

# Implementation of Manual Process Planning Methodology for Production

*A case study of aerospace parts manufacturing industry*

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**Abstract:** Process Planning is the technique of setting a sequence of operations for converting the raw material into finished product. In this paper, method of manual process planning has been described briefly and the focus is kept on the Batch Production. In small scale and medium scale industries, this technique of process planning is not implemented. A case study of aerospace parts manufacturing company has been discussed. This paper recommends the necessary action related with process planning which should be taken by the company. The sequence of operations performed there depends on the skills of the worker, availability of machines and time available which has nothing to do with the proper utilization of facility available. With the prior knowledge of Process Planning in production and various of its relative factors like machining, management of idle time of machines and cost estimation can be done effectively. By giving keen attention on the selection of machining facility, tools and jigs and fixtures, complex operations are carried out efficiently. This paper also discusses about the perfect utilization of available facility and provides recommendations for reducing the unnecessary time involved in setup time.

**Index terms – Process Planning, Manual Planning, Batch Production, Manufacturing, Process Design, Machines.**

## I. Introduction

The market today is customer oriented wherein industries are competing against each other to cater to the demands of their customers. Hence, it is mandatory for them to increase their potential in order to compete in this race. This being the reason, Process Planning and all other innovative techniques have been introduced.

Process Planning can be defined as determination of most economical methods for converting the raw material into finished product [1]. There are various research papers available about process planning like, Selen [2], Maja [3] and Magnus [4] etc. They all have defined process planning in their own way.

The main purpose of Process Planning is to utilize the available facilities and manpower effectively so as to improve the productivity of the plant by determining the most efficient sequence of the manufacturing processes for conversion of raw material into finished product. There are two main approaches to Process Planning which are as follows:

- a) Manual Experience Based Process Planning
- b) Computer Aided Process Planning method (CAPP)

### *Manual Process Planning*

In this method, the entire planning depends on the experience of the planner in manufacturing field and various available methods of machining operations which are required at the time of manufacturing of any component. Hence, the most qualified person is chosen for determination and selection of processes involved in the production. This method is most suitable for the small scale and medium scale industries as they cannot afford the expensive automated computerized mechanisms for process planning.

### *Computer Aided Process Planning (CAPP)*

It helps in determination of processes for any operation. CAPP develops the flow of sequence or the route sheet for entire production by using two different approaches which are as follows:

- a) Variant approach
- b) Generative approach

The plan can be changed as per requirement if it is not appropriate. It is not as simple as it seems because it has numerous complexities. Since, it integrates with the Computer Integrated Manufacturing (CIM) which can only be implemented in large scale industries. As the initial cost involved in Computer Aided Process Planning is considerably high, industries refrain from implementing it.

*That is the reason why major focus should be kept at Manual Process Planning and improvement in it for better productivity of medium scale industries.*

## II. Problem Definition

Actual name of the industry has not been disclosed for some reason. The method of Batch Production is currently being utilized to manufacture aerospace components at the industry because the parts are manufactured in a limited quantity. Also, the components differ drastically from each other in terms of specifications, design and purpose of their use. Thus, each component is manufactured by a completely different set of operation form each other. Therefore, it is a challenging assignment to select the best production method for a given component with the available machinery at the shop-floor. After a complete study of the planning method of their production system, it has been observed that the previous process sheets required some improvements. As the data available was not sufficient and significant information like machining parameters, set-up time, types of clamping devices or fixture used was not concisely mentioned. Hence, there was a hinderance in the interpretation of sheet by a person who did not have sufficient knowledge about resources available in the industry.

## III. Methodology

Following are the steps involved in process planning for Batch Production:

1. Identification of available resources (Machining facilities, Man power, Skills of labor, Time per shift, etc.)
2. Observation of plant layout.
3. Review the drawing of component and raw material.
4. Make decision about outsourcing.
5. Planning of production.
6. Check whether any special tool, clamp or fixture is required and design if any.
7. Prepare process sheet (Route sheet).
8. Inspect the processes on site.
9. Set quality standards for production.

### A) *Identification of available resources*

Available resources could be machine tools, man power, budget, etc. All these parameters should be considered while commencing the planning of production because they are directly associated with production.

The initial step in an industry is to analyze the available resources like accessibility of machines and their quantity, capacity and accuracy. It is very crucial to check that the employed workers have sufficient skill for operating the machines under any condition and to utilize the machine impeccably. If workers do not possess required skills then it may cause wastage of time which will directly affect the productivity and plant efficiency. Hence, the skills of the workforce should be considered while selecting the production method. We must know the time available per shift in order to estimate total time for production which is very important in cost estimation.

### B) *Observation of plant layout*

Plant layout is a generalized arrangement of all the machines on the shop-floor in a plant and it also incorporates personnel, storage space and material handling equipment [1]. Plant layout specifies the position of all machines and determines the flow of material while production for reducing the material handling time. We must arrange the production processes as per plant layout. Plant layout is most influenced by the type of production system. Hence, we must ensure that the current plant layout is best suitable for Batch Production [5].

Nowadays, a trend of segregating machines based on their functions is followed. For e.g. machines required for turning are grouped together and separate section is made for CNC machines. This pattern is particularly followed in small scale industries. Hence, special attention is required for such layouts. Over here planner should arrange the sequence of the operations in such a way that, operations which require similar set of machines should be arranged simultaneously one after another.

### C) *Review the drawing of component and raw material*

Before initiating process planning, it is a requisite to ensure that the drawing provided is accurate in all aspects and if there are any errors in it, then it should be reported to higher authorities and the drawing should be modified. Occasionally, it may happen that the raw material provided is substantially larger than the actual material required. This necessitates excessive roughing process on material for bulk removal of unwanted material which is a waste of resources like time and money. Similarly, machining is not possible on smaller raw material. Therefore, one must confirm that the raw material provided is as per requirement. All of these can be determined only after thorough study of drawing. At times, the composition of raw material does not match after the chemical testing. Hence, precise decision should be made before starting the production regarding material compositions by contacting customer.

### D) *Make decision about outsourcing*

Occasionally, it may happen that we might require outsourcing for certain orders. In case of lack of availability of machines or certain operations requiring machining, which is not achievable from existing facilities then the necessary job is done from some other organization. Also, just for reducing time industries opt to outsource few orders. In Process Planning, the aim of planner is to utilize the available machines and resources effectively so as to minimize outsourcing. However, it becomes very difficult in specific

cases to decide that whether the job should be outsourced or not. It only happens when it is not well thought out at the beginning of production. Thus, decision about outsourcing should be taken in the preliminary stages for avoiding inconvenience in future.

Some components are more economical when outsourced than production. Such parts should be attended before production and remaining parts should be produced within the industry. In case of batch production, design changes frequently and quantity is less in comparison to mass production which necessitates a decision about requirement of outsourcing. If outsourcing is cost effective then it is the paramount alternative when it comes to batch production.

### **E) Planning of production**

Planning starts for converting the raw material into finished component. This is the most fundamental part of process planning in which following important steps are taken:

#### **a) Selection of machine tools:**

One operation can be performed on various machines. For example- a hole can be drilled on drilling machine, lathe machine or milling machine. Hence, for a particular operation one suitable machine could be selected on the basis of following factors [1]:

- 1) Set-up time involved
- 2) Economical consideration
- 3) Rate of production
- 4) Accuracy needed
- 5) Capacity of machine
- 6) Component size

Requirement of minimum machines can also be found out by the formulae provided in book of Martand Telsang [1] which is given below:

$$\text{No. of machines required} = \frac{\text{Standard time for the operation} * \text{Maximum production required in specified time}}{\text{Machine capacity} * \text{Utilization of machine capacity (\%)}}$$

#### **b) Consider related science of the material to be manufactured:**

Depending upon the material and its composition various actions are taken during the manufacturing process. Soft materials require different heat treatment processes than hard materials. Various materials demand heat treatment intermittently so as to reduce the internal stresses and make the material further machinable. Materials like Aluminium and its alloy require aging at certain intervals. (When components are kept for long duration after machining process at room temperature for enhancing strength and mechanical properties, it is termed as Aging)

#### **c) Determine the machining parameters:**

Machining parameters like speed, feed, depth of cut have major impact on the quality of machining, surface finishing and time elapsed in machining. They depend on various factors like tool material used, material to be machined and surface finish required. Machining parameters are determined by various theoretical formulae although the relative experience of the worker also aids in determining those parameters.

#### **d) Sequencing of job on machines:**

In case of batch production, the quantity manufactured is significant but the availability of machines on the shop-floor is limited. Hence, sequencing is done on the basis of time required for machining on a particular machine. Johnson's Algorithm is used for sequencing.

### **F) Check whether any special tool, clamp or fixture is required and design if any**

In some situations, few machining processes becomes complex due to clamping problem. Also, certain cases involve special tools for performing the operation. In the method of process planning, this concern is well thought of beforehand. A befitting clamp or tool should be designed and detailed instructions should give to the workers. This will permit in minimizing time for future orders and will also aid in increasing rate of production.

### **G) Prepare process sheet (Route sheet)**

The representation of all the congregated information on a sheet in a concise manner, pertaining to each operation involved in the transformation of raw material to finished component is called as process sheet or route sheet. It comprises all the necessary descriptive data related to manufacturing like machines, tools, machining parameters and operation description.

Previously in this industry, the employed process sheets had deficiency of information and now they have been replaced by recommended process sheets. Figure 1.0 shows the previous process sheet used by the company.

PROCESS SHEET						
PART NAME - XYZ		DRG NO. - XYZ		MATERIAL AND SIZE - XYZ	HARDNESS - XYZ	SURFACE TREATMENT - XYZ
OP. NO	OPERATION	DESCRIPTION OF OPEARATION		WORKSTATION	MEASURING TOOLS	REMARKS

Figure 1.0

It can be observed from Figure 1.0 that machining parameters (speed, feed and depth of cut) had not been mentioned. Thus, according to the experience of operator suitable parameters were assumed which resulted into non-adherence to the demands of accuracy and surface finish as obliged by the customer. In case of absence of supervisor on the shop floor, it will be arduous for the operators to interpret the process sheet.

PROCESS SHEET													
PART NAME - XYZ		DRG NO. - XYZ		MATERIAL AND SIZE - XYZ					HARDNESS - XYZ		SURFACE TREATMENT - XYZ		
OP. NO	OPERATION	MACHINE	LOCATORS	ATTACHMENTS	TOOLS	MACHINING PARAMETERS			SET-UP TIME (MIN)	MACHINING TIME (MIN)	OUTPUT PER SHIFT (NOS)	INSPECTION & INSTRUMENT USED	DISCUSSION
						SPEED (RPM)	FEED (MMP)	DEPTH (MM)					

Figure 2.0

Following are the advantages of implementation of new process sheet over previous one:

1. Set-up time and machining time assists the supervisor to schedule the similar jobs.
2. Operators are able fathom the process sheet and the obligatory requirements of machining.
3. Predefined machining parameters mentioned in the sheets helps to perpetuate uniformity.
4. It provides data regarding selection of locators, jigs/fixtures and special attachments which facilitates in holding the job aptly.
5. A special column for discussion is added to notify the operator when special actions are required to be undertaken.

**H) Inspect the processes on site**

When production commences, it is the responsibility of process planner to certify that the proposed machining methods are being implemented appropriately. An inspectional survey is mandatory while production is ongoing and any difficulties encountered by the workers should be resolved coherently. A record about all the intricate details should be made in order to preclude these problems from happening during future orders. Inspection is extremely crucial stage which is skipped time and again but it may cause delay in production if something unpredictable happens. For this reason, inspection should never be disregarded and must be completed sincerely in order to put a check on the production delays. Such delays not only affect the industry economically but also thwarts the relationship with the customer.

**I) Set quality standard for inspection**

In many components, there are specific areas which require acute attention while being manufactured because of their complex geometry and dimensions. When such components are being inspected, these dimensions should be scrutinized carefully. It is the duty of the process planner to inform the quality department regarding the necessary attention to be given to those special areas in the components while doing inspection. Also, knowledge regarding the mandatory geometrical tolerances should be given by the process planner so that the quality engineer can select proper instrumentation for inspecting the specific part.

**IV). Result**

After successful implementation of process planning methodology at the industry following results have been observed:

1. Maximum utilization of resources.
2. Reduction in production cost.
3. Wastage reduction of resources.
4. Improved quality of finished product.
5. Efficient time management.
6. Systematic utilization of available facilities.
7. Increased productivity of plant

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