ME8793 PROCESS PLANNING AND COST ESTIMATION

UNIT 1 INTRODUCTION TO PROCESS PLANNING

3.DRAWING INTERPRETATION AND MATERIAL EVALUATION

3.1 DRAWING INTERPRETAT1ON

Introduction

The first step in preparing the process plan for any component / project is the drawing interpretation.

The technical drawing is usually prepared by the design department, The drawing expresses certain functional requirements of the components / product under consideration.

The component is defined in such a way that, when assembled with the whole mechanism it should fulfill its technical functions. Also, the component should be well dimensioned and tolerance so that it can be mounted in a subset of components.

The design and functional requirements of a component / product are translated into technical "language" recognized by the production department and depicted in the technical drawing.

A typical technical drawing containing a various information that are required for developing a process plan.

In general, the following information can be obtained from the interpretation of an engineering drawing:

- Material of the component, its designation, its coding Number of parts to be produced
- Weight of the component
- Dimensions of the parts
- Dimensional and geometric tolerances of the different features of the part
- Size and accuracy of the parts. etc.

A Brief on Engineering Drawing

As we all know, the engineering drawing is known as universal language of engineers as the drawing is used as the most common form of communication among the engineers.

For the purpose of process planning, the orthographic projection drawings are commonly employed in engineering drawings. The orthographic projection is the method of detailing a 3D object on a 2D plane using a number of different views viz., front, top, right hand and left hand side views.

The orthographic projection is used as an unambiguous and accurate way of providing information, primarily for manufacturing and detail design. However, this form of representation can make ii difficult to visualize objects. Pictorial views (such as perspective. isometric and oblique pictorial projections) can be created to give a more three dimensional impression of the object.

Types of Drawing

The three types of drawings used in the industry are:

1. Detail drawings,
   - (i) Single-part drawings, and
   - (ii) Collective drawings.
2. Assembly drawings, and
   - (i) Single-part assembly drawings, and
   - (ii) Collective assembly drawings.
3. Combined drawings.

1. Detail Drawings

- The detail drawings provide all the information required for manufacture of the required component / product
- This information include all dimensions, tolerances, surface finish specifications and material specifications.

Two types of detail drawings are:

(i) Single-part drawings, and

(ii) Collective singe-part drawings.

(i) Single-part Drawings

- A single-part drawings contain the complete detailed information to enable a single component to be manufactured without reference to other sources.
- Such single-part drawings define shape or form and size, and provide the required specifications.
- The drawings are fully dimensioned, including tolerances where necessary, to show all sizes and locations of the various features.
- The specification of the part includes information relating to the material used, the heat-treatment required and surface finish details.

(ii) Collective Single - Part Drawings

- The collective single-part drawings are used where one or two dimensions of a component are variable, all others being standard.
- Collective Single-Part drawing of a rivet
- The drawing covers 20 rivets similar in every respect except length.
- This type of drawings are generally used for basically similar pails where one or more dimensions differ from the rest.

2. Assembly Drawings

- Machines and mechanisms consist of numerous parts and a drawing which shows the complete product with all its components in their correct physical relationship Le known as an assembly drawing.
- A drawing which gives a small part of the whole assembly is known at sub-assembly drawing.

Two types of assembly drawings a,

(i) Single-part assembly drawing, and

(ii) Collective assembly drawing.

(i) Single-part assembly drawing

The single-part assembly drawing contains the information to build a single sub-assembly or assembly.

The assembly drawings provide the following information;

- Part list
- Quantity required of each component
- Overall dimensions
- Weight
- Material specifications
- Data regarding the design characteristics
- Operating details and instructions

(ii) Collective Assembly Drawings

The collective assembly drawing is used where a range of products which are similar in appearance but differing in size is manufactured and assembled. Typical collective assembly drawing of a nut with bolts of various lengths

It shows a typical collective assembly drawing of a nut with bolts of various lengths. A nut and bolt fastening is used to secure plates of different combined thickness; the nut is standard, but the bolts are of different lengths as shown.

3. Combined Detail and Assembly Drawings

A combined detail and assembly drawing show an assembly with part list and the derails of these parts on one drawing.

Such drawings arc more suited to small “one-off” or limited production-run assemblies. lt not only reduces the actual number of drawings, but also the drawing office time spent in scheduling and printing.

INFORMATION ON THE DRAWING SHEET REQUIRED FOR PROCES PLANNING (CRITICAL PROCESSIÑG FACTORS)

The important Information derived from the drawings that are required for process planning include:

- Geometric and dimensions
- Material specifications
- Notes on special material treatments
- Dimensional tolerances specifications
- Geometrical tolerances specifications
- Surface finish specifications
- Tool references
- Gauge references
- Quantity to be produced
- Part lists
- Notes on equivalent parts
- Notes on screw thread forms

The process planners should have the clear knowledge on the above parameters and some of them are briefed below.

Dimensions

A drawing should provide complete dimensions of the component to ensure that the design intent can be mat of all stages of manufacture.

For our purpose of process planning. all dimensions can be classified into any one of the following three types.

1. Functional dimensions: These dimensions influence/affect the way in which part operates.

2. Non-Functional dimensions: These dimensions do not influence/affect the way

in which the part operates, but they can influence the efficiency of the part,

3. Auxiliary dimensions: Though these dimensions not related to the way the part operates, but they are required in order to manufacture the part.

Material Specifications

- The materials of the parts are to be stated as a specification in the drawing.
- The material evaluation and the most commonly used materials for manufacture are presented.

Special Material Treatments

In order to achieve the desired material] properties of the parts, the parts are treated. Those details should be mentioned as a note in the part drawings.

Tolerances, Limits and Fits

- To ensure that an assembly will function correctly, its component must fit together in a predictable manner.
- In practice, no component can be manufactured to an exact size, so the designer has to decide on appropriate upper and lower limits for each dimension.
- Accurately tolerance dimensioned features usually take much time to manufacture correctly and therefore can increase production cost significantly. Good engineering practice finds the optimum balance between required accuracy for the function of the component and minimum cost of manufacture.

Dimension Tolerances

If a dimension is specified, in millimeters, as 10±0.02, the part will be acceptable if the dimension is manufactured to an actual size between 9,98 and 10,02 mm.

General Tolerancing

General tolerance notes apply tolerances to all unspecified dimensions on a drawing. They can save time and help to make a drawing less clustered.

Example: Tolerance except where otherwise stated ±0.5.

LIMITS AND FITS FOR SHAFTS AND HOLES

Basic size and shaft / hole Tolerancing systems

The basic size or nominal size is the size of shaft or hole that the design specifies before applying the limits to it.

There are two systems used for specifying shaft/hole tolerances:

- Basic hole system: Starts with the basic hole size and adjusts shaft size to fit.
- Basic shaft system: Starts with the basic shaft size and adjusts hole Size to fit.

Because holes are usually made with standard tools such as drills and reamers, etc. the basic hole system tends to be preferred and therefore they are commonly used.

Fit

The fit represents the tightness or looseness resulting from the application of tolerances to mating parts, i.e. Shafts and holes.

Fits are generally classified as one of the following:

1. Clearance fit: Assemble/ dissemble by hand

Creates running and sliding assemblies. ranging from loose low cost to free-running high temperature change applications and accurate minimal play locations

2. Transition fit: Assembly usually requires press tooling or mechanical assistance of some kind.

Creates close accuracy with little or no interference.

3. Interference fit : Parts need to be forced or shrunk fitted together.

Creates permanent assemblies, that retain and locate themselves.

Geometrical Tolerancing

A geometrical tolerance limits the permissible variation of form, attitude or location of a feature of the component.

The various types of Geometrical Tolerancing are:

- Straightness tolerances
- Flatness tolerances
- Roundness tolerances
- Cylindricity tolerances
- Parallelism tolerances
- Squareness tolerances
- Angularity tolerances
- Concentricity tolerances
- Symmetry tolerances
- Position tolerances

Surface Finish

Surface finish is the depth of irregularities of a surface resulting from the manufacturing process used to produce it.

Three basic types of surface irregularities that can occur are:

Form error: The form error is for longer wavelength deviations of a surface from the corresponding nominal surface. Form errors result from large scale problems in the manufacturing process such as errors in a machine tool ways, guides or spindles, inaccurate alignment of workpiece.

Roughness: Roughness includes the finest (shortest wavelength) irregularities of a surface. Roughness generally results from a particular production process or material condition.

Waviness: Waviness includes the more widely spaced (longer wavelength) deviations of a surface from it nominal shape. Waviness is generally caused by machine vibration or heat. The surface texture is the combination of roughness and waviness.

Surface texture = Roughness + Waviness

Surface roughness symbols and surface texture symbols are used for indicating surface roughness and surface texture on components respectively.

3.2 MATERIAL SELECTION AND EVALUATION

INTRODUCTION

The second step in the process planning n material evaluation and process selection.

Though the material selection for a component/product is the responsibility of design engineers, the process planner should evaluate the materials specified along with design engineers, based on the availability of manufacturing processes.

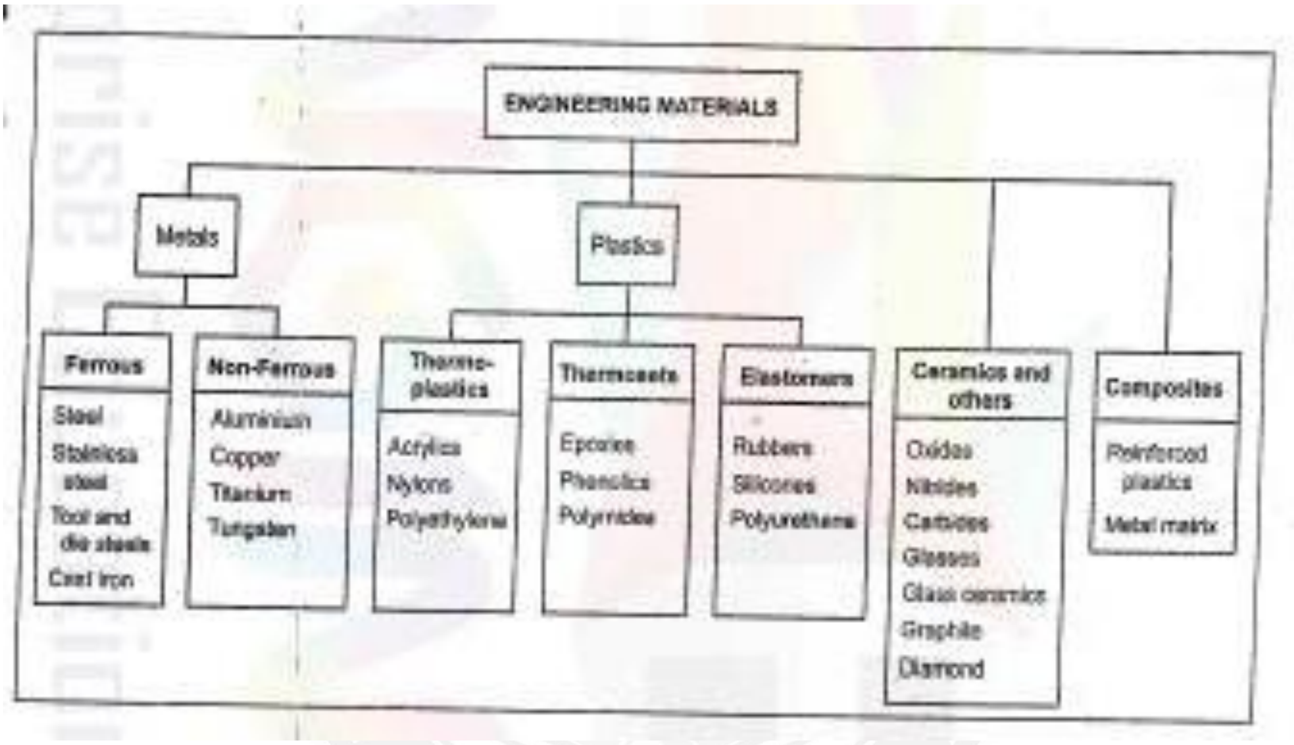
It should be noted that the material and process selections should be made taking into consideration the products to be manufactured, and the materials and processes available within the organization.

Also the selection of materials influences the selection of appropriate manufacturing processes. In the following sections, the common materials and manufacturing processes used in manufacture and the methods for their selection see presented.

OVERVIEW OF ENGINEERING MATERIALS FOR MANUFACTURE

Classification of Materials for Manufacture

A taxonomic classification scheme of engineering materials used in manufacturing is presented.



Properties of Engineering Materials

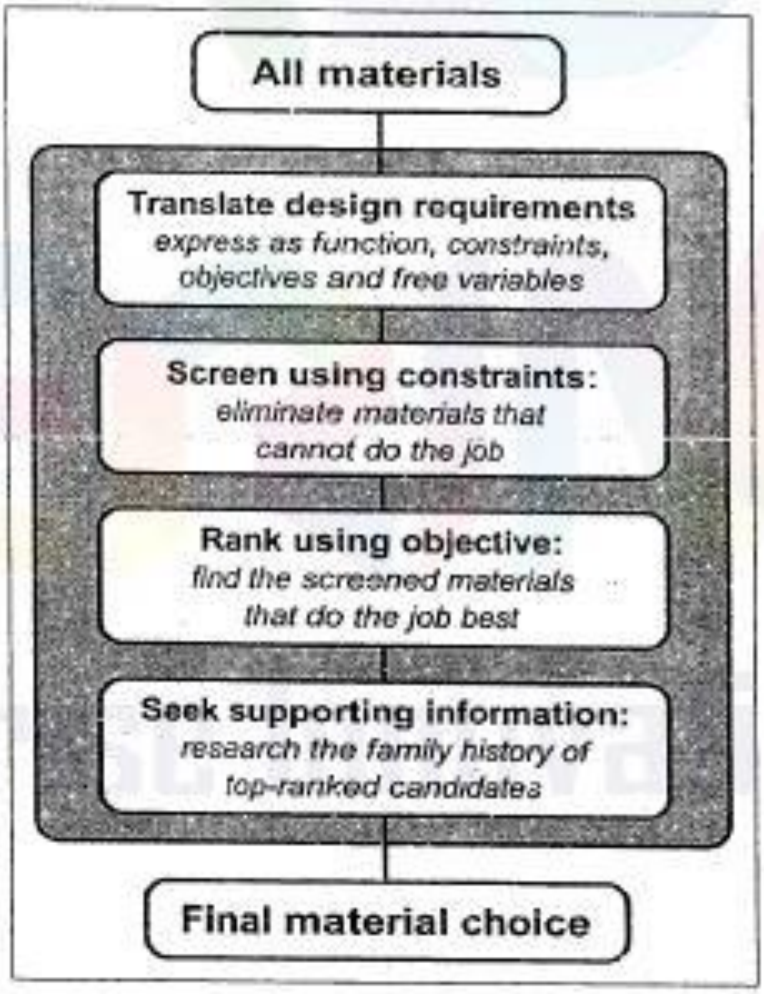
All materials exhibit many different properties and qualities. The properties of material provide a basis for predicting its behavior under various conditions.

Both design engineer and process planner should have wide knowledge of materials and their properties so that they can select a suitable material for the product.

MATERIAL SELECTION PROCESS AND METHODS

Material Selection Process

The selection of approximate materials for the product under consideration is a complex task.



The four-steps involved in the material selection process are:

Translation: Interpreting the design requirements in terms of function, constraints, objectives, and free variables.

Screening: Deriving attribute limits from the constraints and applying these to isolate a subset of viable materials.

Ranking: Ordering the viable candidates by the value of a material index, the criterion of excellence that maximizes or minimizes some measures of performance.

Seeking supporting information for the top-ranked candidates, exploring aspects of their past history, their established uses, their behavior in relevant environments. their availability and more until a sufficiently detailed picture is built up that a final choice can be made.

Material Selection Methods

The commonly used methods for material selection are:

- Selection with computer-aided databases
- Performance indices
- Decision matrices
- Selection with expert systems
- Value analysis
- Failure analysis
- Cost-benefit analysis

MATERIAL EVALUATION METHOD

The materials considered for selection are to be evaluated based on the following three considerations:

1. Shape or geometry considerations,
2. Material property requirements, and
3. Manufacturing considerations.

Shape or Geometry Considerations

- The shape or geometry considerations of a component/product influences die manufacturing processes to be employed to manufacture the component/product.
- Some of the important shape or geometry considerations are:
- Relative size of the component
- Complexity of the shape (symmetrical or uniform)
- Dimensional tolerance requirements
- Surface finish requirements
- Allowances to be made for wear during service
- Design for assembly
- Design for manufacturability

The influence of shape/geometry of raw materials on the selection of manufacturing processes to be employed.

Material Property Requirements

The material property requirements can be obtained under the following three categories.

(i) Mechanical properties.

(ii) Physical properties, and

(iii) Service environment.

Some of the mechanical property requirements include:

- Loading type involved
- Loading magnitude involved
- Chance of impact and cyclic loading
- Need for wear resistance
- Permissible temperature range
- Material deformation requirement

Some of the physical property requirements include:

- Effect of processing in electrical property requirements
- Effect of processing in magnetic property requirements
- Effect of processing in thermal property requirements
- Significant of weight
- Significance of aesthetic requirements Some of the service requirements include:
- Range of operating temperatures and rate of temperature change
- Expected life span of the product
- Most extreme working environment anticipated
- Anticipated maintenance of the product
- Reliability of the product
- Serviceability of the product

- Recyclability of the product

Manufacturing Considerations

The various considerations that influence the selection of manufacturing processes include

- Use of standard components/pans to take the advantage of interchangeability
- Consideration of ease of manufacture of the design
- Quantity and rate of components to be made
- Minimum and maximum section thickness
- Desired level of quality
- Anticipated QA and inspection requirements
- Consideration of ease of assembly of the design