

# The Effectiveness Using Drill Bit Sharpening Jig during Practical Practices in Politeknik Muadzam Shah

M. Syirazi<sup>1</sup>, M. Helmi<sup>2</sup>, M. R. Azman<sup>3</sup>

<sup>1</sup>Department of Mechanical Engineering, Politeknik Muadzam Shah, 26700 Muadzam Shah, Pahang, Malaysia.

<sup>2</sup>Department of Mechanical Engineering, Politeknik Muadzam Shah, 26700 Muadzam Shah, Pahang, Malaysia.

<sup>3</sup>Department of Mechanical Engineering, Politeknik Muadzam Shah, 26700 Muadzam Shah, Pahang, Malaysia.

Corresponding Author's Email: [1syirazisuhaimi@pms.edu.my](mailto:1syirazisuhaimi@pms.edu.my)

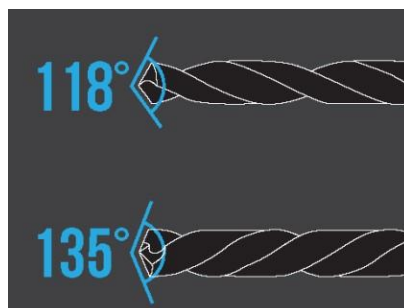
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**ABSTRACT** – The effectiveness of sharpening a blunt drill bit with a development jig was investigated in this study. During the practical practice session, the Mechanical Engineering students at Politeknik Muadzam Shah had to sharpen the drill bit. It is important to sharpen the drill bit at the right angle, but it can be challenging when students use their free hands to sharpen the blunt drill bit. The purpose of this study is to determine the effectiveness of the drill bit sharpening device by surveying the participants. Another aim of this study is to compare the time taken to sharpen the drill using free hand and using the drill bit sharpening jig. The total sample size for this study was 126 people. During the study, respondents were given the task of sharpening blunt drills using two methods. The first method was to sharpen the blunt drill with their free hand, and the second method was to use the drill sharpening jig developed by the researchers. The results show that respondents had difficulty sharpening blunt drills with their free hand, taking an average of three minutes to sharpen these drills. Furthermore, respondents were uncertain that the freehand method of sharpening drills is symmetrical and can produce flawless holes. On the other hand, respondents were assured that the use of this jig would produce a good drill point, resulting in a flawless hole. The jig can help respondents sharpen the drill bit better, and the respondents were confident that this jig can produce a symmetrical drill point angle that can result in a flawless hole. The results showed a time savings of 66.6% when using the drill bit sharpening jig compared to sharpening a blunt drill with the free hand. Overall, the researcher believes that the developed product can provide an effective teaching and learning environment during practical practice sessions.

**KEYWORDS** : Drill Bit, Jig Development, Practical Practice, Education,

## 1.0 INTRODUCTION

Cutting equipment plays a critical role in the machining process of finished products. Designing and determining the geometries of cutting equipment is extremely important, and drilling is the most commonly used method for generating machined holes because it is simple, fast, and low-cost [1]. A drill is a rotary cutting tool primarily used for drilling round holes in materials such as drywall, wood, metal, and masonry [2]. The drilling technique is also affected by machining parameters, with a higher feed value on a variable velocity resulting in a higher surface hardness [3]. During drilling, the drill bit is exposed to mechanical, thermal, and chemical influences that cause the bit to become blunt [4]. This is because the drilling process destroys the connections between the material particles.



**Figure 1.** Commonly Used Drill Bit Angles [6]

The most commonly used drill bit angles are between 118 and 135 degrees, with a clearance angle of 7 to 15 degrees [5]. As shown in Figure 1, the 118-degree drill bit angle is more aggressive and is usually used for drilling soft materials like wood, while the 135-degree drill bit is usually used for drilling harder materials like steel [6]. According to Botak et al., harder materials require a greater point angle, while softer materials need a sharper angle [7].

In a previous study by Aldio and Mustafa, it was found that the point angle used had an impact on the hole diameter [8]. Another study had designed a drill bit fixture as a holding and locating device to obtain a step angle on the drill bit, but the disadvantage of this design was that the blunt drill bit needed to be inserted and removed from the fixture [9]. In this study, the students in the Mechanical Engineering Department at Politeknik Muadzam Shah need to sharpen their blunt drill bit to 135 degrees to drill a hole in a steel plate during their practical practice.

### 1.1 PROBLEM STATEMENT

During practical practice, students in the Mechanical Engineering Department at Politeknik Muadzam Shah need to sharpen their drill bits. It is essential to grind the drill bit at the correct angle, but it is challenging when students use their free hands, as shown in Figure 2, to grind the blunt drill bit.

The weakness of the previous manual method, in which the correct angle of the drill bit could only be assessed by the naked eye, inspired the researcher to overcome the problem of inaccuracy in the degree of sharpening of the drill bit. The inaccuracy in the degree of sharpening can cause damage to the drill bit and result in a poor finish to the finished product. In a prior study by Gange et al., a drill bit fixture was designed to eliminate individual marking, positioning, and regular inspection of the part during drill bit sharpening [9]. Jig and fixture design allows for variable holding forces and optimizes the design for both machine and process functionality [10].



Figure 2. Students Use Their Free Hands To Grind The Blunt Drill Bit.

### 1.2 RESEARCH OBJECTIVES

The objectives of this study are to determine the effectiveness of the drill bit sharpening jig through a survey of respondents. Another purpose of this study is to compare the time taken to sharpen the drill bit using free hand and using the drill bit sharpening jig.

### 2.0 METHODOLOGY

The survey research was conducted with students from the Mechanical Engineering Diploma program at the Mechanical Engineering Department, Politeknik Muadzam Shah, Pahang, who took the Workshop Practice 1 course in Session 1: 2022/2023. The total sample used in this study was 126 respondents. During this study, the respondents were given the task of sharpening the blunt drill bits using two methods. The first method was to grind the blunt drill

bit using their free hand, and the second method was using the sharpening drill bit jig developed by the researchers. After the two methods of practical practice were conducted by the respondents, a questionnaire was distributed and answered by them at the end of the teaching and learning process.

## 2.1 DESIGN AND DEVELOPMENT OF DRILL BIT SHARPENING JIG

The design process of the drill bit sharpening jig was generated by the researchers using CAD software Autodesk Inventor 2021. Once the design was produced as shown in Figure 2, the 3D drawing was converted from a CAD file to a .stl file. Then, after the file format conversion took place, CURA software was used. This software converts the 3D model into the instructions the 3D printer needs to produce a prototype. In the CURA software, the design model file was entered and analyzed. Once analyzed, the file was saved to .gcode format. Finally, the design was printed on a 3D printer to produce the drill bit sharpening jig prototype. Figure 3 shows the prototype of the drill bit sharpening jig that was printed using 3D printing, and it took 2 hours to produce this prototype.

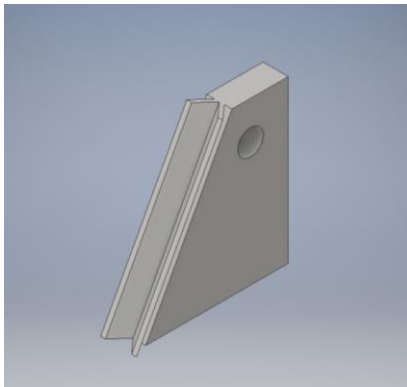


Figure 3. CAD Drawing of Drill Bit Sharpening Jig.

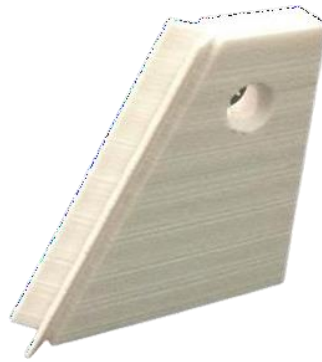


Figure 4. Drill Bit Sharpening Jig Prototypes.

The finished printed prototype is attached to the hand grinder machine, as shown in Figure 5. The drill bit is attached to the drill bit sharpening jig, and the honing process begins. During the sharpening process, the drill bit must be firmly attached to the jig.



Figure 5. Drill Bit Sharpening Jig Attached on Hand Grinder Machine

## 2.2 RESEARCH INSTRUMENT

A questionnaire was developed by the researcher to obtain data and information from the respondents. The use of questionnaires is very suitable because it is practical, effective, and saves time. The questionnaire provided contains three parts: A, B, and C. Part A is related to the demographics/background of the respondents, such as gender and experience in sharpening drill bits. Part B is related to the continuation of the process of sharpening the drill bit manually, while

Part C is related to the effect of using a jig to sharpen the drill bit. Responses to the statements in Parts B and C are in the form of a Likert scale. The Likert scale is suitable for measuring the opinion, attitude, or belief of a person or a community group towards an event. The five Likert scale response options are Strongly Disagree (SD), Disagree (D), Not Sure (NS), Agree (A), and Strongly Agree (SA). The Likert scale scores are shown in Table 1.

**Table 1.** The Five Likert Scale

Likert Scale	1	2	3	4	5
Feedback Options	SD	D	NS	A	SA

### 2.3 RESEARCH DATA COLLECTION METHOD

The instrument used in this study is a questionnaire. The researcher distributed a set of questionnaires to each respondent after the teaching and learning process of the Workshop Practice 1 course ended. By making a Likert scale on each set of simple questionnaires, the data that has been analysed can be reviewed again if there is any discrepancy in the final findings. Through this questionnaire, the researcher was confident in carrying out the study because the researcher could communicate directly with the respondents. The researcher felt assured that the data and information obtained through this method were accurate because the respondents could respond directly to the aspects surveyed, and the questionnaire presented was also easy to answer because the answer choices had been provided.

In addition, the time taken to sharpen the blunt drill bit using respondents' free hands and the development of the sharpening jig had been recorded. The percentage improvement in response time can be calculated using Equation 1 [11]. The improvement for this innovation is the reduction in time needed to complete the same task using the existing method ( $t_{old}$ ) and using the drill bit sharpening jig ( $t_{new}$ ). The researcher also observed the result of producing a hole without a defect caused by sharpening the drill bit.

$$\frac{(T_{old} - T_{new})}{T_{old}} \times 100 \quad (1)$$

### 3.0 RESULT AND DISCUSSION

The results of this study were obtained from the analysis of the questionnaire that was distributed to 126 respondents, who are students from the Mechanical Engineering Diploma program at Politeknik Muadzam Shah, Pahang. The data analysis was divided into two methods for sharpening the drill bit, the first being that the respondents sharpened the drill bit with their hands, and the second being that the respondents used the drill bit sharpening jig invented to sharpen the blunt drill.

#### 3.1 ANALYSIS OF SHARPENING DRILL BIT USING FREE HAND

The questionnaire was distributed and answered by respondents regarding sharpening the drill bit using free hand. Table 2 shows the analysis of the distribution of feedback from respondents who sharpened the blunt drill bits

**Table 2.** Feedback of Respondents Sharpen the Blunt Drill Bits Using Free Hand.

Questions	Min
I had a hard time at the beginning of the drill bit sharpening process.	4.00
It took me a long time to set the right angle of the drill bit.	4.13
I only use eye to make sure both ends of the drill bit tip are symmetrical	4.25

I wouldn't know if the tip angle of the drill bit was symmetrical	4.62
I'm confident sharpen the blunt drill bits using free hand.	2.38

### 3.2 DISCUSSION SHARPENING DRILL BIT USING FREE HAND

According to the survey, respondents have difficulty sharpening drill bits by hand. Referring to Table 2, the average score for respondents who had a hard time sharpening drill bit is 4.0. This result shows that respondents had difficulty sharpening the drill bit using free hand. In addition, respondents also took a long time to get the right angle when sharpening the drill bit. Based on the survey, the average score for the respondents who took a long time to set the right angle of the drill bit was 4.13. This means that respondents need to spend a lot of time sharpening the drill bit using this method.

In addition to getting the right angle when sharpening the drill bit, respondents also need to ensure that the two tip angles are symmetrical. From the feedback received, the mean average score was 4.25, indicating that respondents used their eyes to make sure both ends of the drill bit tip were symmetrical. This shows that the respondents faced difficulties producing symmetrical drill bits.

Furthermore, respondents were not confident that the sharpened drill bit was symmetrical. From Table 2, it is shown that the respondents do not know if the drill bit that had been sharpened was symmetrical with a minimum score of 4.62. Respondents are also not assured that a sharpened drill bit will produce a good finish on the finished product. This was proven by the last question answered by respondents, which had a mean average score of 2.38. This outcome shows that the respondents doubted the results of sharpening the drill bit using free hand.

Overall, respondents had problems sharpening blunt drill bits and took a long time to sharpen these blunt drill bits. Furthermore, respondents were unsure that using the free-hand method to sharpen drill bits would produce symmetrical and defect-free holes.

### 3.3 ANALYSIS ON SHARPENING DRILL BIT JIG

Before the survey was distributed and answered, the respondents had used both methods to sharpen the drill bit. Table 3 shows the analysis of the distribution of respondents on sharpening the drill bit by using the jig that had been innovated.

**Table 3.** Feedback of Respondents Using the Drill Bit Sharpening Jig.

Questions	Min
This jig makes it easier for me during the initial process of sharpening the drill bit	4.50
This jig save time for me to set the right angle of the eye tip	4.75
This jig reduces the use of my eye to ensure precision both ends of the drill bit tip are symmetrical	4.13
This jig ensures that the angle of the tip of the drill bit is symmetrical	4.25
This jig ensures that the drill bits that been sharpen can produce holes without defect.	4.88

### 3.3 DISCUSSION ON SHARPENING DRILL BIT JIG

Sharpening fixture drill bits improves their accuracy and reproducibility, according to a previous study by Gange et al. [9]. Based on Table 3, the first question obtained a mean average score of 4.50, and it was identified that the drill bit sharpening jig made it easier for respondents to sharpen the drill bit during the initial process. This exposed that the jig had helped the respondents during the process of sharpening the drill bit. In addition to that, the respondents said that using this jig had saved them time by eliminating the need to sharpen drill bits. With a mean score of 4.75, respondents agreed that the drill bit would save them time when setting the right angle of the eye tip, as shown in Table 3.

Based on the results, the respondents reduced the use of their eyes to ensure precision, and both ends of the drill bit tip were symmetrical, with a mean average of 4.13. The aspect of obtaining the accuracy of both symmetrical tip angles of the drill bit using this jig also showed a mean average score of 4.25. This proves that the respondents were confident that drill bits sharpened using the jig would produce a symmetrical tip angle. Regarding this survey, the respondents are confident that the drill bits that have been sharpened using this jig can produce holes without defects, with a mean score of 4.88.

Furthermore, respondents were assured that using this jig would result in a good drill point and a defect-free hole. From these two methods to sharpen the drill bit, it is clear that the produced jig can help the respondents sharpen the drill bit better, and the respondents are confident that using this jig can produce a symmetrical drill bit tip angle and a hole without any defects.

### 3.3 ANALYSIS ON TIME TAKEN USING TWO METHODS SHARPENING THE DRILL BIT

The time taken to sharpen a drill bit by hand and with the drill bit sharpening jig was recorded during the respondents' practical practices. According to Table 4, respondents take an average of 3 minutes to sharpen a drill bit by hand, while only an average of 1 minute is needed to sharpen the drill bit using the newly produced jig. This finding verifies that this innovation can save time when sharpening a blunt drill bit.

**Table 4.** Time Taken to Sharpening the Drill Bit

Items	Average Respondents Sharpening Drill Bit Using Free Hand	Average Respondents Using Drill Bit Sharpening Jig
Time taken to sharpening the drill bit	3 minute	1 minute

$$\frac{(T_{old} - T_{new})}{T_{old}} \times 100$$

$$\frac{(3\text{minutes} - 1\text{minute})}{3\text{minutes}} \times 100 = 66.6\%$$

Based on the data in Table 4, the percentage of improvement by means of time for the unit using Equation 1 has been calculated. The result showed a 66.6% improvement in time using the drill bit sharpening jig compared to using a free hand to sharpen the blunt drill bit.

### 4.0 CONCLUSION

In general, the drill bit sharpening jig is beneficial to both students and instructors in the teaching and learning process, particularly in the Workshop Practice 1 course, as it makes the process more effective and efficient. This was supported by the fact that respondents scored a minimum of 4.62 when asked if they knew that the drill bit sharpened using the jig was symmetrical, while they questioned their results when sharpening the drill bit by hand. Conversely, the respondents agreed that using the jig saved time for them to set the right angle of the eye tip, with a mean score of 4.75. Additionally, with a mean score of 4.88, respondents were confident that drill bits sharpened using the jig could produce holes that are free of defects, resulting in a good drill point and defect-free hole.

This study also showed that respondents took an average of 3 minutes to sharpen the drill bit by hand, while only 1 minute was needed using the jig, demonstrating the effectiveness of the jig in saving 66.6% of time when sharpening a blunt drill bit. Overall, the researcher believes that this product can provide an effective teaching and learning atmosphere, particularly in technical courses such as Workshop Practice 1. Since the jig ensures that the drill bits produced are defect-free, students and instructors can focus on practical practice and be more effective as a result of this innovation.

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