$$D_{average} = \frac{D + d}{2}$$

D = Dia of stock before turning

d = Dia of job after turning

Time required for turning (in minutes) $T = \frac{L}{f \times N} \times P$

f = Feed per revolution (in mm)

L = Length of stock to be turned (in mm)

P = Number of cuts (passes) required

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

If over travel and approach are also to be taken into account,

$$\text{Time required for turning (in minutes) } T = \frac{A + L + O}{f \times N} \times P$$

f = Feed per revolution (in mm)
L = Length of stock to be turned (in mm)
P = Number of cuts (passes) required
A = Approach length
O = Over Travel

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
1. Problem: Turning

Calculate the machining time to turn the dimensions shown in Fig. 5.22.

Starting from a m.s. bar of f 80 mm. The cutting speed with HSS tool is 60 meters per minute and feed is 0.70mm/rev., depth of cut is 2.5 mm per pass.

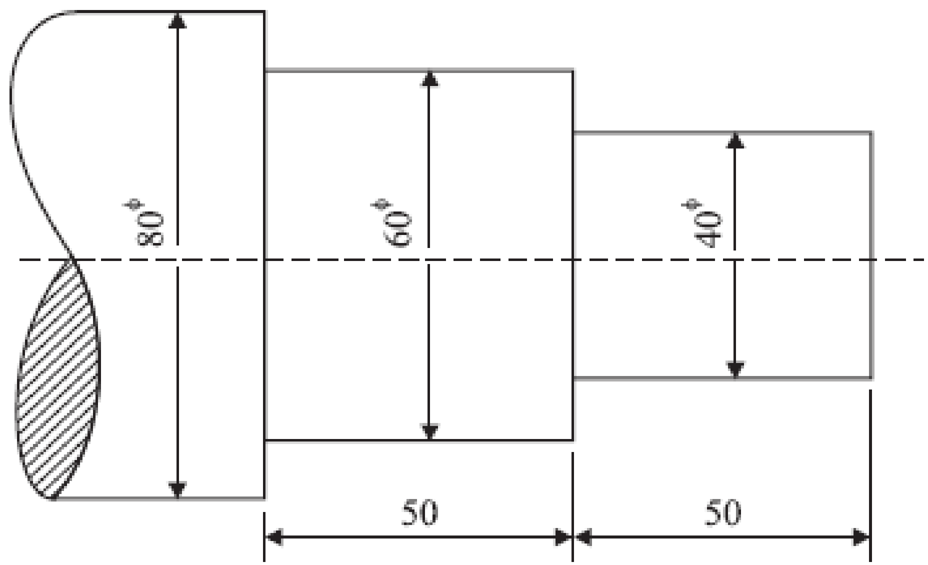


Fig. 5.22

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
1. Problem: Turning

Turning will be done in 2 steps.

1st step: length of (50 + 50) = 100 mm will be reduced from 80” to 60”

2nd step: length of 50mm is to be reduced from 60” to 40”.

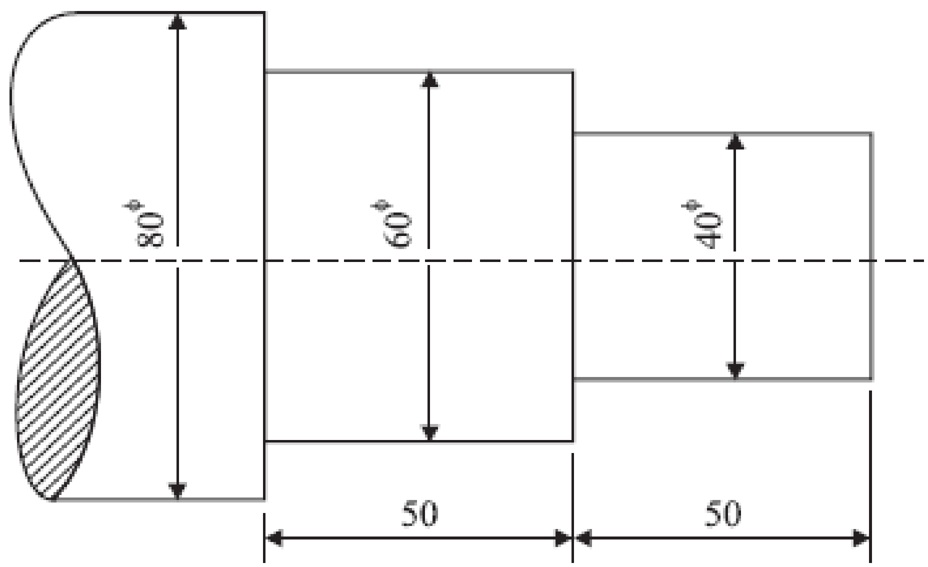


Fig. 5.22

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

1. Problem: Turning

Given S = 60 m/min *f = 0.70 mm/rev.*

Step I : turning from Ø80" to Ø60" for 100 mm long.

$$N = \frac{1{,}000 \times S}{\pi \times D} = \frac{1{,}000 \times 60}{\pi \times 80} = 238.8 = 240 \text{ r.p.m.}$$

$$\text{No. of passes} = \frac{\text{Depth of material to be removed}}{\text{Depth of cut}}$$

$$= \frac{(80 - 60)}{2 \times 2.5} = 4$$

Time required = L / (f x N) X P = 100 / (0.7 × 240) × 4

= 2.38 min.`

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

1. Problem: Turning

Step 2 : turning from Ø60" to Ø40" for 50 mm long.

$$N = \frac{1{,}000 \times S}{\pi \times D} = \frac{1{,}000 \times 60}{\pi \times 60} = 318 \text{ r.p.m.}$$

$$\text{No. of passes} = \frac{\text{Depth of material to be removed}}{\text{Depth of cut}}$$

$$= \frac{(60 - 40)}{2 \times 2.5} = 4$$

Time required = L / (f x N) X P = 50 / (0.7 × 318) × 4

= 0.9 min.

Total time = 2.38 + 0.90 = 3.28 min.

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
2. Problem: Turning, external relief, facing & chamfering

A mild steel bar 100 mm long and Ø38 mm is turned to Ø35 mm and was again turned to a Ø32 mm over a length of 40 mm as shown in the Fig. 5.23.
The bar was machined at both the ends to give a chamfer of 45° × 5 mm after facing.
Calculate the machining time. Assume cutting speed of 60 m/min and feed 0.4 mm/rev. The depth of cut is not to exceed 3 mm in any operation.

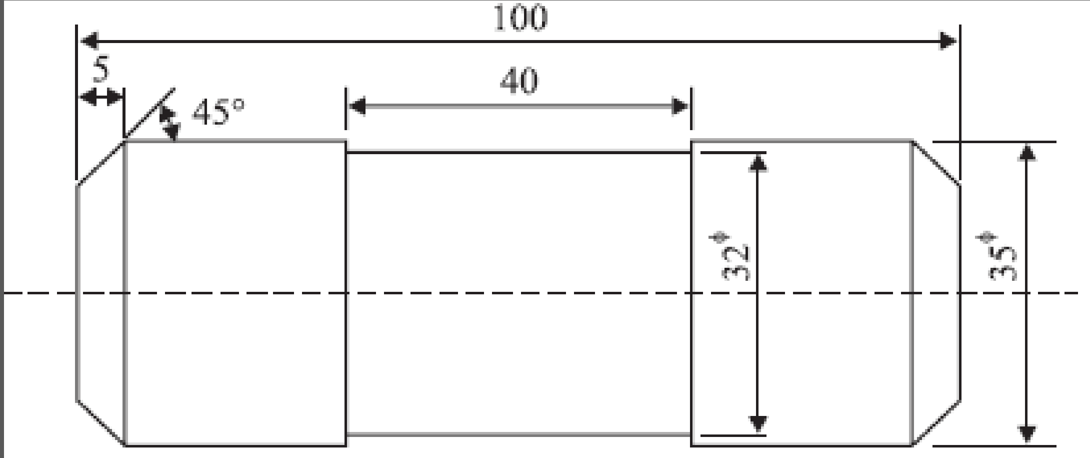


Fig. 5.23

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

2. Problem: Turning, external relief, facing & chamfering

1st operation : Turning from Ø38 mm to Ø35 mm
2nd operation : External relief
3rd operation : Facing of both ends
4th operation : Chamfering 45° × 5 mm

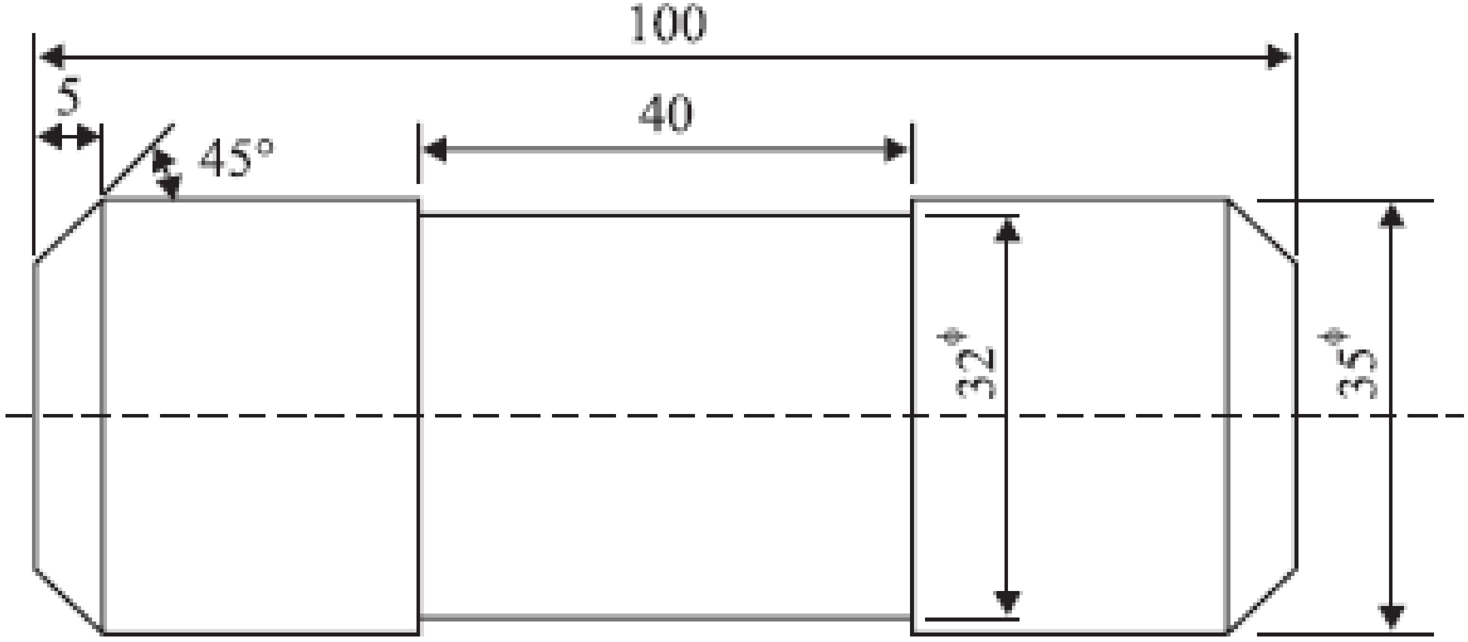


Fig. 5.23

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

2. Problem: Turning, external relief, facing & chamfering

1st operation : Turning from Ø38 mm to Ø35 mm

S = 60 meters/min.   D = 38 mm   f = 0.4 mm/rev

$$N = \frac{1{,}000\,S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 38} = 503 \text{ r.p.m.}$$

$$\text{Time taken} = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}} = \frac{100}{503 \times 0.4} = 0.5 \text{ min.}$$

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

2. Problem: Turning, external relief, facing & chamfering

2nd operation : External relief (L = 40 mm, D = 35 mm, S = 60 m/min)

$$N_2 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 35} = 545 \text{ r.p.m.}$$

$$T_2 = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}} = \frac{40}{545 \times 0.4} = 0.18 \text{ min.}$$

3rd operation : Facing (L = 35/2 mm, D = 35 mm, S = 60 m/min)

$$N_3 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 35} = 545 \text{ r.p.m.}$$

$$T_3 = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}} = \frac{17.5}{545 \times 0.4} \text{ x 2 faces} = 0.16 \text{ min.}$$

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

2. Problem: Turning, external relief, facing & chamfering

4th operation : Chamfering (L = 5 mm, D = 35 mm, S = 60 m/min)

$$N_4 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 35} = 545 \text{ r.p.m.}$$

$$T_4 = \frac{\text{Length of cut}}{\text{r.p.m.} \times \text{Feed/rev.}} = \frac{5}{545 \times 0.4} \text{ x 2 faces} = 0.04 \text{ min.}$$

Total Time (T) $= T_1 + T_2 + T_3 + T_4$

$= 0.5 + 0.18 + 0.16 + 0.04$

$= 0.88$ min

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

3. Problem: Facing, Turning, drilling & knurling

A mild steel shaft, shown in Fig. 5.24 is to be turned from a 24 mm dia bar. The complete machining consists of the following steps :

(i) Facing 24 mm on both sides

(ii) Turning to 20 mm.

(iii) Drilling 8 mm hole

(iv) Knurling.

With H.S.S tool the cutting speed is 60 m/min. The feed for longitudinal machining is 0.3 mm/rev. The feed for facing, 0.2 mm/rev., feed for knurling 0.3 mm/rev., and feed for drilling is 0.08 mm/rev. Depth of cut should not exceed 2.5 mm in any operation. Find the machining time to finish the job.

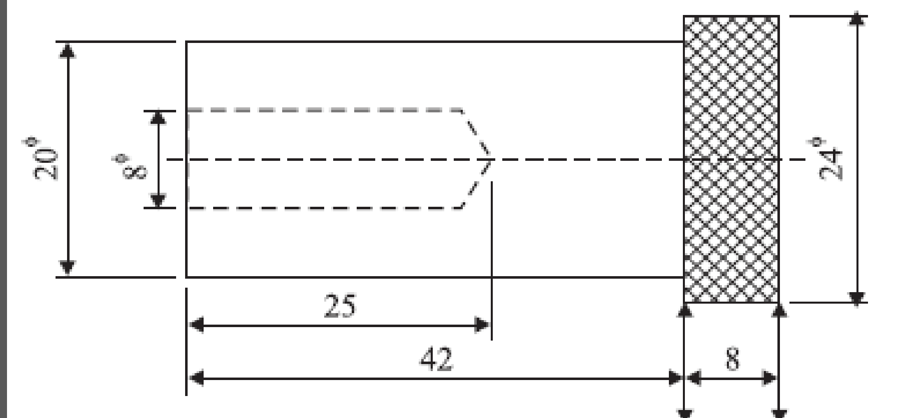


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

3. Problem: Facing, Turning, drilling & knurling

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn f 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

Step 1 : Facing 24mm bar on both ends

f = 0.2 mm/rev

Cutting speed = 60 m/min

Diameter = 24 mm

Length of cut = 24mm ÷ 2 = 12 mm

$$N_1 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 24} = 796 \text{ rpm}$$

$$T_1 = \frac{L}{f \times N} = \frac{12}{0.2 \times 796} \times 2 \text{ faces} = 0.14\text{min}$$

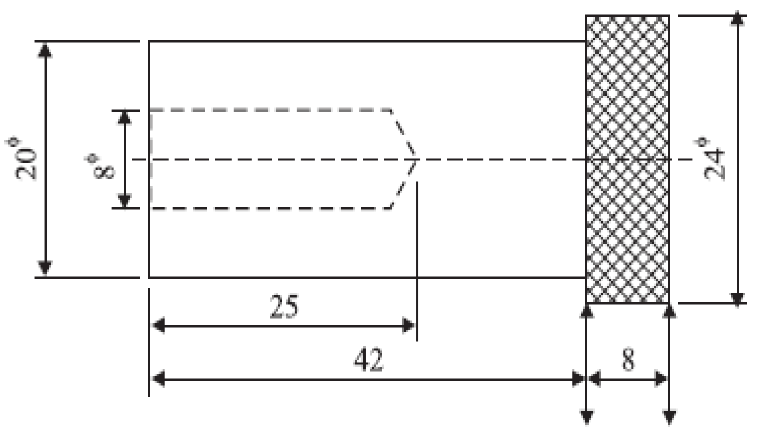


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
3. Problem: Facing, Turning, drilling & knurling

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

Step 2 : Turning from 24 mm to 20 mm
f = 0.3 mm/rev
Cutting speed = 60 m/min
Diameter = 24 mm
Length of cut = 42mm

$$N_2 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 24} = 796 \text{ rpm}$$

$$T_2 = \frac{L}{f \times N} = \frac{42}{0.3 \times 796} = 0.17 \text{min}$$

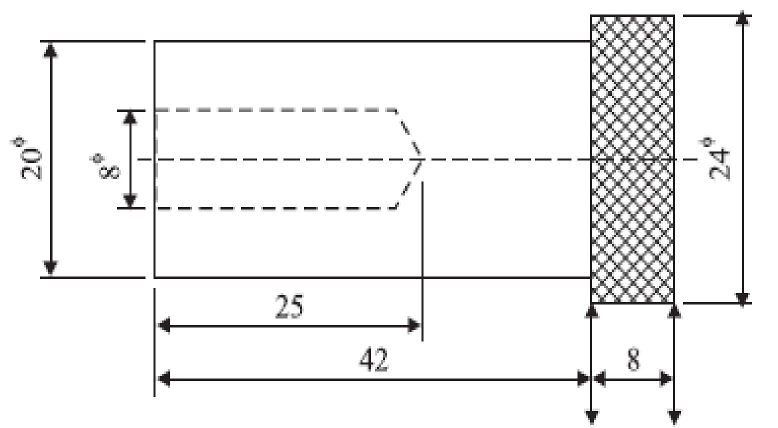


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
3. Problem: Facing, Turning, drilling & knurling

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

Step 3 : Drilling 8 mm dia hole
f = 0.08 mm/rev
Cutting speed = 60 m/min
Diameter = 8 mm
Length of cut = 25mm

$$N_3 = \frac{1{,}000\ S}{\pi D} = \frac{1{,}000 \times 60}{\pi \times 8} = 2{,}388 \text{ rpm}$$

$$T_3 = \frac{L}{f \times N} = \frac{25}{0.08 \times 2388} = 0.13 \text{min}$$

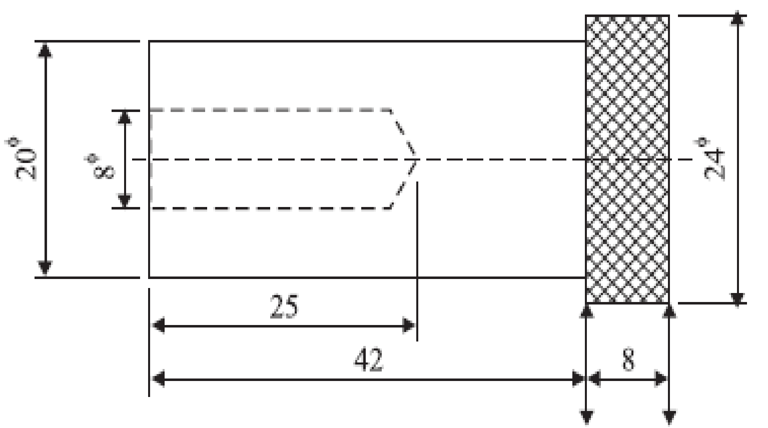


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS

3. Problem: Facing, Turning, drilling & knurling

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

Step 4 : Knurling
f = 0.3 mm/rev
Cutting speed = 60 m/min
Diameter = 24 mm
Length of cut = 8mm

$$N_4 = \frac{1,000\ S}{\pi D} = \frac{1,000 \times 60}{\pi \times 24} = 796 \text{ rpm}$$

$$T_4 = \frac{L}{f \text{ x } N} = \frac{8}{0.3 \text{ x } 796} = 0.03\text{min}$$

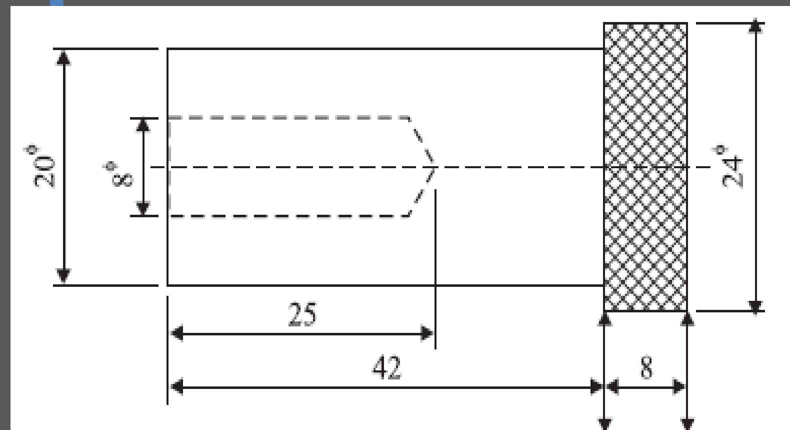


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
3. Problem: Facing, Turning, drilling & knurling

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

Total Time

$= T_1 + T_2 + T_3 + T_4$

$= 0.14 + 0.17 + 0.13 + 0.03$

$= 0.47$ min.

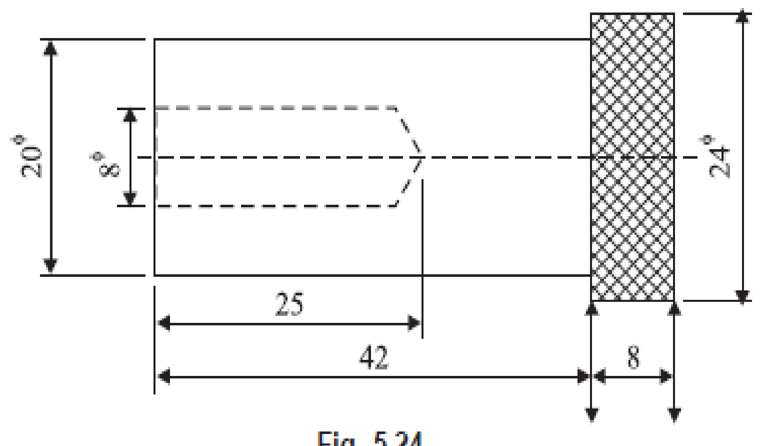


Fig. 5.24

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
4. Problem: Threading

Step 1 : Facing 24mm bar on both ends
Step 2 : Turn 20 mm from f 24 mm
Step 3 : Drilling 8 mm dia hole
Step 4 : Knurling

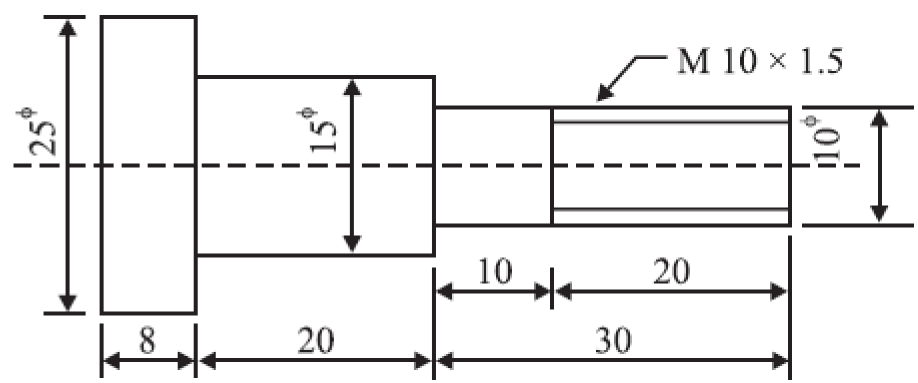


Fig. 5.25

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
5. Problem: Drilling and Tapping

Step 1 :

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
6. Problem: Shaping, Planning and Slotting

Step 1 :

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
7. Problem: Milling

Step 1 :

CALCULATION OF MACHINING TIME: LATHE OPERATIONS
8. Problem: Grinding

Step 1 :