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Process and material flow design for vise manufacturing with routing sheet and from to chart

Muhammad Haikal Sitepu*¹, Alison McKay², Tania Alda¹, Talitha Almira Muharrami¹, Yohannes Tulus Martinez¹

¹Industrial Engineering Department, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia, 20155

²Institute Design, Robotic and Optimization, School of Mechanical Engineering, University of Leeds

*Email: mhd_haikalkarana@usu.ac.id

Abstract. Process design is important steps in production layout planning. At this step, processes and machines for making parts and products are identified. Then these processes and machines are arranged so the flow of materials can be minimized. Vise is a support tool for various manufacturing processes such as cutting, drilling and grinding. Vise consist of various parts such as platform base, body and clamping parts. To make these various parts several manufacturing processes are required. This paper aims to demonstrate the use of routing sheet to identify processes and machines to manufacture vise as well as to show the use of from to chart to arrange those machines in order to minimize material flows. Several machines configurations with minimum material flows are presented.

1. Introduction

Vise is an important support tool for manufacturing process particularly for finishing process. Vise is used to hold an item during the manufacturing process, for example during the cutting process, vise is beneficial to make the item motionless. Vise consists of several parts such as platform, clamping body and clamp jaw. Different manufacturing processes are required to manufacture each part of vise. Hence, these processes need to consider in designing production layout for vise manufacturing. This paper has an aim to demonstrate the process and material flow design for vise manufacturing

Process design focuses on configuring stage of process to manufacture a product. Routing sheet is one tool to support process design. Routing sheet accumulates information from production floor related to the process required to manufacture part of product. There are some information appeared in the routing sheet, namely: (a) The type of process needed for each part of product, (b) The processing times and (c) raw materials needed. These information are essential to support the arrangement of machines and to calculate the production capacity [1].



After manufacturing processes for each part identified, the arrangement of machines is performed. This step is critical in production layout planning because it determines the flow of materials in production floor [2]. Error in the arrangement of machine might increase the flow of materials which in turn incrementing material handling cost. From to chart is one support tool for setting the sequence of machines in production floor. From-to-chart is used to evaluate the initial sequence of machines by calculating the total movement of materials. This paper focuses on evaluating the proposed machines sequences using from to chart in order to determine better sequences with lower material movements [3].

2. Methodology

This research used experiment methodology to design the process and material flow for vise manufacturing. The experiment was performed in Laboratory of Facility Planning and material handling, Engineering Faculty, Universitas Sumatera Utara.

2.1. Research Process

This research is divided into four critical steps including manufacture the vise, develop the routing sheet, develop alternative of machine sequences and evaluate those alternative using from to chart. In the first step, the observation of the vise manufacturing process was conducted. At this step, manufacturing process and processing times for each part of vise were recording. This was followed by developing routing sheet by considering the data from observation. At this step, processes for each part of vise were ordering. Then based on the information from routing sheet, the alternative of machine sequences were developed. At the final step, alternative of machine sequences were evaluated using from to chart. The evaluation was implemented by considering quantity of part, quantity of part movements and weight of parts [4].

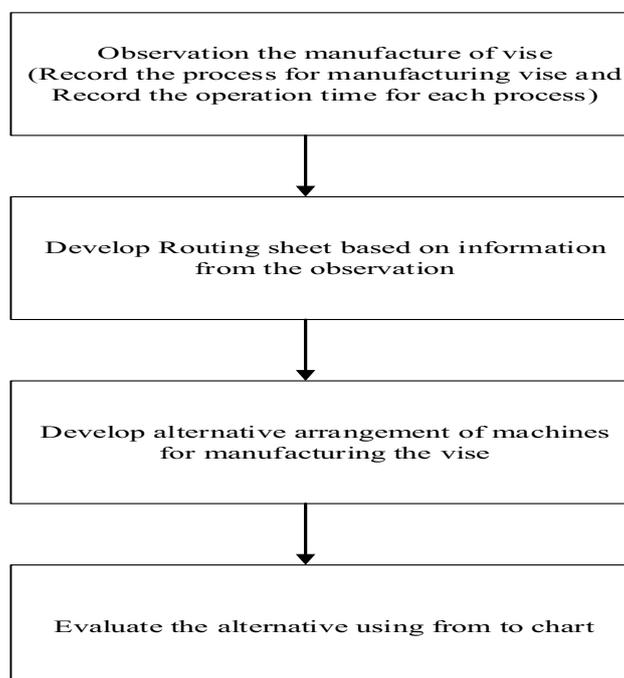


Figure 1. Research Process

3. Result and Discussion

3.1. Routing Sheet

Routing sheet is produced based on observation data. The observation was conducted on Laboratory of manufacturing process, Faculty of Engineering, Universitas Sumatera Utara. The main work in developing routing sheet is to determine the ordering process for making each part of vise. The following table displays routing sheet for part platform, clamp jaw and clamping body (right and left).

Table 1. Routing Sheets for Part of Vise

No	Platform		Left Clamping Body		Left Clamp Jaw		Right Clamping Body	
	Machine Type	Operation Time (Seconds)	Machine Type	Operation Time (Seconds)	Machine Type	Operation Time (Seconds)	Machine Type	Operation Time (Seconds)
1.	Grinding machine	600	Shredder	240	Grinding machine	300	Shredder	240
2.	Drilling Machines	360	Shredder	180	Drilling Machines	240	Shredder	180
3.	Drilling Machines	360	Shredder	180	Drilling Machines	240	Shredder	180
4.	Shredder	240	Drilling Machines	240	Shredder	120	Drilling Machines	300
5.	Shredder	240	Drilling Machines	240	Grinding machine	240	Drilling Machines	300
6.	Drilling Machines	240	Drilling Machines	240			Drilling Machines	360
7.	Drilling Machines	240	Drilling Machines	240			Tap and Dies	240
8.	Milling Machine	420	Tap and Dies	240			Tap and Dies	240
9.			Tap and Dies	240			Grinding machine	300
10.			Tap and Dies	240				
11.			Tap and Dies	240				
12.			Grinding machine	300				

3.2. Alternative of Machines Sequences

Based on information from routing sheet which is the order of process for each part, the alternative of machines sequences were developed. The following table shows the alternative of machine sequences.

Table 2. Alternative of Machines Sequences

Sequence Number	Alternative 1	Alternative 2	Symbol Meaning
1	PM	PM	PM = Entrance
2	G.	S.	G = Grinding Machine
3	S.	D	S = Scrap Machine
4	M	TD	M = Milling Machine
5	D	M	D = Drilling Machine
6	B	B	B = Lathe Machine
7	TD	G.	TD = Tap and Dies Machine
8	Assembly	Assembly	Assembly = Work Centre to assembly
9	PK	PK	PK = Exit

3.3. From to Chart

From to chart was used to evaluate the alternative of machines sequences. Two factors were used in evaluation including weight of part and quantity of part. To consider these factors, relative importance of part is calculated by diving total weight of vise with part with smallest weight. Equation 1 show the formulation. Table 3 shows the weight of part, quantity of part and relative importance of part.

$$\text{Relative importance} = \frac{\text{Part weight} \times \text{Quantity}}{\text{Smallest Total Part Weight}} \quad (1)$$

Table 3. Calculation of relative importance

Part	Percentage	Part Weight	Quantity / Day	Total Weight / Part	Relative Importance
Base	40%	6	52	312	8
Left Clamping Body	10%	1.5	52	78	2
Left Clamp Jaw	5%	0.75	52	39	1
Right Clamp Jaw	5%	0.75	52	39	1
Right Clamping Body	10%	1.5	52	78	2
Rotating Board	14%	2,1	52	109.2	2.8
Lava Body	9%	1.35	52	70.2	1.8
Handle	7%	1.05	52	54.6	1,4

From to chart is developed by identifying the movement of each parts (from routing sheet). For example the movement from PM-G (entrance to grinding) are experienced by several parts including RI base, left and right clamp jaw. As the result, in from to chart, the colom PM-G is filled with 10 which is

accumulated from 8 (relative importance from RI base), 1 (relative importance from left clamp jaw) and 1 (relative importance from right clamp jaw). Table 4 displays from to chart for alternative 1.

Table 4. From to chart for alternative 1

	PM	G.	S.	M	D	B	TD	Assembly	PK	Total
PM	0	10	6.8	0	0	3,2	0	0	0	20
G.	0	0	1	0	8	0	0	12	0	21
S.	0	1	0	0	15.8	0	0	0	0	16.8
M	0	0	0	0	0	0	2.8	8	0	10.8
D	0	2.8	9	10.8	0	0	4	0	0	26.6
B	0	1,4	0	0	1.8	0	0	0	0	3,2
TD	0	6.8	0	0	0	0	0	0	0	6.8
Assembly	0	0	0	0	0	0	0	0	0	0
PK	0	22	16.8	10.8	25.6	3,2	6.8	20	0	105.2
									Total	210.4

Then penalty point needs to assign to from to chart. Penalty point reflects number of processes or machines that is stepped over. For example, from PM to S (Entrance to scarp machine), there is one machine (grinding machine) that is stepped over. Penalty point is calculated by multiplying relative importance with penalty point and number of machine that is stepped over. For example, for PM to S total value is 13.6 which is accumulated by multiplying 6.8 with 2

Table 5. Penalty Point for Alternative 1

	PM	G.	S.	M	D	B	TD	Assembly	PK	Total
PM	0	10	13.6	0	0	16	0	0	0	39.6
G.	0	0	1	0	24	0	0	72	0	97
S.	0	2	0	0	31.6	0	0	0	0	33.6
M	0	0	0	0	0	0	8.4	32	0	40.4
D	0	16.8	36	21.6	0	0	8	0	0	82.4
B	0	11.2	0	0	3,6	0	0	0	0	14.8
TD	0	68	0	0	0	0	0	0	0	68
Assembly	0	0	0	0	0	0	0	0	0	0
PK	0	108	50.6	21.6	59.2	16	16.4	104	0	375,8
									Total	751.6

Using the similar steps, alternative 2 was evaluated using from to chart. Table 6 and 7 show the initial from to chart and penalty point for alternative 2.

Table 6. From to Chart for Alternative 2

	PM	S.	D	TD	M	B	G.	Assembly	PK	Total
PM	0	6.8	0	0	0	3,2	10	0	0	20
S.	0	0	15.8	0	0	0	1	0	0	16.8
D	0	9	0	4	10.8	0	2.8	0	0	26.6
TD	0	0	0	0	0	0	6.8	0	0	6.8
M	0	0	0	2.8	0	0	0	8	0	10.8
B	0	0	1.8	0	0	0	1,4	0	0	3,2
G.	0	0	9	0	0	0	0	12	0	21
Assembly	0	0	0	0	0	0	0	0	0	0
PK	0	15.8	26.6	6.8	10.8	3,2	22	20	0	105.2
									Total	210.4

Table 7. Penalty Point for Alternative 2

	PM	G.	S.	M	D	B	TD	Assembl y	PK	Total
PM	0	6.8	0	0	0	16	60	0	0	82.8
G.	0	0	15.8	0	0	0	5	0	0	20.8
S.	0	18	0	4	21.6	0	11.2	0	0	54.8
M	0	0	0	0	0	0	20.4	0	0	20.4
D	0	0	0	5.6	0	0	0	24	0	29.6
B	0	0	10.8	0	0	0	1,4	0	0	12.2
TD	0	0	72	0	0	0	0	12	0	84
Assembly	0	0	0	0	0	0	0	0	0	0
PK	0	24.8	98.6	9.6	21.6	16	98	36	0	304.6
									Total	609.2

Based on the results of calculations, alternative 1 produces penalty point 751.6 while the penalty point for alternative 2 is 609.2. Based on this result, alternative 2 is selected as machine sequence due to lower penalty points.

4. Conclusion

This paper demonstrates the use of routing sheet to support process design and presents the use of from to chart to evaluate alternative of machines sequences. For product that consist of several parts and those parts required different manufacturing process, to arrange the machines in production floor requires further approach. Several factors such as weight and quantity of parts can be used as consideration in configuring the sequence of machines. However, the use of from to chart mainly depends on initial alternative for machines sequences. Further approach is required by considering more factors such as social aspects (safety of worker) and environmental aspects (emission) in the arrangement of machines.

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