

Process Planning for Manufacturing of Aircraft component (Front spar L/H): A Case study

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Abstract: The key to a successful project is in planning, creating a process plan is the principal thing we ought to do when undertaking any project. A project is successful when it needs to address the needs of the stakeholders. Process planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Process control guarantees that production team can accomplish required target, optimum utilization of resources, quality management and cost savings. This paper has an a far reaching purpose of finding methods that cover all the activities of process planning, including abilities to anticipate the result of a proposed process. This is done by gathering supporting methods suitable to manage both qualitative and quantitative characterization and analyses of a process. The production team from the company has requested systematization and deeper understanding of industrial process planning. This paper incorporates with a flow chart describing the process planning process (PPP), this includes process planning activities and information flows between these activities. The research has been performed in an industrial environment for high volume manufacturing of gear parts. The objective of the paper is to make a process Plan for manufacturing of an aircraft component (front spar L/H) IIR-2B-2500-O01-IAO. The process was observes by analyzing the previous components and their processes and then reducing the cycle time. At the end the Process Plan for Manufacturing of Aircraft Component was designed and tested successful. Then it was implemented on the prototype first and then on the real aircraft component that will be used in the future aircraft named HTT-40. The time for the Different operations was reduced by combining the operations and successfully completing the project and helping the company in attaining profit by reducing operational cycle time.

Index Terms - Process Planning, Work Flow Plan, style, Work breakdown structure, Spar.

I. INTRODUCTION

To enhance the overall system performance production planning plays a very important role, particularly when a process works in an uncertain condition. Raw material quality, processing time and product demand are some regular sorts of uncertainties that describe production system. These uncertain parameters are considered t build a robust production planning process, on the grounds that ignoring them will influence on system efficiency and performance. The models of decision making process in production planning are classified into three categories: long-term, medium-term, and short-term planning. Long-term planning fundamentally focuses on equipment, process choices and product whereas the short-term and medium term planning deals with the material flow, sequencing and lot size for optimizing overall performance. Normally, the time range decision is within one day for the short-term planning [1].

Production planning is also called as process planning; process planning directs such production performance metrics as manufacturing lead time, throughput, plant and process optimization, production cost, delivery lead time, quality, revenue, sales and so forth. Initially at the design stage, production planning includes suitable raw material selection, production equipments and sequencing, evaluating cost and time, setting up which machines will be utilized, the machine process parameters for example, feed rate, working temperature, dimensioning and so forth.



Fig1: Process planning puts product design into work [2]

Production planning for production covers wide range of exercises expected to determine the process for producing work part. Unfortunately, the term process planning has not having clear definition it is somewhat fuzzy [3]. The basic definition of the process planning in the production context is the finding the process and resources required for finishing any of the process for converting raw materials into a useful product to fulfil the design requirement, aim and respect the geometric, technological constraints [4].

Process plan is described as the interface between the design and manufacturing; therefore the process planner plays a very important role not just to define a process but to contribute with knowledge in manufacturing. There are four levels in process

planning to get some clarity in different directions in process planning. The levels are put in order from low level to detailed level, the direction and final output is also identified according to Table 1.

Process planning level	Main focus of planning at this level	Level of detail	Planning output at this level
Generic planning	Selecting technology and rapid process planning	Very low	Manufacturing technologies and processes, conceptual plans, and DfX analysis results
Macro planning	Multi-domain	Low	Routings, nonlinear plans, alternate resources
Detailed planning	Single domain, single process	Detailed	Detailed process plans (sequence, tools, resources, fixtures, etc.)
Micro planning	Optimal conditions and machine instructions	Very detailed	Process/Operation parameters, time, cost, etc., NC codes

The field of process planning of transmission parts, based on experiential research. It describes what is the role does the process planner play in various circumstances, what is the area of responsibility, what motivates the use of systematic and transparent process planning methods? Figure 2 shows characterizes the interaction between the process planner and collaboration parties while developing a process plan. [5]

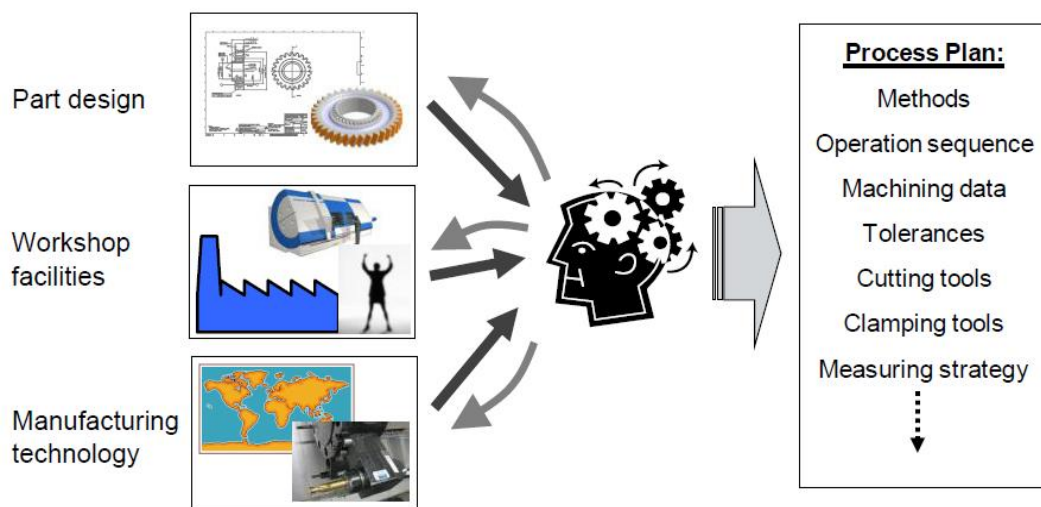


Figure 2: The role of the process planner [5].

Flow of information from design to process planning, and regularly a probability to input back to part design. This relies upon the circumstance and where the designed part is in the product life cycle. In product improvement stages usually to have coordinated effort between part design and process planning and here small adjustments can be made in design. At the time the product is develop, perhaps turning into an spare part, and a sub-supplier is allotted to start production, the edge for changing the design is on the other hand high. Also, cooperation with other suppliers of technologies particularly relies upon the circumstance and on organization strategies.

Regularly process planning depends on experiences and knowledge of the process planner, performed by instinct, and without any explicit procedures for working. The main documentation is the finally defined process plan and the traceability of made decisions is poor.

1. CASE STUDY ON PROCESS PLANNING

The key to a successful project is in planning. Creating a process plan is the first thing we should do when undertaking any project. Often process planning is ignored in favor of getting on with the work. However, many people fail to realize the value of a process plan for saving time money and many problems. This Paper is a practical approach to process planning. For efficient, effective and economical operations in manufacturing unit of an organization, it is essential to integrate the process planning and control system.

Process planning and subsequent production control follow adaption of product design and finalization of a production process. Process planning and control address a fundamental problem of low productivity, inventory management and resource utilization. Process planning is required for scheduling, dispatch, inspection, quality management, inventory management, supply management and equipment management. Process control ensures that production team can achieve required production target, optimum utilization of resources, quality management and cost savings.

Planning and controlling is an essential ingredient for a success of an operation unit. The ultimate aim of all process plans is to develop a road map which best depicts how a work material will be converted to a finished product in accordance with its engineering design and drawing. Although process planning may vary from one planner to another; the underlying principles remain the same: establishing an efficient and optimum sequence of operations, selecting proper equipment and tooling, and specifying their operations in such a manner that the product will meet the requirements stipulated in the design specifications.

2.1 Work Flow Plan

The workflow which has a start point and an end point. Workflows can be linear (the the initial step begins from outside the workflow) or looped (the flow is independent, and the endpoint starts another new start point). Each workflow requires an initiator, an individual or event that sets off the workflow. A workflow likewise incorporates team members or participants, who

might be assigned work to process and move to the following stages. You can plan workflow steps with the goal that work things are done at a specific time, and they may expect essentials to progress to the subsequent stage. For instance, to move a work thing in a bug tracking system to the finished state, a remark may be required.

Workflow planning can consist of two efforts: defining or creating the workflow, and running or scheduling the workflow:

- To define a workflow, find a set of ordered activities that, when run, can change a situation to achieve a goal. The workflow is a model and may be automated through a software program.
- To run the workflow, apply it to a specific situation. For example, a printing job shop may diagram a basic workflow that includes taking an order, receiving a deposit, adding the order form to the To-Do folder, adding the completed work to an Approval folder, and then adding the work to a Customer Pick-Up folder. The workflow is run when an order is received, and the forms and work are applied to the correct folders in the correct order.

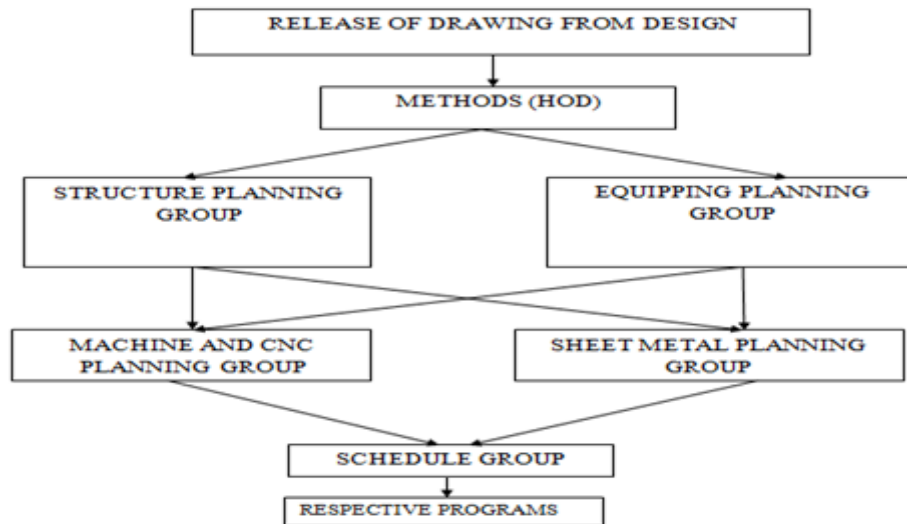


Figure 3: Work Flow

From figure3 the starting point of workflow is from receiving the design from the design team then the team leader set the methods of process plan and the final step is to give process planning documentation.

2.2 Planning break down

An evolutionary WBS should organize the planning elements around the process framework rather than the product framework. The basic recommendation for the WBS is to organize the hierarchy as follows:

- First-level WBS elements are the workflows (management, environment, requirements, design, implementation, assessment, and deployment).
- Second-level elements are defined for each phase of the life cycle (inception, elaboration, construction, and transition).
- Third-level elements are defined for the focus of activities that produce the artifacts of each phase.

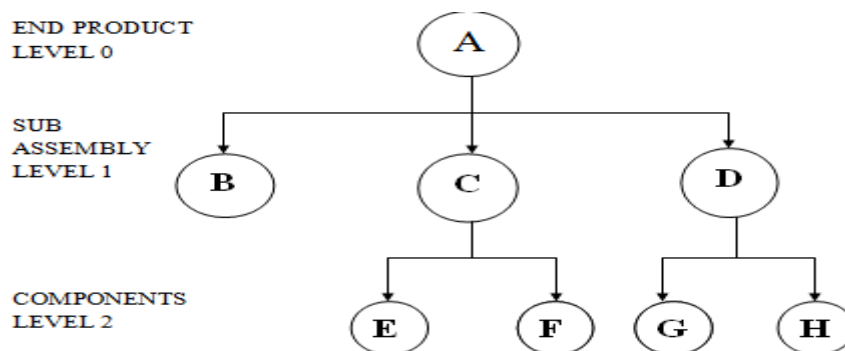


Figure 4: Planning Breakdown

Work breakdown structure

- This defines the major structural component their individual parts, sub-assembly and system installed in each major component
- It indicates the levels of components
- Sequence of manufacturing of individual parts of stages of assembly

2.3 Planning Procedure of Aircraft

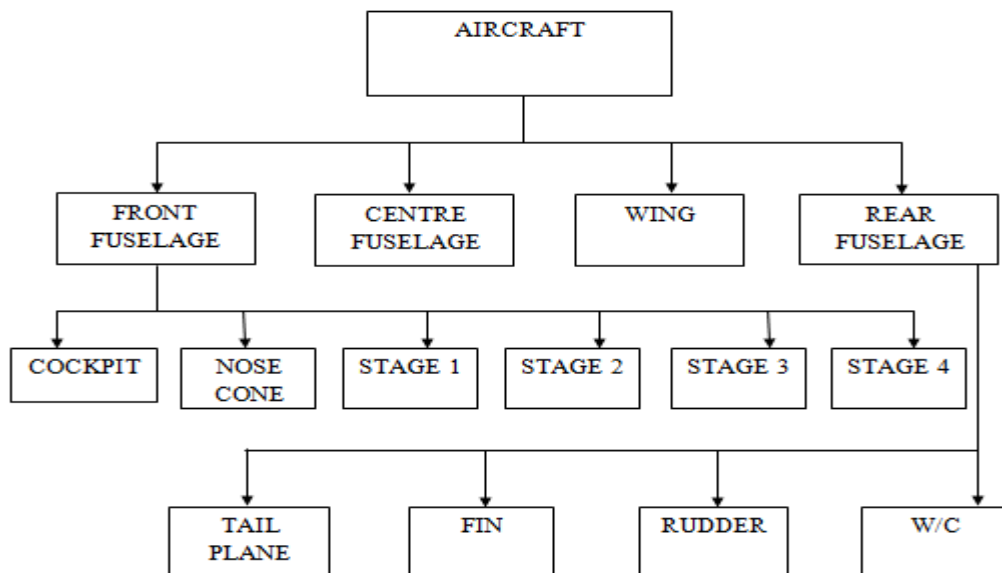


Figure 4: Planning Procedure of Aircraft

- Some Details Can Be Fitted On Final Assembly
- Some Assemblies Can Be Fitted On Final Assembly.

2.4 Processing or methodizing:

It gives the information regarding

- Types of machines, to be used
- Materials to be used, condition of the materials
- Heat treatment required before and after machining
- Surface treatment required (temperature and performance)
- Surface finishing required
- Advise material summary to material plan for taking procurement action
- Quantity to be produced in one batch or multiple batch
- Resource required/technological required
- Make or buy decisions
- Updating of product

Table 2: Process Planning for actual part [front spar (L/H) 11R-2B-2500-001-1A0]		
Operation No.	Note Text	Check Points
5	Certify G.D	Along 2770mm
10	Slit to get Size Aluminum	180mm*345mm*2770mm & 2770mm along GD-AL along plate
		Material
		Aluminum
		Aluminum
		Machining Allowance
		5mm
		20mm
15	Skim Cut to facilitate NDT 006	Reduce the Diameter by 2mm for ROD. for Rectangular Bar Reduce all dimensions by 5mm
20	Deburr	Material supply 175mm*340mm*2750mm & 2750mm along G.D
25	Check for Heat Treat	For aluminum
30	NDT006	Class A = for class 1 parts
		Class B = for class 2 parts
35	Rough Machining	Hold in shop made/ vacuum fixture rough mill contour with Pockets and flanges keeping 3mm extra material all around as per NC program setup
40	Check/fabricate for special tools required for fabrication of parts	split/threaded bush, Spherical form tool, Mandrel
45	Check for Gauges, if not available give request	
50	Layout for milling/Drilling	Hold in shop made/vacuum fixture, reset and ranger mill contour With pockets & flanges keeping 3mm extra material cell around as per NC program setup – 2

55	Fabrication Details, Hold in chuck & turn/step turn or set & mill/step mill	Deburr all sharp edges, if war page is more than 1mm then open out existing location Hole from 14(H7) and datum hole from 12(H7) to 14(H7) diameter deburr locating and datum holes. Set & drill & ream & jig holes 6mm (H7) dia. Tooling holes at 4 places & maintain drawing dimensions.
60	Inspect Controlled Dimensions & Certify (dimensions to be mentioned)	
65	Write Part no.	11R-2B-2500-001-1A0
70	Inspect Fabrication	
75	C/O NDT004 or NDT015	NDT004, NDT015, NDT004, NDT015
80	Inspect	Required only if previous step is NDT015
85	Inspect	checked
99	Close JC	Close and certify

Table 2 shows the Process Planning for actual part (front spar (L/H) 11R-2B-2500-001-1A0) with their operation number along with the details of the operation and the remarks of the operation.

Table 3 shows the Process Planning for actual part (front spar (L/H) 11R-2B-2500-001-1A0) with their operation number along

Table 3: Process Planning for actual part [front spar (L/H) 11R-2B-2500-001-1A0] With Time

Operation No.	Note Text	Check Points	Time in min
5	Certify G.D	Along 2770mm	
10	Slit to get Size Aluminum	180mm*345mm*2770mm & 2770mm along GD-AL along plate	25
		Material	Machining Allowance
		Aluminum	5mm
		Aluminum	20mm
15	Skim Cut to facilitate NDT 006	Reduce the Diameter by 2mm for ROD. for Rectangular Bar Reduce all dimensions by 5mm	45
20	Deburr	Material supply 175mm*340mm*2750mm & 2750mm along G.D	90
25	Check for Heat Treat	For aluminum	60
30	NDT006	Class A = for class 1 parts	30
		Class B = for class 2 parts	
35	Rough Machining	Hold in shop made/ vacuum fixture rough mill contour with Pockets and flanges keeping 3mm extra material all around as per NC program setup	20
40	Check/fabricate for special tools required for fabrication of parts	split/threaded bush, Spherical form tool, Mandrel	10
45	Check for Gauges, if not available give request		5
50	Layout for milling/Drilling	Hold in shop made/vacuum fixture, reset and ranger mill contour With pockets & flanges keeping 3mm extra material cell around as per NC program setup – 2	15
55	Fabrication Details, Hold in chuck & turn/step turn or set & mill/step mill	Deburr all sharp edges, if war page is more than 1mm then open out existing location Hole from 14(H7) and datum hole from 12(H7) to 14(H7) diameter deburr locating and datum holes. Set & drill & ream & jig holes 6mm (H7) dia. Tooling holes at 4 places & maintain drawing dimensions.	150
60	Inspect Controlled Dimensions & Certify (dimensions to be mentioned)		10
65	Write Part no.	11R-2B-2500-001-1A0	5
70	Inspect Fabrication		5
75	C/O NDT004 or NDT015	NDT004, NDT015, NDT004, NDT015	60
80	Inspect	Required only if previous step is NDT015	30
85	Inspect	checked	20
99	Close JC	Close and certify	20
Total			600

with the details of the operation and the remarks of the operation with the operational cycle time.

Table4 shows the revised Process Planning for actual part (front spar (L/H) 11R-2B-2500-001-1A0) with their operation number

Table 4: Process Planning for actual part [front spar (L/H) 11R-2B-2500-001-1A0] With Time-Revised				
Operation No.	Note Text	Check Points	Time in min	
5	Certify G.D	Along 2770mm		
10	Slit to get Size Aluminum	180mm*345mm*2770mm & 2770mm along GD-AL along plate	65	
		Material		Machining Allowance
		Aluminum		5mm
		Aluminum		20mm
15	Skim Cut to facilitate NDT 006	Reduce the Diameter by 2mm for ROD. for Rectangular Bar Reduce all dimensions by 5mm		
20	Deburr	Material supply 175mm*340mm*2750mm & 2750mm along G.D	90	
25	Check for Heat Treat	For aluminum	60	
30	NDT006	Class A = for class 1 parts	30	
		Class B = for class 2 parts		
35	Rough Machining	Hold in shop made/ vacuum fixture rough mill contour with Pockets and flanges keeping 3mm extra material all around as per NC program setup	20	
40	Check/fabricate for special tools required for fabrication of parts	split/threaded bush, Spherical from tool, Mandrel	10	
45	Check for Gauges, if not available give request		5	
50	Layout for milling/Drilling	Hold in shop made/vacuum fixture, reset and ranger mill contour With pockets & flanges keeping 3mm extra material cell around as per NC program setup – 2	15	
55	Fabrication Details, Hold in chuck & turn/step turn or set & mill/step mill	Deburr all sharp edges, if war page is more than 1mm then open out existing location Hole from 14(H7) and datum hole from 12(H7) to 14(H7) diameter deburr locating and datum holes. Set & drill & ream & jig holes 6mm (H7) dia. Tooling holes at 4 places & maintain drawing dimensions.	150	
60	Inspect Controlled Dimensions & Certify (dimensions to be mentioned)		17	
65	Write Part no.	11R-2B-2500-001-1A0		
70	Inspect Fabrication			
75	C/O NDT004 or NDT015	NDT004, NDT015, NDT004, NDT015	60	
80	Inspect	Required only if previous step is NDT015	46	
85	Inspect	checked		
99	Close JC	Close and certify	20	
Total			588	

along with the details of the operation and the remarks of the operation with the operational cycle time. The process was observed by analyzing the previous components and their processes and then reducing the cycle time. At the end the Process Plan for Manufacturing of Aircraft Component was designed and tested successful. Then it was implemented on the prototype first and then on the real aircraft component that will be used in the future aircraft named HTT-40. The time for the Different operations was reduced by combining the operations and successfully completing the project and helping the company in attaining profit by reducing operational cycle time.

2. RESULTS AND DISCUSSION

Process planning is done by gathering supporting methods suitable to manage both qualitative and quantitative characterization and analyses of a process. The production team from the case company has requested systematization and deeper understanding of industrial process planning. This paper incorporates with a flow chart describing the process planning process (PPP), this includes process planning activities and information flows between these activities. The research has been performed in an industrial environment for high volume manufacturing of gear parts.. The process was observed by analyzing the previous components and their processes and then reducing the cycle time. At the end the Process Plan for Manufacturing of Aircraft Component was designed and tested successful. Then it was implemented on the prototype first and then on the real aircraft component that will be used in the future aircraft named HTT-40. The time for the Different operations was reduced by combining the operations and successfully completing the project and helping the company in attaining profit by reducing operational cycle time.

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