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Modification of the jig slider grinding hook design

Windy Andaresta[1], Adi Syahputra Purba[2], Nidia Yuniarsih[3], Abri Andry Saresa Marbun[4], Rangga Saputra[5]

[1]Manufacturing Engineering Technology, Mechanical Engineering, Politeknik Negeri Medan, Indonesia
[2,3,5]Mechanical Engineering, Politeknik Negeri Batam, Indonesia
[4]Welding Engineering and Fabrication Technology, Mechanical Engineering, Politeknik Negeri Medan, Indonesia

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ABSTRACT

Tools such as jigs are becoming important in the production process. Jigs are often used in the cutting or shaping process in the form of making workpieces in production. However, ever-changing variations in demand can lead to changes in jig efficiency. Therefore, modifications are necessary to maintain accuracy and meet the demands of diverse markets. This research was carried out by modifying the design of the slider jig on the width of the rail slider which was enlarged from before and adding support to the clamping plate which aims to improve the accuracy and effectiveness in the drilling process. To find out the results of the difference before and after the modification of the slider jig, a test was carried out by conducting a visual inspection of the profile point hook that had been ground using a profile projector with a scale of 10 :1 which showed that the results of this modification were included in the value of the drawing tolerance value and in accordance with the specifications in the company and based on data taken from PT. XYZ in the engine working time of 3 hours and 3 minutes, a total output of 164 pcs was found out of the total target of 158 pcs. This resulted in a productivity percentage of 103.80%. This shows that this jig modification is effective when used.

Corresponding Author:

Adi Syahputra Purba,
Mechanical Engineering,
Politeknik Negeri Batam,
Jl. Ahmad Yani, Batam Centre, Batam, 29461, Indonesia
Email: adipurba@polibatam.ac.id

1. INTRODUCTION

The manufacturing industry continues to grow, creating increasingly fierce competition among companies. The machining concept, which uses any machine, is among the greatest inventions (Said et al., 2023). Complex part machining requires detailed preparation to reduce production time and expense (Kumar et al., 2019). Product quality is key, which drives the need for efficient and reliable production technologies and methods (Fatkhurrohman & Subawa, 2016; Ishac et al., 2021; Prayogi & Prasetyo, 2019). Today's mechanical engineering environment is increasingly losing the need for high-precision, high-productivity (Anh & Tung, 2025). Woodworking and wood products manufacturing sector has undergone dyanmic transformation in the developed countries of the world (Asibong Icha & Odey, 2024). Ultra-high temperature ceramics (UHTCs) have been the focus of intense research in recent years because of their potential use as thermo-structural bulk materials in aerospace applications (Sciti et al., 2022).

Constantly changing demand variations can lead to changes in jig efficiency. Therefore, modifications are needed to maintain accuracy and meet diverse market demands. Auxiliary tools frequently used by manufacturing industrial companies are jigs, which can be modified according to the items being produced (Nugrahanto et al., 2018). Auxiliary tools like jigs are essential in the production process. Simple tools such as hammers and screwdrivers up to the most shophisticated machines are the resultt of men trying to reduce the amount of energy expounded in labour (Odey & Icha, 2022).

Sliding jigs are commonly used to apply intra or intermaxillary forces in the procedure of tooth distalization or mesalization (Fashih et al., 2021). Where precise stitching lines are necessary, stitching jigs are employed as work aides (Vijay Kirubakar Raj & Renuka Devi, 2021). The process of design is regarded as the systemic approach in manufacturing (Arnaoutis et al., 2023a). In order to cut down on design time and expense, the industry is very interested in automated design evolution and optimization (Arnaoutis et al., 2023b).

Jigs are frequently employed in cutting or forming operations throughout the production process, such as when creating workpieces (Ishac et al., 2021). However, constantly changing demand variations can lead to changes in jig efficiency, as research conducted by Riyadi on jig design states that using aids such as a sliding cutting jig also makes the process of cutting plates of various thicknesses and equal lengths faster (Riyadi & Kusumawati, 2022). Therefore, modifications are needed to maintain its accuracy and meet diverse market demands. For example, PT. XYZ improved the jig used to facilitate the grinding process. Problems were found due to the rail slider being too narrow and the lack of support to withstand excessive plate clamping loads, causing the jig to be unbalanced. This necessitated a modification to the jig. One method and technique for improving production efficiency and productivity is by designing production aids (Jones, 1934).

PT. XYZ is a company focused on manufacturing hooks. One stage in this process involves using a grinding process with a jig as an aid to shape the profile point hook according to the specified requirements. A jig is described as a special instrument used to support, bare, or position components that are to be processed. This tool is specifically designed as a production aid, not only to position and hold the workpiece but also to guide it during the operation (Imansuri, 2019; Ishac et al., 2021; Mukti, 2023).

This jig modification research was conducted by Maulana in a journal titled "Jig Modification in the Vertical Cutting Bandsaw Process." The results of this research indicate that the modification can maximizee the performance of the jig, significantly improve the consistency of jig movement efficiency, and achieve results that meet the product quality standards (Indrawan et al., 2024).

These issues have led to the research's goals of changing the jig's design on the rail slider section by increasing the width dimension from the previous one and adding support to the plate clamping to better maintain the jig's balance. The scope of this research is limited to improving the design of the jig slider and conducting testing after fabrication, which is useful in determining the effectiveness, accuracy, and productivity during the profile point grinding process on the hook to achieve the specified standards and meet complex customer demand variations.

2. RESEARCH METHOD

This type of research is part of qualitative research, involving direct observation in the field. This research was carried out by modifying the design of the slider jig on the width of the rail slider which was enlarged from before and adding support to the clamping plate which aims to improve the accuracy and effectiveness in the drilling process. To find out the results of the difference before and after the modification of the slider jig, a test was carried out by conducting a visual inspection of the profile point hook that had been ground using a profile projector with a scale of 10 :1 which showed that the results of this modification were included in the value of the drawing tolerance value and in accordance with the specifications in the company.

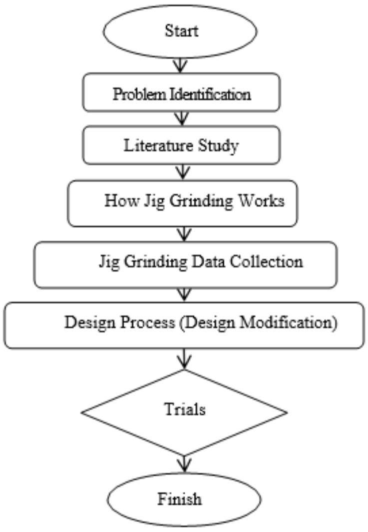


Figure 1. Flow chart

This research was carried out at PT. XYZ, a company that manufactures hooks. The research involved modifying the jig slider. The research stages are shown in the flowchart in Figure 1.

Problem Identification

Problem identification is the process of analyzing existing problems to determine whether they are occurring. After field observation, it was found that the machine was not working due to a problem with the jig slider. Figure 2 shows the previous design of the slider jig, where several issues were found, including the rail slider being too narrow and not supported to withstand the excessive plate load during clamping, causing the jig's position to be lopsided and not upright as expected. When the jig slider is moved back and forth, the imbalance in the jig slider causes the ground profile point hook results to not meet the existing specifications. From the explanation above, it can be concluded that the issue that requires to be solved is how to improve the performance of the jig slider so that it is able to perform the grinding process, allowing the machine to be used.

In this study, it is necessary to modify the slider grinding jig to improve performance results compared to before.

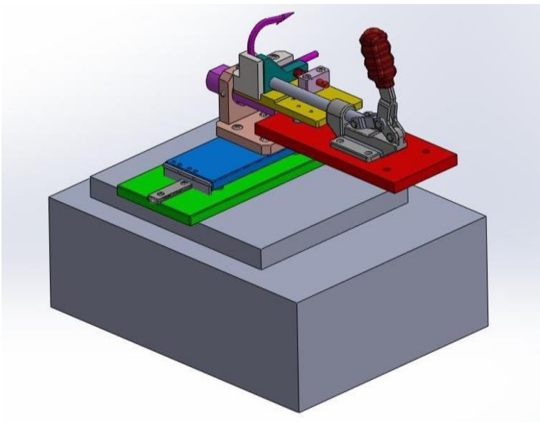
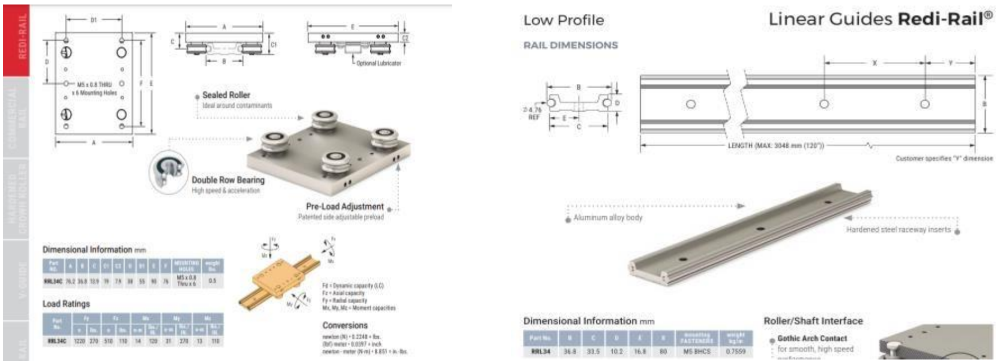


Figure 2. Jig slider grinding design

Literature Study

The next method used was a literature study, which involved searching for references used as a new basis for the modification process, both from the internet and literature books. The results of this literature study provided references obtained through internet searches. In modifying the rail slider design, based on Figure 3.a, obtained from the Linear Guides RRL34C catalog using bearings that provide stability and support to keep the moving object in the desired position, serving as the forward and backward movement mechanism of a jig with a wider rail than before, with the main rail dimensions: length 200 mm, width 36.8 mm, and height 10.2 mm. The next step is to add support plate clamping to the jig, based on Figure 3.b, using ball rollers taken from the Ball Casters T5L5B catalog, which make the jig movement more flexible and support the support base clamping.



(a)

Type	Standard	Shape	[Flange] Flange
Load Capacity Range(N)	50.1~100.0	Load Capacity(N)	78.4
Body Material	[Steel] Steel	Ball Material	[Steel] Steel
Outer Dia. D(Ø)	28	Pitch(mm)	48.5
Length(mm)	59.3	Width(mm)	42
Height(mm)	20	Specifications	For Up Mount

(b)

Figure 3. (a) Rail slider part reference, (b) reference for ball roller parts for support plat clamping jig

How Jig Grinding Works

In the initial stage, what needs to be done is to understand how jig grinding works. This involves placing a hook on the surface of a jig's seat, which is moved manually using a back-and-forth system with clamping tools to hold the workpiece. The hook is positioned between the two grinding wheel positions, which rotate using a machine resembling the letter V to form the profile point on the hook.

Figure 4. Profile Point Hook Grinding Machine at PT. XYZ

Jig Grinding Data Collection

This research was conducted by collecting data through observation and discussing with the production supervisor of the machine. The data obtained is the width of the rail slider, which makes the jig unbalanced and unstable, causing the tilt of the jig to be estimated at ±45 degrees until it touches the base surface. The main dimensions of the rail slider are: length 200mm, width 14mm, and height 9mm, using SUS440C material.

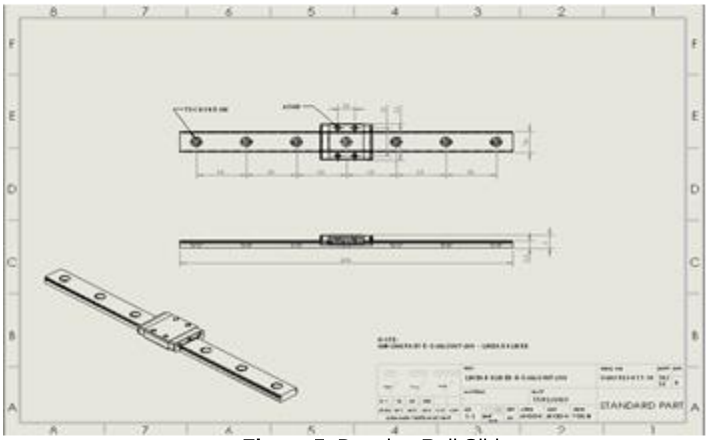


Figure 5. Drawing Rail Slider

Design Process (Design Modification)

In the jig slider modification stage, it began by designing the rail slider using SolidWorks software (Darmawan & Sulistyarini, 2021;(Imam Pratomo et al., 2022; Radhwan et al., 2019) (Imam Pratomo et al., 2022), referencing the Linear Guides RRL34C catalog. This design was then adjusted to fit the relevant parts, such as adding hole positions and dimensions for the shafst holder and the jig slider base.

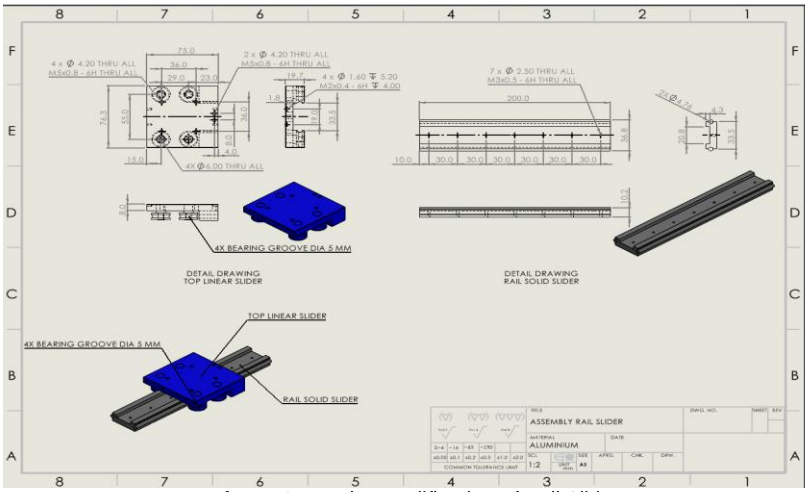


Figure 6. Drawing Modification of Rail Slider

After creating the rail slider design modification using SolidWorks software, the next step was to design the support plate clamping. This was done to match the height from the top surface of the base jig to the bottom surface of the plate clamping, and the length of the plate clamping, as shown in Figure 7. Ball rollers from the Ball Casters T5L5B catalog were used as the movement mechanism for the support plate clamping.

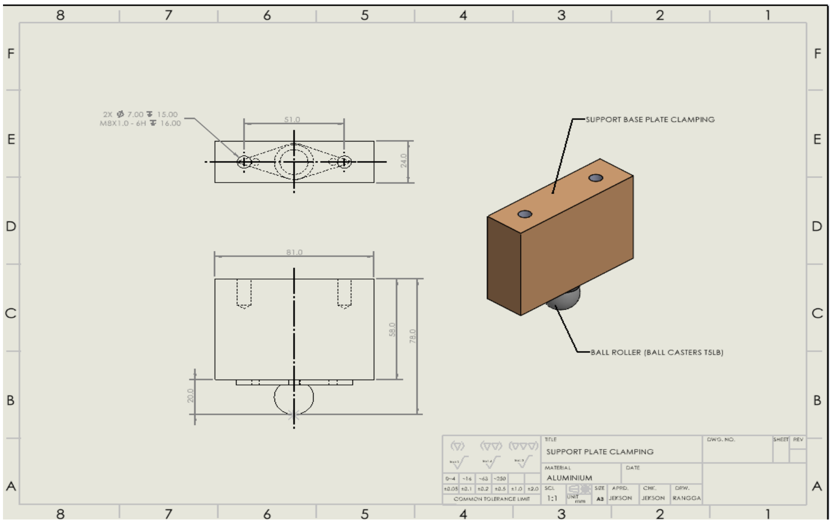


Figure 7. Drawing support plate clamping

Trials

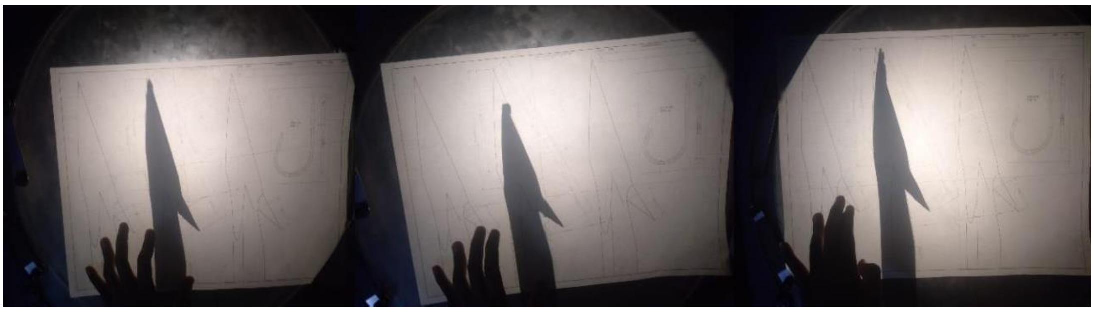
The testing phase includes research and testing aimed at determining the accuracy, effectiveness, and productivity of the modified jig slider grinding results.

3. RESULTS AND DISCUSSIONS

At this stage, the researcher conducted testing at PT. XYZ on the results of the design modifications that had been implemented by a third party, specifically by modifying the rail slider and support plate clamping parts using aluminum as the main material.

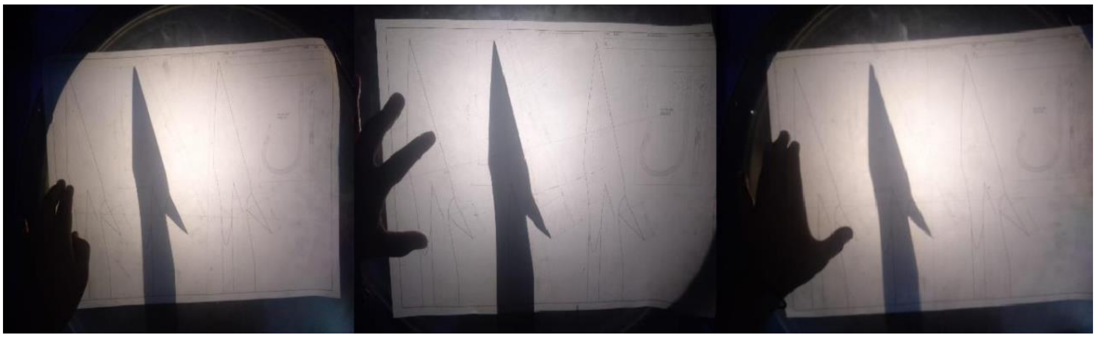
Figure 8. Jig slider grinding modification

To determine the results of the difference before and after modifying this jig slider, a trial stage will be conducted to test the profile point hook model dynacut results by performing 3 experiments using a profile projector with a scale of 10:1, which is commonly used as a projection tool for various types of objects. The following are the results of the profile point hook comparison using a grinding machine as shown in Figures 9.a and 9.b.



(1) (2) (3)

(a)



(1) (2) (3)

(b)

Figure 9. (a) Profile point hook model dynacut results before modification (b) profile point hook model dynacut results after modification

Based on the trials conducted, the results of this jig modification are within the standard drawing values and meet the specifications of the company. Therefore, it can be concluded that the results of this slider jig modification can improve the accuracy in forming the profile point hook.

Table 1. Comparison results of profile point specifications before and after modification

Experiment	Before Jig Modification	After Jig Modification
1	The profile point results obtained exceeded the standard dimensional value of ds: 11.89±0.30mm	The results obtained for dimension d are: 17.21±0.05mm, for dimension d1: 14.02±0.30mm, and for ds: 11.89±0.30mm, which are consistent with the standard drawing
2	The results showed that the profile point did not reach the standard dimension d1: 14.02±0.30 mm, and the dimension value ds: 11.89±0.30 mm	The results for dimension d were: 17.21±0.05 mm, dimension d1: 14.02±0.30 mm, and ds: 11.89±0.30 mm, which were consistent with the standard drawing
3	The results showed that the profile point did not reach the standard dimensions and was 11.89±0.30mm	The results for dimension d were 17.21±0.05 mm, for dimension d1: 14.02±0.30mm, and for dimension ds: 11.89 ±0.30mm, which were in accordance with the standard drawing

Based on data collected from PT. XYZ from May 13-30, 2024, it can be seen that the results of this jig modification are able to produce varying output depending on production needs. For example, on May 17, 2024, within 3 hours and 3 minutes of machine working time, a total output of 164 pieces was achieved from a total target of 158 pieces, resulting in a productivity percentage of 103.80%. This can be seen in Table 2. There are several factors that can cause this to happen, including variation, where diverse customer demand requires companies to always strive to meet customer needs well; operator ability, where operators' ability to operate equipment effectively allows them to work more efficiently and productively; and providing incentives or bonuses to operators who meet or exceed targets can increase their motivation and work spirit.

Table 2. Production data at PT. XYZ

Date	Model	Operator	Total Output	Working Hours	Target / H	Total Target	Output / H	%Productivity
13-May-24	DYNACUT	Andreas Zai	380	7 jam 54 menit	46	369	48	102.98%
16-May-24	DYNACUT	Andreas Zai	938	9 jam 30 menit	97	925	99	101.41%
17-May-24	DYNACUT	Andreas Zai	164	3 jam 3 menit	51	158	54	103.80%
27-May-24	DYNACUT	Andreas Zai	44	2 jam 42 menit	16	43	16	101.85%
28-May-24	DYNACUT	Andreas Zai	175	3 jam 12 menit	53	171	55	102.34%
29-May-24	DYNACUT	Andreas Zai	497	7 jam 30 menit	65	490	66	101.43%
30-May-24	DYNACUT	Andreas Zai	870	9 jam 6 menit	95	860	96	101.16%

4. CONCLUSION

In light of the finding of the jig slider grinding modification, it can be concluded that this modification can improve the balance of the jig slider by widening the rail slider from 14mm to 37mm and adding support to the clamping plate. It can also improve the accuracy of the profile point hook forming process to meet existing specifications, and achieve productivity with a percentage of 103.80%. This indicates that this jig modification is effective when used. This research can also be conducted for other manufacturing industries, such as welding, to reduce deformation.

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