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Process Planning for Aircraft Frame

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Abstract
Manufacturing process planning is the process of selecting and sequencing manufacturing processes such that they attain one or more goals and assure set of field constraints. The main function of operations scheduling is to arrange part lists, operations schedules, NC programming and to map special-purpose manufacturing resources. It also provides accurate and clear chronological directions about how the product is to be routed and made-up in a manufacturing facility. This paper gives details regarding the unmachined part or element and then determining the sequence of operations, choosing manufacturing resources and determining regular times. The result of these planning operations is recognized in work schedule. The information in the work schedule is very important since they are necessary for supplementary use in many areas of the industry. Among their other functions, they develop into part of the so-called "working papers".

Keywords: manufacturing, tape time, process planning, working paper.

I. INTRODUCTION

Process planning in manufacturing may be generally defined as the development of set of instructions describing all the operations required converting a design into a product. In highly developed manufacturing, process planning will control how the capacity will be designed and laid out in preparation for the new product. Process planning deals with the assortment of the processes and determination of environment of the processes [1]. The preferred operations and conditions have to be realized in order to change raw material into a given shape. Process planning in assembling provides exact and clear successive rules about how the item is to be routed and created in a manufacturing capacity. All the specifications and environment of operations are included in the process plan. The process plan is a document such as engineering drawing. Both the engineering drawing and the process plan present the fundamental document for the manufacturing of products. A successful manufacturing method depends on a manufacturer's capability to construct products in repeatable and consistent ways. The planning activities have a better significance for competitive improvement. The best possible process plan has to accomplish the selected production criteria (quality, time and cost) [2]. The manufacturing background and the production facilities are subjected to comparatively little changes over time. This means that processes, machine tools, measuring machines, cutting apparatus, fixtures, jigs and other tools are not subjected to great changes over time. Once the process planning is done, then the billet is machined according to the setup sheet for the manufacture of the aircraft frame.

A Gantt chart is a kind of bar chart, tailored by Karol Adamiecki in 1986 and separately by Henry Gantt in the 1910s, that illustrates a project timetable. Gantt charts demonstrate the start and end times of the terminal elements and summary basics of a project. Terminal elements and summary elements consist of the work breakdown arrangement of the project. Present Gantt charts also illustrate the dependency (i.e., precedence network) relations between activities. This chart is also used in information technology to characterize data that have been composed. Gantt charts can be used for scheduling common resources as well as in project management; they can be used in preparing production processes.

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20. EXPERIMENTAL DETAILS

The aim of process planning is to convert design specification into manufacturing instructions and to make products within the function and quality specification at the lowest cost. Process planning is the preparation activity of an engineer or a planer [3]. One can see planning activities in various purpose areas, for example: The product is manufacturable in many ways. In order to manufacture this part, the work is carried out in the following stages,

- Study for the improvement of manufacturing aircraft frame.
- Study the concept of process of planning and fabrication.
- Modify and improve machining process.
- Increasing process capability which directly results in cost reduction.
- Collecting the results in each process.
- Improving the existing process.
- Avoiding warpage during machining and reducing machining time.

Manufacturing methods depend on several parameters of part and production (Fig.1).

- Material properties of part
- Geometrical properties (shape and dimensions) of part
- Total amount of parts
- Available manufacturing equipment
- Batch
- Production amenities
- Constraints of manufacturing location
- Time to manufacture
- Cost to manufacture

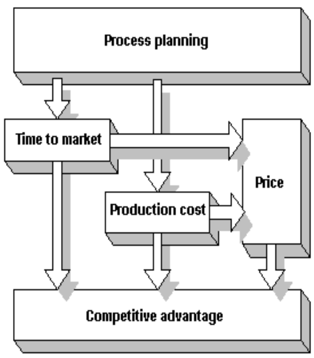

Fig 1: Influence of process plan on competitive advantage

This paper presents the process planning for the manufacturing of the 'frame' part of aircraft. The frame of an aircraft is its mechanical structure. It is usually considered to include fuselage, undercarriage and wings and keep out the propulsion system. Airframe design is a field of aerospace engineering that combines aerodynamics, materials technology and manufacturing methods to attain balances of reliability, performance and cost. Fuselage is an aircraft's main body section that holds crew and passengers or cargo. It is divided into three sections. They are, front fuselage, centre fuselage and rear fuselage. The front fuselage consists of station 1 to station 21. Centre fuselage consists of station 21 to station 30 and the rear fuselage consists of station 30 to station 38. The aircraft frame comes under centre fuselage, with the station number 22.

One can see planning activities in various purpose areas, for example: The product is manufacturable in many ways [4]. Manufacturing methods depend on several parameters of part and production. Initially the material for the manufacture of top frame is decided. The material selected for the manufacture of the 'frame' part is aluminium alloy. Since aluminium in its pure state is lightweight, rust resistant and glowing. Also, it has very high thermal conductivity [5]. It is nonmagnetic, ductile and malleable in nature. When shared with different percentages of other metals (generally magnesium, manganese and copper), aluminum alloys that are used in the aircraft construction are formed. Corrosion resistance can be incredible because of a slender surface layer of aluminium oxide that forms when the metal is exposed to air. Aluminum alloys are strong as well as lightweight (Table I & Table II). They do not attain the corrosion resistance of pure aluminum and are usually treated to avoid corrosion. Metals usually come in all structures. On account of aluminum, plate and bar stock are the two principle general structures from which machined parts are equipped. The end cutter and ball nose cutter are the two types of milling cutters used in the manufacturing of aircraft frame. The properties and composition of the tool used in machining of the part is given in the table III and table IV respectively.

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TABLE I: COMPOSITION OF ALUMINIUM ALLOY

Physical properties	Metric
Density	7780kg/m^3
Ultimate tensile strength	850MPa
0.2% Yield strength	480MPa
Modulus of elasticity	200GPa
Poisson's Ratio	0.3

TABLE 21.: PROPERTIES OF ALUMINIUM ALLOY

Component	Weight %
Aluminium	93.06
Copper	6.3
Manganese	0.3
Zirconium	0.18
Vanadium	0.1
Titanium	0.06

TABLE III: COMPOSITION OF TOOL STEEL

Component	Weight %
Carbon	0.4
Silicon	0.25
Manganese	0.85
Chromium	1.0
Molybdenum	0.3
Sulphur	0.035 max
Phosphorus	0.04 max

TABLE IV: PROPERTIES OF TOOL STEEL

Physical properties	Metric
Density	7780kg/m^3
Ultimate tensile strength	850MPa
0.2% Yield strength	480MPa
Modulus of elasticity	200GPa
Poisson's Ratio	0.3

The setup sheet is process of making such as a machine or computer program, prepared to be used. The way that something is done or categorizes the assembly and arrangements of the tools and equipments necessary for the performance of an operation. It also includes the preparation and modification of machines for an assigned task. In addition it consists of preparation, modification of machines for the assigned task. Two steps are involved in the manufacture of the aircraft frame. The below Gantt chart represents the setup sheets by taking tape time at 200mm/min and various processing operations into consideration. The tape time in the setup sheet is the time when the machine is handling some operations. It is also utilized as a part of different circumstances for example, when a machine introduces screws in a case automatically.

Gantt charts demonstrate the start and end times of the terminal elements and summary basics of a project. Terminal elements and summary elements consist of the work breakdown arrangement of the project. Present Gantt charts also illustrate the dependency relations between activities (Fig. 2 & Fig. 3). Gantt charts can be used to track shifts or tasks and also vacations or other types of out-of-office time. According to the process planning two setups are involved in the fabrication of the top frame. The x-axis in the Gantt chart represents the tape time (hr) and the y-axis represents the various

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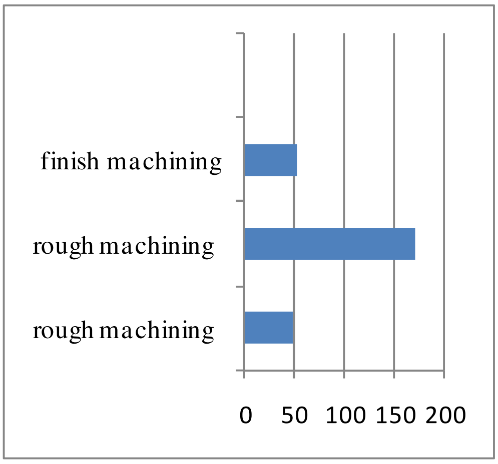
machining process according to the process plan sheet.

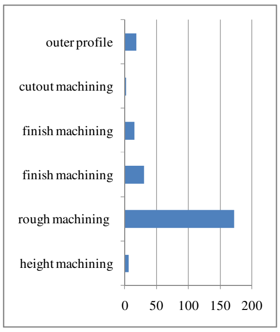
Gantt chart for setup1: tape time @ 200mm/min (Fig: 2).



Tape time (hour)

Fig 2: Gantt chart for setup 1

Gantt chart for setup 2: tape time @ 200mm/min (Fig. 3)



Tape time (hr)

Fig 3: Gantt chart for setup 2

According to the process planning sheet,

The total time taken for the first setup = rough machining time (47.5hr) + rough machining time (172.5hr) + finish machining time (52.5hr) =272.5hr (1)

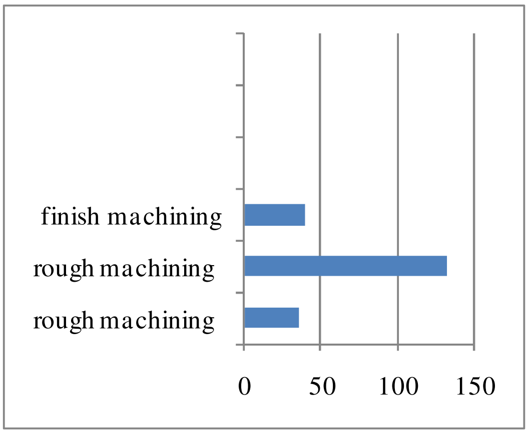
The total time taken for the second setup = height machining time (6.25hr) + rough machining time (172.5hr) + finish machining time(30.83hr) + finish machining time (15hr) + cutout machining time (1.66hr) + outer profile time (18.33hr) + extra material removal time(125hr) = 370hr (2)

Therefore the actual total time taken for the machining of the entire part = (1) + (2) = 642hr.

22. RESULTS AND DISCUSSIONS:

Machining process is modified and improved. The feed rate is increased by 280mm/min. Then the results are taken down after each machining operation. The total time taken for the manufacturing of the part is reduced. The Gantt chart is drawn for the setup I and set up 2 according to the exact time taken down at the end of each machining operation (Fig. 4 & Fig. 5).

Gantt chart for setup 1: tape time @280mm/min (fig. 4).



Tape time (hr)

Fig 4: Gantt chart for set up 1

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Gantt chart for the setup 2: Tape time @ 280mm/min (Figure 5).

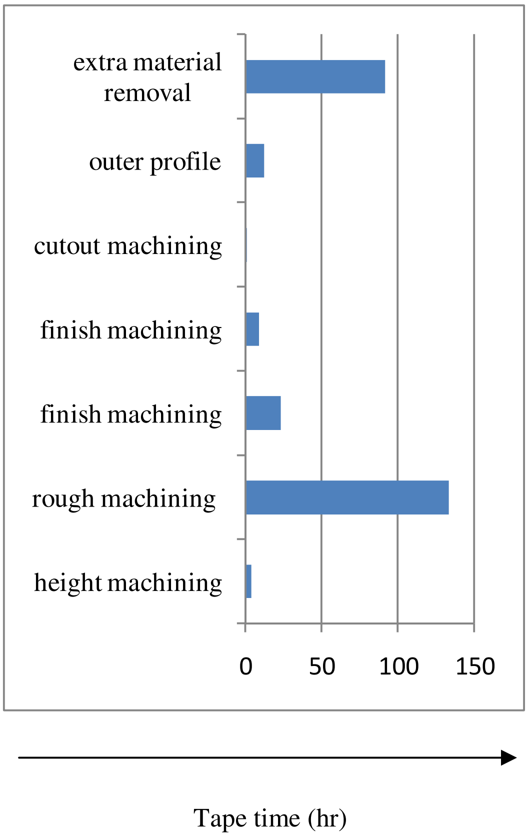

Fig 5: Gantt chart for set up 2

The actual time taken when the feed rate is increased at around 280mm/min,
Time taken for the first setup = rough machining time (35.83hr) + rough machining time (133.33hr) + finish machining time (40hr) = 209hr (3)
Time taken for the second setup = height machining time(4.16hr) + rough machining time (133.33hr) + finish machining time (23.33hr) + finish machining time (9.166hr) + cutout machining time (1.25hr)+ outer profile time (12.5hr)+ extra material removal time (91.66hr) =275hr (4)
Therefore total actual time take taken for the manufacture of part = (3) + (4) =209+275=484hr

So the total reduction in time = total actual time taken according to the process plan at feed rate at 200mm/min – total time taken for the manufacture of the part at feed 280mm/min =642 – 484= 158hr

The changes made during the processing operation and usage of fixtures influenced on the various factors such as machining time, warpage, labor cost, process capability and efficiency(Fig: 6).

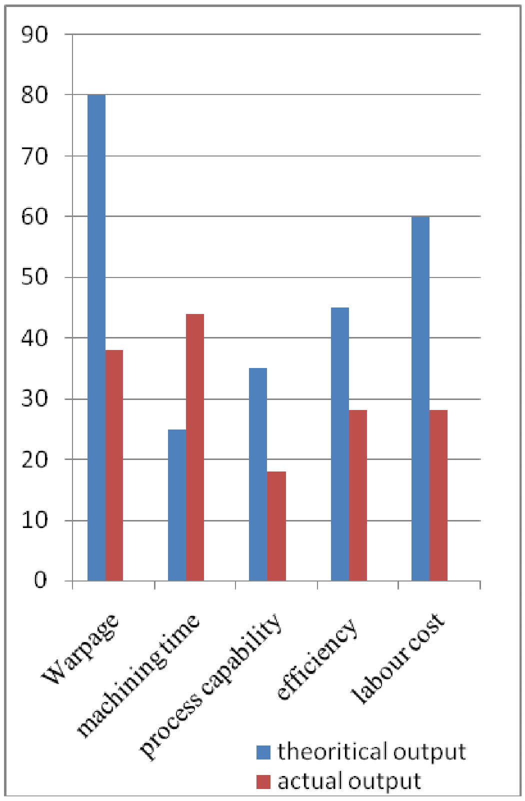

Fig 6: Gantt chart comparing theoretical output and actual output

The warpage, machining time, labour cost has been reduced. The process capability and efficiency has been increased around 30% of the theoretical output. Warpage is reduced by proper heat treatment, usage of fixture and by machine optimization. The total time taken for the manufacturing of the part is reduced by 158hr.

23. CONCLUSION

- Total time taken for the manufacturing of the part is reduced around 25% of the theoretical assumed time during the process planning stage.
- Process capability is increased by increasing the feed rate @ 200mm/min to

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280mm/min, which directly resulted in cost reductions.

- Because of the modification during the machining process the given part is manufactured 158hour earlier than assumed during process planning. Which impact in the reduction of machining cost and labor cost.
- To lessen process duration required for loading and unloading of part, this methodology is valuable.
- Fixture and rigid clamping strength optimization technique based on optimal fixture outline could minimize the deformation most adequately.
- The fixture used according to the process plan accomplished the production goal and increased the efficiency.

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