UNIT II

PROCESS PLANNING ACTIVITIES

Introduction:-

The process planning involves the various activities such as drawing Interpretation, material evaluation and process selection, selection of machines and tooling, setting process parameters, selection of workholding devices, selection of quality assurance and Inspection methods, cost estimating and then documenting the details using route sheet.

Process parameters calculation for various production processes:-

Process Parameters:-

The three important process parameters to be calculated for each operation during process planning are.

1. Cutting speed.
2. Feed rate.
3. Depth of cut.

Cutting Speed :-

The cutting speed also known as surface cutting speed or surface speed can be defined as the relative speed between the tool and the workpiece.

It is a relative term. Since either the tool or the workpiece or both may be moving during cutting.

Unit: It is expressed in metres per minute, mpm.

Factors Affecting the selection of Cutting speed.

1. Nature of the cut.
2. work material.
3. Cutting tool material.
4. Cutting fluid Application.
5. Purpose of Machining.
6. Kind of Machining operation.
7. Capacity of Machining tool operation.
8. Condition of the Machine tool.

Calculation of cutting Speed :-

Cutting speed for Turning, Boring, Milling and Drilling operations.

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

S = Cutting Speed in m/min

D = Diameter of the workpiece in mm for turning / boring operation.

= Diameter of the cutter in mm. for milling, drilling operation.

N = Revolutions of the workpiece in rpm for turning / boring operation.

$$D = \frac{d_1 + d_2}{2}$$

2. Cutting speeds for shaping, planing and slotting operations.

$$S = \frac{L \times N_s}{1000\,C} \quad m/min.$$

S = Cutting Speed in m/min,

N_s = number of cutting strokes / min and

C = Cutting time ratio,

$$= \frac{\text{Time for cutting (forward) stroke}}{\text{Time for return stroke}}$$

L = Length of cutting (i.e forward) stroke (includes clearance on each ends) in mm.

problem:-

Calculate the cutting speed for a shaping operation. If the shaper is capable of 20 strokes per minute over a stroke length of 1.5m with a cutting time ratio of 3:2.

Given data,

$N_s = 20$ strokes/min.

$L = 1.5\,m = 1500\,mm.$

Cutting time ratio $= \frac{3}{5} = 0.6$

∴

$C = 3:2 = \frac{3}{5} = 0.6.$

$$S = \frac{L \times N_s}{1000\,c} = \frac{1500 \times 20}{1000 \times 0.6}$$

$= 50\,m/min$

calculation of spindle speeds:-

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

Stroke speeds:-

$$N_s = \frac{1000 \times S \times C}{L}$$

Feed and Feed rate :-

Feed :-

Feed is the distance through which the tool advances into the workpiece during one revolution of the workpiece or the cutter.

Feed rate :-

Feed rate is the speed at which the cutting tool penetrates the workpiece.

Unit :- Feed rate is usually expressed in millimeter per spindle revolution, (mm/rev) or millimeter per minute. (mm/min)

Factors Affecting feed rate :-

1. work material (type, strength, hardness etc)
ii) capacity of the machine tool. (power, rigidity etc)
iii) cutting tool. (material, geometry and configuration)
iv) cutting fluid application.
v) surface finish desired.
vi) Type of operation.
vii) nature of cut.

Selection of Feed rate :-

Feed rate for Turning and Boring :-

Feed rate in mm/min = Feed rate in mm/rev × Speed of rotation of the spindle in rpm.

Feed rate for Shaping and Planning :-

A typical feed rate for shaping is in the range of .05 – 0.75 mm/stroke.

A typical feed rate for planning is in the range of 0.5 – 3 mm/stroke.

Feed rate for grinding :-

A typical feed/for surface grinding is in the range of 1.0–1.5 mm/pass.

A typical feed rate (also known as infeed or depth of cut) for cylindrical grinding is in the range of 1 – 1.5 mm/pass.

Depth of cut :-

Depth of cut is the thickness of the layer of metal removed in one cut or pass measured in a direction perpendicular to the machined surface.

Unit :- It is generally measured in MM.

The feed and depth of cut for a particular operation depend on the material to be machined, surface finish required and tool used.

Selection of Jigs and Fixtures :-

The process planner has to identify the need for a workholding device or a Jig or a fixture for the selected operation.

work holding device :-

The main purpose of any workholding device is to position and hold a workpiece in a precise location while the manufacturing operation is being performed.

Types of working devices :-

The workholding devices can be broadly classified into two.

1. General workholding devices.
   a) Vices.
   b) Clamps and abutments.
   c) Chucks.
   d) Collets.

e) Centra.

f) Mandrels.

g) Face plates.

2. Specialist workholding devices.

a) Jigs.

b) Fixtures.

Jigs:-

A Jigs may be described as a workholding device which locates and holds the workpiece for a specific operation. It is also provided with tool guiding element.

Jigs are usually lighter in construction and direct the tool to the correct position on the workpiece.

Jigs are used on drilling, reaming, tapping and counterboring operations.

Functions of Jigs :-

1. To locate and position the workpiece relative to the cutting tool.

2. To clamp the workpiece during drilling, reaming or tapping.

3. To guide the tool (drill, reamer or tap) into the proper position on the workpiece.

Fixtures :-

A Fixtures may be defined as a work holding device which only holds and positions the workpiece. It does not guide the cutting tool.

Fixtures are used in turning, milling, grinding, shaping, planing and boring operation.

Functions of fixtures :-

1. To locate and position the workpiece relative to the cutting tool.

2. To clamp the workpiece during machining, welding, inspection, or assembly.

Reasons for using Jigs and Fixtures. (purpose and Advantages of Jigs and Fixtures.) :

1. It reduces / eliminates the efforts of marking, measuring and setting of workpiece on a machine.

2. It reduces the production cycle time and hence increases production capacity.

3. Interchangeability of manufacture is achieved by enabling the production of identical parts.

4. It reduces the cost of inspection as the products are produced with less defects.

Elements of Jigs and fixtures :-

The three basic elements of Jigs and fixtures are given below.

1. Clamping elements.
2. Locating elements.
3. Tool guiding and setting elements.
4. Tool setting elements.

Principles of Jigs and fixture Design :-

1. Location.
2. Clamping.
3. Loading.
4. Stability and Rigidity.
5. Clearance for chips.
6. Fool proof Design.
7. Provision for Tool Guides.
8. Provision for indexing.
9. Weight.
10. Safety.
11. Coolant supply
12. Economy.

Types of Jigs and Fixtures.

1. Types of Jigs.

Jigs can be classified broadly into two types based on the manufacturing process involved as.

1. Drill Jigs
2. Boring Jigs.

Types of Fixtures :-

Fixtures are designed specifically for an operation and so these can be named on the base of the operation to be carried out with the help.

The different types of fixture base on the operation include.

i) Turning Fixture.
ii) Milling Fixture.
iii) Fixture for grinding.
iv) Fixture for broaching.
v) Fixture for boring / drilling.
vi) Tapping fixture
vii) Fixture for welding.
viii) Assembling fixture

Fixtures can also be classified based on their construction type as.

i) Plate fixtures.
ii) Angle plate fixtures.
iii) Vice Jaw fixtures.
iv) Indexing fixtures.

Standard parts for Jigs and Fixtures:-

There are various standard parts being used in the design and construction of Jigs and fixtures some of the standard parts include

i) mechanical fastners.
ii) locating and supporting device,
iii) Indexing pins.
iv) drill bushes.
v) hand knobs and handles.

Selection of Quality Assurance methods:-

The process planner is to specify the quality assurance methods / Inspection criteria for all the critical processing factors such as dimensional and geometric tolerances and surface finish specifications that are identified from the drawing interpretation

The process planner provides the inspection criteria and accordingly the quality engineer decides on the QA tools and techniques to be employed.

The process planner in this stages of selection of QA methods include.

* identification of inspection locations.
- Identification of the most appropriate inspection and testing methods.
* Determination of the frequency of inspection and testing.
* Evaluation of inspection and test data.
- Identification of corrective action.

Quality :-

Quality is fitness for use. — Juran.

Quality is conformance to requirements.

— Crosby.

Total Quality Management :-

TQM is the management approach of an organisation centered on quality based on the participation of all its members and aiming at long term success through customer satisfaction and benefits to all members of the organisation and to society.

Basic principles / concepts of TQM

The six principles / basic concepts of any quality management system are given below.

1. Top management commitment & leadership.
2. Focus on the customer.
3. Effective involvement and utilisation of the entire work force.
4. Continuous improvement.
5. Treating suppliers as partners.
6. Establishing performance measures for the process.

Basic Quality strategies:

The two basic quality strategies are.

1. Detection Strategy.
2. Prevention Strategy.

Detection Strategy:-

This Strategy focuses on the question of Are we making it correctly.

Prevention Strategy:-

This strategy focus on the question of 'can we make it correctly.'

Seven Statistical Tools of Quality Q7 tools.

1. Flow chart
2. Check Sheet
3. Histogram
4. Pareto diagram.
5. Cause and effect diagram.
6. Scatter diagram
7. Control Chart.

Statistical Quality control :-

Statistical Quality control SQC is about employing inspection methodologies derived from statistical sampling theory to ensure conformance to requirements. Two main methods employed in SQC are.

1. Statistical process control SPC
2. Acceptance Sampling.

Control charts :-

A control chart is a graph that displays data taken over time and the variations of this data.

uses of control charts

1) To check whether the process is controlled statistically or not.

2. To determine process variability.

3. To establish the process capability of the production process.

4. To determine the effects of process changes.

Types of control charts:-

1. Control charts for variables
2. Control charts for attributes

Control charts for variables:-

The quality characteristics which can be measured and expressed in specific units of measurements are called variables.

Types of variable control charts.

i) $\overline{X}$ or average charts.
ii) R or range charts.
iii) S or standard deviation charts.

Control charts for attributes:-

An attribute refers to those quality characteristics that conform to specifications.

Control charts for attributes monitor the number of defects or fraction defect rate present in the sample.

Types of attributes control charts.

1. P chart.
2. np-chart.
3. C chart.
4. u-chart.

Process capability:-

Process capability may be defined as the minimum spread of a specific measurement variation which will include 99.7% of the measurements from the given process.

Inspection and measurement:-

Objectives of Inspection:-

Inspection is the function by which the product quality is maintained.

The main aims of inspection are.

1) To sort out the conforming and non conforming product.

2. To initiate means to determine variations during manufacture.

Methods of Inspection:-

There are two methods of Inspection. They are

1. 100% Inspection.
2. Sampling Inspection.

Types of Inspection.

1. Inspection of variables.

2. Inspection of attributes.

All qualitative characteristics are known as attributes. All characteristics that can be quantified and measurable are known as variable.

Measurement Instruments:-

The selection of appropriate measurement instrument to be employed is basically depend on the type of quality characteristic of the component considered.

Measurement:-

The different types of quality characteristics that are to be measured are.

1.) Dimensions / size.
2.) physical properties
3.) Functionality.
4.) Appearance.

Measurement Instruments used for variables:-

characteristics	Basic measurement Instruments used
Measurement of length.	1. Engineer's rule. 2. Micrometer. 3. Depth gauge 4. Vernier caliper 5. Vernier depth gauge. 6. Vernier height gauge.

Measurement of Angles — 1. Bevel protractor, 2. Sine bar.

Measurement of Straightness — Auto collimator.

Measurement of flatness. — Interferometer.

Measurement Instruments used for attribute Inspection:

Types of Limit Gauges	Purpose
1. Plug gauges	Plug gauges are used for checking holes of many different shapes and sizes.
2. Ring gauges.	Ring gauges are used to test external diameter.
3. Taper gauges	Taper gauges are used to test tapers
4. Snap gauges	They may be solid and progressive or adjustable or double ended.
5. Thread gauges	Thread gauges are used to check the pitch diameter of the thread.
6. Feeler gauges	Feeler gauges are used for checking clearance between mating surface.
7. Plate and wire gauge	The thickness of a sheet metal is checked by means of plate gauges and wire dia by wire [illegible]

Selecting measuring Instruments:-

Factors to be considered for selecting measuring instrument.

1. Accuracy.
2. Linearity
3. Magnification.
4. Repeatability.
5. Resolution.
6. Sensitivity.
7. Stability.

Set of Documents Required for Process Planning:-

1. Assembly and components drawing of the product and bill of materials.

The detail include.

* Component drawings.
* Assembly drawings.
* Raw material specification.
* Dimensional and geometric specification.
* Surface finish specification
* Number of parts required.
* Bill of materials.

2. Specification of various machine tools available in the catalogues of machine tools.

- The various possible operations that can be performed.
- capacity / power rating of motors.
- Spindle size, table size etc.

3. machining / Machinability data hand book.
4. Catalogues of various cutting tools and tool inserts.
5. Sizes of standard materials commercially available in the market.
6. Charts of limits, fits and tolerances.
7. Tables of tolerances and surface finish obtainable for various machining processes.
8. Tables of standard time for each operation.
9. Tables of machine hour cost of all machine tools available.
10. Tables of standard cost.
11. table of allowances.
12. Process plans of certain standard components such as shafts, bushings, flanges etc.
13. Handbooks such as design data Hand book, Tool engineers hand book etc.

Economics of process planning:-

Introduction:-

The process planner should have the fundamental knowledge on cost estimating, cost accounting various types of costs, components of cost and calculation of manufacturing of a product.

The knowledge of costing will help the process planner and the management to take the following decision,

- Type of material to be used for a product.
- Type of manufacturing process to be used for a product
- Volume of product to be manufactured.
- Make or buy a product.
- Design of a product.

Break even analysis:-

Break even analysis is also known as cost-volume-profit analysis is the study of inter-relationships among a firm's sales, costs and operating profit at various levels of output.

It is concerned with finding the point at which revenues and costs are exactly equal. This point is known as Break even point

Break Even point:

It is also known as no profit no loss point.

Determination of Break Even point.

1) The algebraic method.
2) The graphical method.

The algebraic method:

FC = Fixed cost
VC = Variable cost per unit.
TVC = Total variable cost.
TC = Total cost.
TR = Total revenue.
Q = Sales volume.
SP = selling price per unit

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

$$TR = SP \times Q.$$

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

$$\text{BEP in rupees} = \frac{FC}{1 - \left(\frac{VC}{SP}\right)}$$

The Graphical method :-

Break even chart is a graphical representation of the relationship between costs and revenue at a given time.

The point at which the total revenue line ~~between~~ intersects the total cost line is the break even point.

Margin of safety :-

Margin of safety is the difference between the existing level of output and the level of output at BEP.

Problem :-

The fixed costs for a factory for the year 2009-10 are Rs 1,50,000 and the variable cost is Rs 10 per unit produced. The selling price per unit is Rs 25. Calculate the break even quantity.

Given Data.

FC = Rs 1,50,000 VC = Rs 10, SP = Rs 25

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

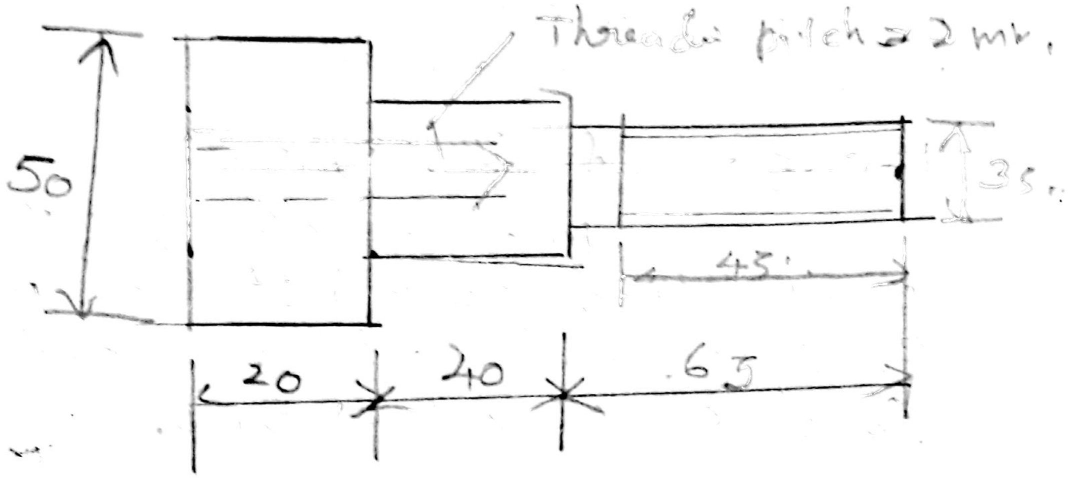
$$= \frac{1,50,000}{25 - 10}$$

$$= 10,000 \text{ units}$$

Case Study :-

Problem :-

A mild steel spindle is shown in figure is required to be manufactured in a workshop. present the various activities involved in process planning.



The various activities to be carried out to manufacture the mild steel spindle.

The given component drawing is carefully analysed to identify and list out the key features of a part.

i) The spindle has to be manufactured from 60 mm Φ and 130 mm length stock.

ii) The spindle consists of the three concentric cylinders.

iii) One internal thread and one external thread are to be cut.

IV) Material of the component is mild steel.

V) The dimensional tolerance is ±0.05 mm.

VI Number of parts to be made = 200

2. The next step is identification of the operation involved and the sequence of operation. To manufacture the gear spindle the following operations are to be carried out.

i) First operation :- Turning from 60 mm ϕ to 50 mm ϕ for 130 mm length.

ii) second operation. Turn from 50 mm ϕ to 40 mm ϕ for 110 mm length.

iii) Third operation :- Turning from 40 mm ϕ to 35 mm ϕ for 60 mm length

IV) Fourth operation :- Drilling a 10 mm ϕ hole for a 45 mm length.

V) fifth operation. internal threading

VI) sixth operation :- External threading.

3. Based on the operation identify the machines, cutting tool and measuring and checking instruments.

S.N	Operation	Machine	Tool.
1.	Turning to 50 mm	Centre Lathe	Single point cutting tool.
2.	Turning to 40 mm	Centre Lathe	Single point cutting
3.	Turning to 35 mm.	Centre lathe	single point cutting tool
4.	Drilling of 10 mm ϕ hole.	Centre lathe	Twist drill
5.	Internal threading	Tap	Tip and tap.
6.	External threading	Centre lathe	Die with die holder

Measuring and checking instrument:-

steel rule, Vernier caliper, depth gauge, thread plug gauge, ring thread gauge.

4. The cutting speed, feed and depth of cut for the specification are also approximately selected from the data book. The suggested processing parameters are,

Cutting speed for turning = 28 m/min

Cutting speed for thread cutting = 10 m/min

Cutting speed for drilling = 30 m/min

Feed for turning = 1 mm/rev

Feed for drilling = 0.25 mm/rev

Depth of cut = 3 mm.

5. The process planning is completed with the documentation of the above details in the route sheet.