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Process planning of Door Handle Component Manufacturing Process at PT. Pindad Engineering Indonesia

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ABSTRACT

PT. PindadEngineering Indonesia has a make-to-order strategy so that in its activities, it has production activities that are different from the parameters of the machining process. These parametersare taken in manufacturing Release Plate, Carrier Arm, and Padlock components in front door handle projects that were previously made using conventional machines with process planning charged to the operator. This shows that in PT. Pindad Engineering Indonesia has no communication between engineering and operators.

Toovercome these issues, a methodology was carried out that is tailored to particular needs. The methodology uses process planning technology with outputs of working plans with tools to facilitate the production process.

The final result of this study was in the form of a working plan document that can be a solution to facilitate communication between the engineering departments with the operator. Thus, the machining/ production time can be significantly reduced to reach the optimum time.

Keywords: Process Planning Technology, Process time, System concepts and tools.

1 INTRODUCTION

PT. Pindad Engineering Indonesia (PEI) is one of the companies that has a parent company, namely PT. Pindad (Persero)engaged in military and commercial products. One of the business fieldsthat PT. Pindad Engineering Indonesia owned is manufacturing. This company uses *a make-to-order* strategy which in its activities is based on the *job order* system.

To improve the current production process, on the occasion of composing this study, it was tried to carry the title "The planning process Technology of making *Release Plate, Carrier Arm,* and *Padlock* components in the *front door handle* project." Still, this project has been done, but several things attract the author to raise this title, namely The *Release Plate* component, *Carrier Arm*, and *Padlock,*which are done without prior process planning and are not under calculations.The conventional engine carries out the data obtained based on the work process.The obstacle is that the process of work is very long[1]. It is necessary to make a process planning to getgood planning and results.In order to anticipate this project will be raised again, a process planning will be done for thecomponents of the Release Plate, Carrier Arm, and Padlock is expected to be a reference for other job orders so that it can make it easier for operators in the process of working[2]. This component will be done in aCNC Milling machine, but it needstools during the process to get good planning and be able toshorten the processing time[3].

Based on the research background of the problems described, it can be formulated that the main issue of PT. Pindad Engineering Indonesia lacks communication between the engineeringdepartment and the operator, resulting in the work being charged to the operator, the production time becoming more extended, and even delivery delays.

1.2. LITERATURE REVIEW

The American Society of Mechanical Engineering (ASME) defines process planning technology (PPT) as namely "Systematic determination of the methods by which a product is to be manufactured economically and competitively". Process planning must have and prepare documentation regarding the process of working on components entirely so that it can be used with many functions by everyone that has an interest in an organization (Company). The documentation were drawing, working plan, machine set-up sheet, tool set-up sheet, and programming sheet.

2 METHOD

The flow chart of the study showed in figure 1.

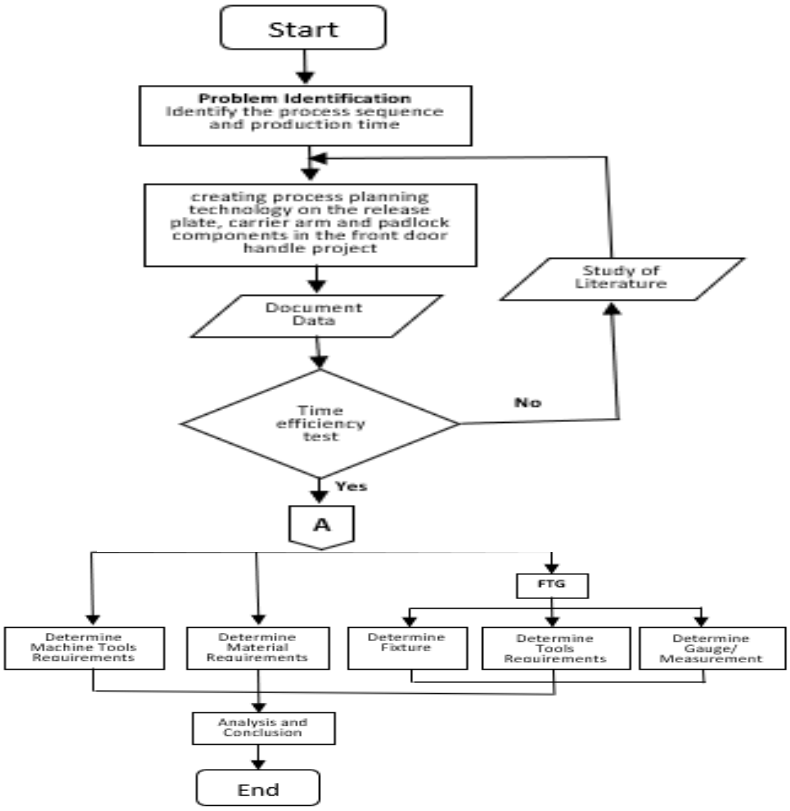

Figure 1 Research FlowChart

2.1 Identifying the Problem

Identifying problems in the production system in the CNC machining section with the object of making *the Release Plate*, *Carrier Arm*, and *Padlock* components in the *Front Door Handle* project, the problem lies in the production process and the estimated time.

2.2 Troubleshooting Methods

The problem-solving method in this study is to create a process plan on the *Release Plate*, *Carrier Arm*, and *Padlock* components in the *Front Door Handle* project with the data that has been obtained. A process plan will be made based on the calculation of the parameters of the basic elements of the machine that are exposed to the working plan format. Besides, the concept of the system and shape will be made as tools on the workpiece so that it can facilitate the production process and is expected to speed up the production process and be able to fulfill the consumer needs in terms of time.

2.3 Operation Process Chart

This Operation Process Chart is created based on needs, and according to calculations and sequences of work, steps created using the Autodesk Inventor Professional 2015 application.Process Planning Technology Manufacturing.

At this stage, creating documentation related to the complete component work process can facilitate the operator in working on it and be widely used by people that havean interest in the company's organization. The documentationswere design, working plan, machine set-up Sheet, tool set-up sheet, and programing sheet.

After making a process plan using a working plan format, it will be simulated using the MasterCAM application and *CIMCO Edit* V6. (2)

2.4 The Basic Elements of Machining Calculation

This basic element calculations were calculated as followed:

1. Cutting Speed (Vc)

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Vc = $(\pi \; x \; d \; x \; n)/1000 =$ m/min(1)

Information:

π = Constant value

d =Tool diameter

n =*Spindle* speed or cutting tool

2. *Spindle Speed* (n)

n = $\frac{Vc \; x \; 1000}{\pi.D}$=rpm (2)

Information:

d = Tool diameter

Vc = Cutting speed

3. Feeding Speed (f)

Vf = z x n x fz = mm/min (3)

Information:

z = Number of cut eyes

n = *Spindle* speed or cutting tool

fz = Feed per *tooth* (3)

2.5 Material Requirements

Material needs are obtained from the calculation of Vb = Volume of iron (m^3) and Bjb = Specific gravity of material = (Kg / m^3) so that later material needs will be known for the manufacture of *Release Plate*, *Carrier Arm*, and *Padlock* components with each to be made as much as 1500 pcs.

2.6 Jig and Fixture Planning

At this stage, theconcept of the tool was created using the *Autodesk Inventor Professional* 2015 application.

2.7 Testing

This test is carried out based on the production process time, comparing the initial time previouslyworked in conventional machines.

2.8 Conclusion

Theworkingplan format and the concept of tools selected inthe conclusion will later be directed to be a comparison of the production process time in making the three components based on the process planning technology made so that it can be a good solution to improve the production system at PT. Pindad Engineering Indonesia.

3 RESULTS AND DISCUSSION

3.1 RESULTS

One ofthe data collections was based on observations and interviews with the operator during the work process. This interview was conducted on Thursday, March 15, 2018Morning *shift* hours at PT. Pindad Engineering Indonesia and the following below is one of the release plate component data collection.

Figure 2. Data Retrieval Activities

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1. The working drawings and sequence of processes on manufacturing components (*Release Plate*).

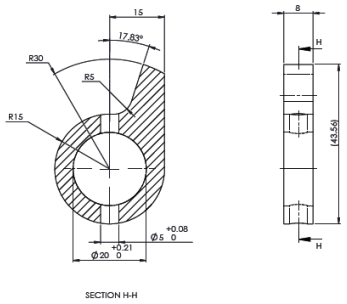

Figure 3.1 Components (Release Plate)

Release Plate components were previously produced in conventional machines with the following process sequence:

Table1. The Sequence process ofthe release Plate functions as a rotor*release platewith a production process time of 14 minutes.*

No	Sequence of Part Release Plate Process				OP1
	Process	Time (Minute)	Machine Type	Machine Number	
1	Clamping	1	CNC Miling	MC10	Loading
2	Contour	5			4 Minutes
3	Drill Ø5	2			
4	Unclamping	1			Cutting Time
5	Clamping	1			8 Minutes
6	Facing Thickness	3			
7	Unclamping	1			
Total Time	14 Minutes				

Fig 4 show the concrete example of a process sequence error resulting below.

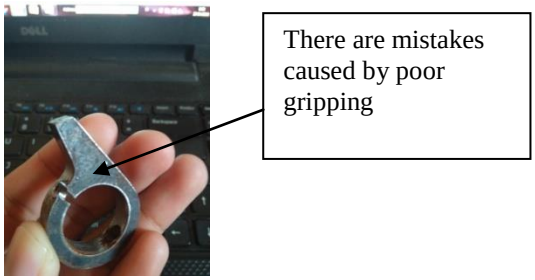

Figure 4. Components (Release Plate)

Table 2.The Remarksof conventional making results

Component Name	Target Size	Tolerance	Machining Result Size	Description
Release Plate	43.56	+0.1	44.2	*Not go*
	8.00	±0.3	7.2	Go
	Ø20	0.21	Ø20.21	Go
	Ø5	+0.08	Ø5.5	*Not go*
	R30	±0.3	R30	Go
	R15	±0.3	R15	Go
	R5	±0.3	R5	Go

The above deviations are an error from the non-creation of a process sequence so that the process sequence is released to the operator.

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3.2 *Operation Process Chart*

An operation process chart is an arrangement of processes experienced by raw materials starting from the sequence of work processes and examinations depicted using diagrams.

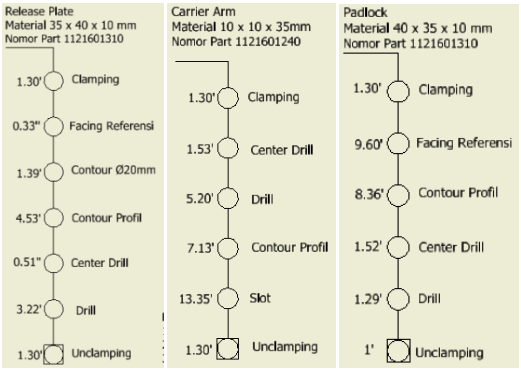

Figure 5 PC Component Release Plate, Carrier Arm, and Padlock

3.3 The Basic Elements of Machining Calculation

The following below is an example of calculating the sequence of processes on the *Release Plate* component.This calculation is based on a working plan creation.The Facing Reference process *uses* theEndmilld Carbide Ø16 tool,which has four numbers of cut points with a predetermined Vc and, according to the table, based on the type of knife material used,the table can be seen on the attachment page.

vc = 80 m/min

$$n = \frac{Vc\ x\ 1000}{\pi.D} = \frac{80.1000}{\pi.16} = 1591\text{rpm}$$

fz = 0.2

Vf = fz x z x n = mm/min

Vf = 0.2 x 4 x 1519 = 1215.2 mm/min

Table 3.The Calculation of Release Plate components results

No	Process Order	Tool	VC m/min	n RPM	a mm	fz mm/gig	Vf mm/min
1	Clamping						
2	Facing Reference	EndmillØ16	80	1591	2	0.2	1215.2
3	Contour	EndmillØ16	80	1591	2	0.2	1215.2
4	Contour Profile	EndmillØ12	80	2122	2	0.2	1697.6
5	Contour Profile	EndmillØ12	80	2122	2	0.2	1697.6
6	Center Drill	EndmillØ10	80	700	1	0.2	280.12
7	Drill	DrillØ5	80	5093	1	0.2	2037.2
8	Unclamping						

3.4 Material Needs

Component requirements for components Release Plate iron plate or material ASTM A36 with a size of 55 mm x 30 mm x 8 mm.

Part made Iron Weight = (0. 055 x 0. 030 x 0. 008) x 7800 = 0. 10296 x 1500 = 154. 44 kg

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Table 4.Material Requirements

Component Name	Material Type	Iron Specific Gravity Kg/m3	Material Weight (Kg)	Material Needs /pcs	Total Weight (Kg)
Plate Release	ASTM A36	7500	0.10362	1500	154.44
Carrier Arm	ASTM A36	7500	0.02653	1500	40.95
Padlock	ASTM A36	7500	0.1099	1500	163.8

3.5 Jig and Fixture Planning

The following below is a picture of an example of an untreated CNC machine.

Figure 6. Sample of CNC Milling Machine Base Plate Tool

1. Conceptualizing Systems and Forms of Tools

a. System Concept And Form 1

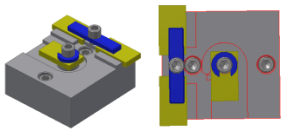

Figure 7. System Concept And Form 1

b. System Concept and Form 2

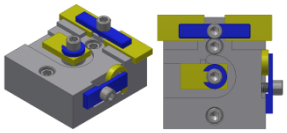

Figure 8.ystem Concept and Form 2

c. System Concept and Form 3

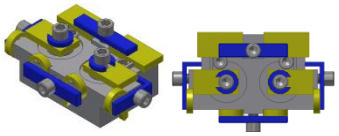

Figure 9.2 System Concept And Form 3

Information:

Part : yellow

Clamping : Blue

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Table 5.Concept Filtering Tools Form

Alternative	The capacity of the Output Component	Description
Concept System and Form 1	0 Component output capacity, the concept of additional tools is needed for the last work, namely a drill with a 5 mm diameter hole.	It has three gripping processes on this concept can be judged not effective in helping the production process.
Concept System and Form 2	Has six processes, namely two processes are facing the side surface for reference and two processes for contouring holes with a diameter of 20 mm, then after that, the contour profile process is for one workpiece, and the last is one drill process for one workpiece so that overall results are 1 component output.	It has three grips: one was gripping for two workpieces with a facing process for reference, one gripping for one workpiece with a contour profile process, and the last one gripping one workpiece for the drilling process.
Concept System and Form 3	Has six processes, namely 2 facing side surfaces for reference and a 20 mm diameter hole contour process, two profile contour processes, and the final product output capacity is four drill processes so that from the whole process, 4 component outputs are obtained.	It has five clamps, namely one was gripping for two workpieces, two gripping for two contour profile processes, and four gripping for the drilling process.

Based on the results of the assessment of the output capacity of the components of the system concept and the form number three alternatives to the concept of at most the output capacity of its components[4].

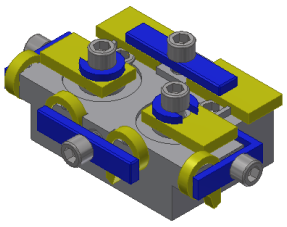

Figure 10. Concept of Method and Form of Component Tool (Release Plate)

3.6 DISCUSSION

PT. Pindad Engineering Indonesia is in the development of more High-end technology. This company is also balanced with a good system so that it can be balanced to remain controlled.

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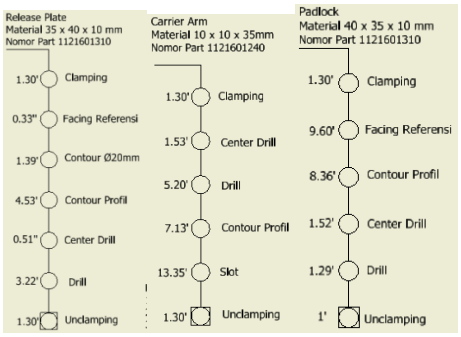

Figure 11.3 Operation Process Chart

This diagram is obtained starting from the process analysis in its completion so that an operation process chart can be made, the creation of this diagram is adjusted to the concept of the form of the tool that has been selected[5].

3.7 Process Planning Technology Manufacturing

The PPT results start from making an operation processchartwhich generally only provides instructions for the sequence of work processes. Then, it is made in the form of a working plan.Asa result, this manufacturer provides results in the form of process time so that the machining process is monitored, and the results of the machining process time provide convenience to the operator in the production process[6].

3.8 Calculation of the Basic Elements of Ordering

The results of the basic elements calculation of the machine for Release Plate, Carrier Arm, and Padlock components with the raw material of the ASTM A36 plate type become a reference in the work process starting from Rpm, cutting speed, Depth of feeding and others so that this can minimize the occurrence of errors during the machining work process, for example, such as the occurrence of stiffness in the chisel due to spindle rotation doesn't match with the calculations[4, 7]. The calculation of this basic element can also make a success factor in accelerating the employment process with values calculated based on existing formulas and used in large companies[8, 9].

3.9 Material Requirements

The typical material requirements for Release Plate, Carrier Arm, and Padlock components are as much as 360,023 kg, with different sizes for each component.This preparation must also be considered because starting from the material calculation. All processes can run correctly.

3.10 Tool Concept Planning

Planning the Release Plate, Carrier Arm, and Padlock component tool in the Front Door Handle project is created to facilitate and speed up the production process[10]. The manufacture of these components is presented on the attachment C page.The components will be produced in CNC milling machines. The planning concept of this tool form wascreated using the Autodesk InventorProfessional 2015 application. Here's a picture of the tools for the Release Plate component.

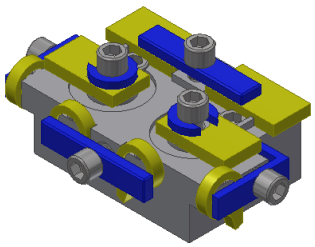

Figure 12.4 Planning of the concept of the method and form of Gripping the Work-piece

The clamping plan for the Release Plate component is shown in the picture above:

1. Make sure the workpiece can withstand shifts and the workpiece is strong enough.
2. Make sure not to damage the workpiece during the clamping process.
3. Ensure fast loading and unloading.

The position of the clamps on this *jig* can be seen based on the sequence of numbers in the figure above and can be explained as follows:

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1. *The first clamping*is the first step on the right side, and lower side workpieces are tightened on the stopper until it is ensured that there are no gaps. After that, the object is clamped until the thing will not shift.
2. *The second clamping* is continued from the first clamping and the first process, the workpiece that has been made a hole with a diameter of 20mm becomes the reference point for the stopper in the second process.
3. *The third clamping* is continued from the second side with the workpiece that has been formed *contour*.The reference to this section remains in the position of the straight side of the workpiece, which is pressed *on the stopper* in a perpendicular position so that the drilling process can be carried out efficiently.

The results of the manufacture start from the process sequence using the operation process chart, making the process sequence based on the calculation of the basic elements of the machine made using a *working plan* formatto help the work process more directed, the sequence of operations made based on the concept of the method and the form of tools to provide more output capacitycomponent with more time efficient[2, 11]. Below is a table of component *output capacities*based on time.

Table 6.Component Output Capacity

Part Num.	Component Output Capacity/ process	Time/Process (minutes)	Clamp &Unclamp Time	Clamping &Unclamping Time (minutes)	Total Time (Minutes)
3	Release Plate	4 Products	11.45	3	14.45
13	Carrier Arm	12 Products	28.22	3	31.22
19	Padlock	4 Products	15.46	3	17.46

The result of this table is that the machining time in one process can producemore than one product output, so this method can help to increase the productivity of the machining process time.

5. CONCLUSION

Based on the results of data processing using process planning technology in completing process sequences on the Release Plate, Carrier Arm, and Padlock components in the *Front Door Handle* project, the conclusions can be drawn about process planning technology (PPT) as follows:

1. Process planning technology can provide solutions to improve the production system at PT. Pindad Engineering Indonesia with the existence of process planning technology made in a working planformat, it becomes a means of communication between engineers and operators.
2. The results obtained from the concept of the method and the shape of the selected tools are based on the product *output* results per 1-time process:a 4-component output capacity release plate component with a time of 14.45 minutes, a 12-component output capacity carrier arm with a time of 32.22 minutes, and a padlock output capacity four components with a time of 17.46 minutes are stated to be able to increase productivity through the production process based on the concept of the system and the form of tools with a component output capacity per 1-time process.
3. For the results of the production process time that has been processed with the comparison of the actual data of the initial time of the production process on the three components based on process planning technology and the concept of the form of the selected tool, it can be known that the time comparison is as follows:
    a. Release plate components with a production process time data of 14 minutes with an *output* capacity of 1 component after being processed into 14.45 minutes with an output capacity of 4 components (Release Plate)
    b. Carrier Arm components with production process time data of 44 minutes with *an output* capacity of 1 component after processing to 31.22 minutes with an output capacity of 12 components (*Carrier Arm)*
    c. Padlock componentswith production time data of 18 minutes with an output capacity of 1 component after being processed to 17.46 minutes with an output capacity of 4 components (Padlock)

Based on the results of the data above, it can be concluded that production process planning based on PPT and the concept of the selected tool method can significantly increase productivity.

REFERENCES

[1] J. P. Davim, *Design of Experiments in Production Engineering*. Switzerland: Springer Cham, 2016, p. 196.

DOI: 10.31695/IJASRE.2023.9.1.4

[2] A. Jacob;, S. Steimer;, N. Stricker;, B. Hafner;, and G. Lanza;, "Integrating product function design, production technology optimization and process equipment planning on the example of hybrid additive manufacturing," *Procedia CIRP*, vol. 86, pp. 222-227, 2019.

[3] A. D. Jayal, F. Badurdeen, O. W. Dillon, and I. S. Jawahir, "Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels," *CIRP Journal of Manufacturing Science and Technology*, vol. 2, no. 3, pp. 144-152, 2010.

[4] P. J. Martínez-Jurado and J. Moyano-Fuentes, "Key determinants of lean production adoption: evidence from the aerospace sector," *Production Planning & Control*, vol. 25, no. 4, pp. 332-345, 2012.

[5] W.-W. Huang, Y. Zhang, X.-Q. Zhang, and L.-M. Zhu, "Wall thickness error prediction and compensation in end milling of thin-plate parts," *Precision Engineering*, vol. 66, pp. 550-563, 2020.

[6] E. A. Skorniakova, V. S. Sulaberidze, and E. G. Semenova, "Production planning process effectiveness improvement through the automated system introduction," *Journal of Physics: Conference Series*, vol. 1399, no. 4, 2019.

[7] T. Kellner;, J. Kyncl;, Z. Pitrmuc;, L. Beranek;, M. Kanak;, and M. Kyncl, "Production Process Planning in Additive Manufacturing and Conventional Machining Technology Manufacturing System " *Manufacturing Technology*, vol. 19, no. 2, pp. 232-237, 2019.

[8] C. Hueber, G. Fischer, N. Schwingshandl, and R. Schledjewski, "Production planning optimisation for composite aerospace manufacturing," *International Journal of Production Research*, vol. 57, no. 18, pp. 5857-5873, 2018.

[9] M. Garetti and M. Taisch, "Sustainable manufacturing: trends and research challenges," *Production Planning & Control*, vol. 23, no. 2-3, pp. 83-104, 2011.

[10] J. C. Najmon, S. Raeisi, and A. Tovar, "Review of additive manufacturing technologies and applications in the aerospace industry," in *Additive Manufacturing for the Aerospace Industry*, 2019, pp. 7-31.

[11] C. Kanagiyani; and N. R. Patel, "Graphical Approach of a Combined Multipurpose Jig and Fixture with Variable P.C.D. and Inclined Machining," *Industrial Engineering Journal*, vol. 12, no. 5, pp. 1-20, 2019.

DOI: 10.31695/IJASRE.2023.9.1.4