ME8793 PROCESS PLANNING AND COST ESTIMATION

UNIT 1 INTRODUCTION TO PROCESS PLANNING

1.PROCESS PLANNING:

Process planning is a preparatory step before manufacturing, which determines the sequence of operations or processes needed to produce a part or an assembly. This step is more important in job shops, where one-of-a-kind products are made or the same product is made infrequently.

Planning processes can result in increased output, higher precision, and faster turnaround for vital business tasks. A process is described as a set of steps that result in a specific outcome. It converts input into output.

Process planning is also called manufacturing planning, material processing, process engineering, and machine routing. It is the act of preparing detailed work instructions to produce a part. It is a complete description of specific stages in the production process.

Process planning determines how the product will be produced or service will be provided. Process planning converts design information into the process steps and instructions to powerfully and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to make simpler and improve process planning and realize more effectual use of manufacturing resources.

It has been documented that process planning is required for new product and services. It is the base for designing factory buildings, facility layout and selecting production equipment. It also affects the job design and quality control.

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

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

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

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

"Process planning is a detailed specification which lists the operations, tools, and facilities. Process planning is usually accomplished in manufacturing department.

Process planning can be defined as "an act of preparing detailed work instructions for the manufacture and assembly of components into a finished product in discrete part manufacturing environments.

According to the American Society of Tool and Manufacturing Engineers. "process planning is the systematic determination of the methods by which a product is to be manufactured, economically and competitively."

It consists of

(î) the selection of manufacturing processes and operations, production equipment, tooling and jigs & fixtures;

(ii) determination of manufacturing parameters; and

(iii) specification of selection criteria for the quality assurance (QA) methods to ensure product quality

Importance of Process Planning

Process planning establishes the link between engineering design and shop floor manufacturing. Since process planning determines how a part / product will be manufactured, it becomes the important determinant of production costs and profitability. Also, production process plans should be based on in-depth knowledge of process and

equipment capabilities, tooling availability, material processing characteristics, related costs, and shop practices.

The economic future of the industry demands that process plans that are developed should be feasible, low cost, and consistent with plans for similar parts.

In addition, process planning facilitates the feedback from the shop floor to design engineering regarding the manufacturability of alternative.

Process planning is an intermediate stage between designing the product and manufacturing.

Objective of Process Planning:

The chief of process planning is to augment and modernize the business methods of a company. Process planning is planned to renovate design specification into manufacturing instructions and to make products within the function and quality specification at the least possible costs. This will result in reduced costs, due to fewer staff required to complete the same process, higher competence, by eradicating process steps such as loops and bottlenecks, greater precision, by including checkpoints and success measures to make sure process steps are completed precisely, better understanding by all employees to fulfil their department objectives. Process planning deals with the selection of the processes and the determination of conditions of the processes.

The particular operations and conditions have to be realised in order to change raw material into a specified shape. All the specifications and conditions of operations are included in the process plan. The process plan is a certificate such as engineering drawing. Both the engineering drawing and the process plan present the fundamental document for the manufacturing of products. Process planning influences time to market and productions cost. Consequently, the planning activities have immense importance for competitive advantage.

PRINCIPLES OF PROCESS PLANNING:

General principles for evaluating or enhancing processes are as follows:

1. First define the outputs, and then look toward the inputs needed to achieve those outputs.
2. Describe the goals of the process, and assess them frequently to make sure they are still appropriate. This would include specific measures like quality scores and turnaround times.
3. When mapped, the process should appear as a logical flow, without loops back to earlier steps or departments.
4. Any step executed needs to be included in the documentation. If not, it should be eliminated or documented, depending on whether or not it's necessary to the process.
5. People involved in the process should be consulted, as they often have the most current information.
6. Process planning includes the activities and functions to develop a comprehensive plans and instructions to produce a part. The planning starts with engineering drawings, specifications, parts or material lists and a forecast of demand. The results of the planning are routings which specify operations, operation sequences, work centers, standards, tooling and fixtures. This routing becomes a major input to the manufacturing resource planning system to define operations for production activity control purposes and define required resources for capacity requirements planning purposes.

Process plans which characteristically offer more detailed, step-by-step work instructions including dimensions linked to individual operations, machining parameters, set-up instructions, and quality assurance checkpoints.

Process plans results in fabrication and assembly drawings to support manufacture and annual process planning is based on a manufacturing engineer's experience and knowledge of production facilities, equipment, their capabilities, processes, and

tooling. But process planning is very lengthy and the results differ based on the person doing the planning.

MAJOR STEPS IN PROCESS PLANNING:

Process planning has numerous steps to complete the project that include the definition, documentation, review and improvement of steps in business processes used in a company.

Definition:

The first step is to describe what the process should accomplish. It includes queries like, what is the output of this process? Who receives the output, and how do they define success?, What are the inputs for the process?, Are there defined success measures in place - such as turnaround time or quality scores? And Are there specific checkpoints in the process that need to be addressed.

Documentation:

During the documentation stage, interviews are conducted with company personnel to determine the steps and actions they take as part of a specific business process. The results of these interviews is written down, generally in the form of a flow chart, with copies of any forms used or attached. These flow charts are given to the involved departments to review, to make sure information has been correctly captured in the chart.

Review:

Next, the flow charts are reviewed for potential problem areas.

Process planning in manufacturing may include the following activities:

1. Selection of raw-stock,
2. Determination of machining methods,
3. Selection of machine tools,
4. Selection of cutting tools,
5. Selection or design of fixtures and jigs,

6. Determination of set-up,
7. Determination of machining sequences,
8. Calculations or determination of cutting conditions,
9. Calculation and planning of tool paths,
10. Processing the process plan.

2. METHODS OF PROCESS PLANNING:

The two general methods / approaches to process planning are

1. Manual process Planning and
   (i) Traditional approach
   (ii) Workbench approach
2. Computer Aided Process Planning
   (i) Retrieval CAPP system
   (ii) Generative CAPP system

Manual process Planning

(i) Traditional approach

In traditional process planning systems, the process plan is prepared manually. The task involves examining and interpreting engineering drawing.

Making decisions on machining process selection, equipment selection, operations sequence, and shop practices.

The manual process plan is very much dependent on the skill, judgment and experience of the process planner. That‟s Why, if different planners were asked to develop a process plan for the same part, they would probably come up with different plans.

The traditional process planning usually involves the following three stages, are;

Stage 1: The process planner interprets the component/product drawing using his own experience and intuition. Taking into account the type of resources available, he decides on how the component / product should be made. He lists the sequence of operations to be carried out in order to manufacture the product.

Stage 2: The process planner refers the manual to decide on tools, feeds, speeds. etc., for each element of each operation, Also the specific operation setup times and operation times for each operation are calculated using the manual.

Stage 3: Finally, the resulting process plan is documented as a routing sheet.

Workbook Approach

- The workbook approach is a modified version of traditional approach of process planning that uses the developed workbook for preparing route sheet.
- In this approach, the workbooks of predetermined sequence of operations for possible elements of operations of components / products arc developed. Once the drawing interpretation is carried out, the suitable predetermined sequence of operations are selected from the developed workbook and the details are documented in the route sheet.

Advantages of Manual Process Planning

The advantages of employing manual process planning are as follows:

(i) Manual process planning is very much suitable for small scale companies with few process plans to generate.

(ii) This method is highly flexible.

(iii) This requires low investment costs.

Disadvantages of Manual Process Planning

The disadvantages of manual process planning include the following:

(i) Manual process planning is a very complex and time consuming job requiring a large amount of data.

(ii) This method requires the skilled process planner.

(iii) More possibilities for human error because this method depends on the planner's skill, judgement and experience.

(iv) It increases paper work.

(v) Inconsistent process plans result in reduced productivity.

(vi) It is not very responsive to changing manufacturing environment, new processes, new tooling, new materials, etc.

COMPUTER AIDED PROCESS PLANNNG (CAPP)

In order to overcome the drawbacks of manual process planning, the computer-aided process planning (CAPP) is used.

- With the use of computers in the process planning, one can reduce the routine clerical work of manufacturing engineers.
- Also, it provides the opportunity to generate rational, consistent and optimal plans.
- In addition, CAPPprovides the interface between CAD and CAM.

Benefits of CAPP

The benefits of implementing CAPP include the following

- Process rationalization and standardization: CAPP leads to more logical and consistent process plans than manual process planning.
- Productivity improvement: As a result of standard process plan, the productivity is improved (due to more efficient utilization of resources such as machines, tooling, stock material and labour).
- Product cost reduction: Standard plans tend to result in lower manufacturing

costs and higher product quality.

- Elimination of human error
- Reduction in time: As a result of computerizing the work, a job that used to lake several days, is now done in a few minutes.
- Reduced clerical effort and paper work
- Improved legibility: Computer-prepared route sheets are neater and easier to read than manually prepared route sheets.
- Faster response to engineering changes: Since the logic is stored in the memory of the computer.
- Incorporation of other application programs: The CAPP program can be

interfaced with other application programs, such as cost estimating and work standards.

Approaches of CAPP

The two basic approaches or types of CAPP system are

1. Retrieval CAPP system
2. Generative CAPP system

1. Retrieval CAPP system

- A retrieval CAPP system, also called a variant CAPP system, has been widely used in machining applications.
- The basic idea behind the retrieval CAPP is that similar parts will have similar process plans.
- In this system, a process plan flit a new part is created by recalling, Identifying aid retrieving an existing plan for a similar part and making the necessary modifications for the new part.

Procedure for Using Retrieval CAPP System

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

(amity and the associated standard plan. The standard plan is retrieved edited for the new part.

Advantages of Retrieval CAPP system

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

Drawbacks of Retrieval CAPP System

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

GENERATIVE CAPP SYSTEMS

- In the generative approach, the computer Is used to synthesize or generate each individual process plan automatically and without reference to any prior plan.
- A generative CAPP system generates the process plan based on decision logics and pre -coded algorithms, The computer stores the rules of manufacturing and the equipment capabilities (not any group of process plans).
- When using a system, a specific process plan for a specific part can be generated without army involvement of a process planner.
- The human role in running the system includes: (i) inputting the GT code of the given part design, and (ii) monitoring the function.

Components of a Generative CAPP System

The various components of a generative system are:

a. A part description, which identifies a series of component characteristics, including geometric features, dimensions, tolerances and surface condition.

b. A subsystem to define the machining parameters, for example using look-up tables and analytical results for parameters.

c. A subsystem to select and sequence Individual operations. Decision logic is used to associate appropriate operations with features of a component, and heuristics and algorithms are used to calculate operation steps, times and sequences.

d. A database of available machines and tooling.

e. A report generator which prepares the process pIan report

Advantages of Generative CAPP

The generative CAPP has the following advantages:

i. It can generate consistent process plans rapidly.

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

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

Drawbacks of Generative CAPP System:

The generative approach is complex and very difficult to develop.

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