International Journal of Engineering & Technology, 7 (2.14) (2018) 48-52

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

Skills Workers in Mechanical Engineering to Produce Portable Sprocket

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Abstract

Sprocket is a wheel with teeth that mesh with a chain. It is being used widely in automotive and machinery to transmit rotary motion between the shafts. In manufacturing the sprockets, some of the workers have the skills to make it and some of them lack the skills. Skills are important in manufacturing engineering. The main focus of this research is to help: i. the workers in manufacturing the sprocket efficiently; and ii. low cost while providing good quality of sprocket. In this research, operations that require machining some of them are simple which can be done easily such as turning. No other devices needed to hold the workpiece in such an operation. The research aims to develop a jig & fixture tool which is called a sprocket. While the research methodology is divided into 2 which are the procedure during the making of the project and the results and discussion obtained. This study is very useful for small and big industries for the sprocket process. It would help the user to make sprockets only using this sprocket maker to guide the drilling machine. It is a low cost and efficient way for manufacturers that is currently in this sprocket manufacturing.

Keywords: *Skills, Jig, Fixture, Sprocket, Mechanical Engineering*

1. Introduction

The According to the National Society of Professional Engineers [1], the skills can be defined as the ability to perform the duties assigned by using existing knowledge. Skills required in engineering to manage the new challenges for the future will be more competition that will exist in the work environment [2].

The problem that the small industry is facing today is that the process of making a sprocket in a large quantity is quite difficult due to not having a specific tool to guide worker to hold and drill the sprocket they couldn't afford an advanced machine that are being used by the large industry. Definition for jigs and fixture is that the jigs and fixtures is the components of machine-tool specially created in each case to hold the work piece firmly in place and assist the motion of the power tool [3]. While for the definition of a jig is that a jig is a work-holding tool used to hold, assist, locates a specimen or work-piece and direct the cutting tool for machining operations [4]. The definition of a fixture is also important because it relates to both of the definition just now. A fixture is use to locate and hold the specimen during the process and it is unique because it is built to fit a specific part or design [5].

A sprocket is a toothed wheel that is use to engage with anything that will be pulled by the wheel as it rotates. Researcher does have similarity to the gear although it is not created to be meshed with other gears. It has been around for a long time and it is use to powering professional-class bicycle and many other application [6]. The purpose of using the sprocket is to eliminate the use of gearing and rope pulley mechanism to transfer power [7].

The researchers chose this project because it is unique, can be custom made and free size. The main objectives of this study is to make a lot of different kind of sprocket with only one sprocket maker. Three objectives of this research are as follows: (i) the top part of the sprocket maker; (ii) the middle part of the sprocket maker; and (ii) the bottom part of the sprocket maker. Based on the data obtained, the next step is to make it a reality by machining, drilling and cutting.

A lot of the operations that requires machining can be done by clamping the workpiece on to the machine table when only a few parts needed to be machined [8]. Six principles of jigs design is clamping the object, having a very good clearance, a very nice stability and rigidity while providing a very good handling and accuracy. The calculation and explanations of the design are based on these principles [9]. Machining process can be view as bot inner and outer machining depending on the surface where the material removal is happening [10].

2. Methodology

In idea generation, the researchers had made a few discussion about generating the idea for the jig and fixture project and the result of the discussion were to make a sandwich jig for sprocket.

A solid work sketches were made after the idea generation by the researchers.

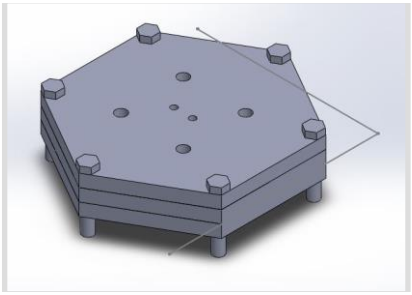

Figure 1: Overview of the Sandwich Jig for Sprocket

The researchers had chosen acrylic as the material to make this sandwich jig for sprocket after being advised by the lab assistance. The choosing of this material is because the researcher wanted to use the CNC machine. Besides that, it is lighter and it can provide the same result as other material. It is easier to be shape and cut according to the researcher.

Figure 2: Acrylic Material

Before the researchers draw the sandwich jig for sprocket, the researchers takes the measurement of the acrylic and apply it to the solidworks software. Then, precise drawings of sandwich jig for sprocket were drawn using the solid works software.

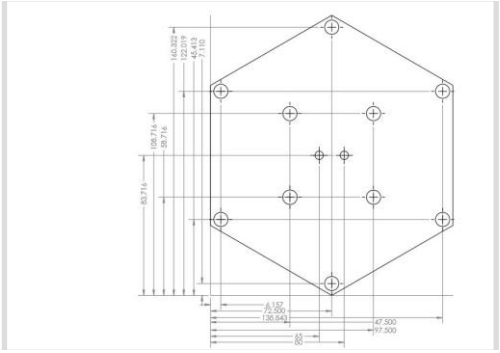

Figure 3: The Top and Bottom Part of the Sandwich Jig.

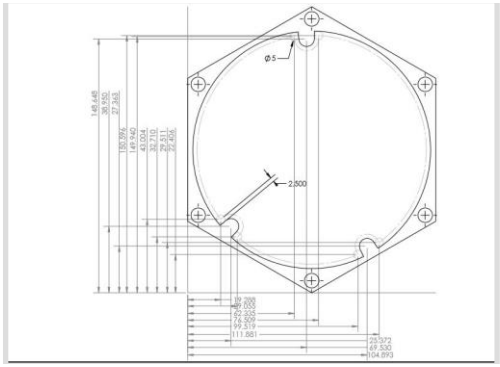

Figure 4: The Middle Part of the Sandwich Jig.

Based on figure 3 and 4, the top and bottom part of the sandwich jig is to cover for the middle part which is like the cookie on top and bottom of the cream. The function of this top and bottom part is as a guide for the user to drill holes into the sprocket.

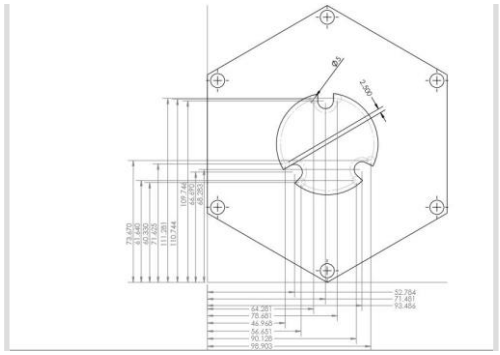

Figure 5: Another Middle Part of the Sandwich Jig

Based on figure 5, any of these 2 middle parts can be chosen as the middle part of the sandwich jig because in the middle is where the sprocket will be placed and these two parts are the example of different size of sprocket that can be applied to the sandwich. This shows that the sandwich jig for sprocket can make sprocket with different size. The function for the middle part is to hold the sprocket before it is being drilled. And by having different type of middle layer, different size of sprocket could be fit in.

In cutting the acrylic process, an acrylic cutter and a metal ruler was used to cut the acrylic into a hexagonal shape. The process was a bit difficult due to cutting it manually.

Figure 6: Cutting the Acrylic

After cutting the material, the researcher used the milling machine to make the side of the acrylic smoother, nicer, better edge finish and more accuracy.

Figure 7: Milling the acrylic

In order to disallow any movement of the jig during any operation, clamping is required. A clamp is a mechanism of a fixture that holds the part together from any external force that is acting on it [6]. It doesn't need to re-clamp the object for the same objective as most of its objective can be achieved by the jig on its own [11]. The system of clamping being used these days is to hold the workpiece together while the process of drilling is being done on it [12]. Thus, the next step is to drill the jig in order to prepare a section for the clamp by using the Up Right Drilling Machine.

Figure 8: Drilling the jig

The most common machining operation on Computer Numerical Control or CNC Machine is hole drilling operation. It is a powerful technique which it can develop the proposed algorithm using parametric programming [13]. CNC machine minimize the time of tooling operation while machining to drill a group of holes [14]. The CNC Machine got the best accuracy. It can even out stand the laser technology or additive manufacturing (AM) [15] . For the final step is CNC Machining. CNC machining is the most important step because it is where the sprocket will fit in to enable surgery on the sprocket itself.

Figure 9: CNC Machine

After that, the researcher needs to transform the coordinate of the SolidWorks into the G-Code. After finished making the code by referring the SolidWorks drawing, the researcher writes the code into a text format and copies it to a thumb drive to transfer it to a CNC machine.

Table 1: G-Code

```
N1 G17
N2 G00 T11 F50 S7000 M03 M06
N3 G00 Z5

N5 G00 X62.32 Y54.17
N6 G01 Z-5
N7 G01 X64.7 Y58.01
N8 G02 X74.3 Y58.01 R8.51
N9 G01 X76.68 Y54.17
N10 G03 X76.68 Y108.83 R28.25
N11 G01 X74.3 Y104.99
N12 G02 x64.7 Y104.99 R8.51
N13 G01 X62.32 Y108.83
N14 G03 X62.32 Y54.17 R28.5

N15 M30
N16 G28
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Figure 10: Inserting the G-Code

Figure 11: Data being executed by the CNC machine

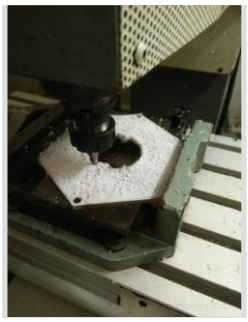

Figure 12: Jig being cut by the CNC machine

3. Results and Discussion

Researchers expect the following results which are to drill the sprocket with the guide provided for the user. This is the final result after struggling to finish this project. This size of portable sprocket maker can support size up to 14T to 33T. The holes provided can be either drill into it. The center part is the only thing

that can be manipulate if the user decides to use a different side of sprocket such as from 14T to 33T. Thus, it is more economical and save money.

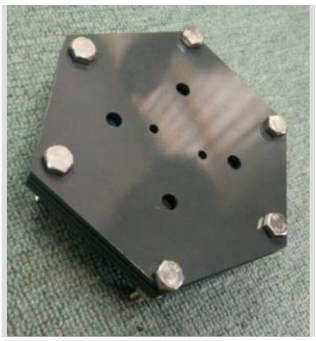

Figure 13: Showing the final result of the project

The results shown that the initial stage of making a sprocket is by making a sprocket jig. Some manufacturer does not use a jig as they can use the machines directly drill the sprocket. This paper does not cover the topic of the individual sprocket rather the jig itself. The mechanism of the sandwich jig of the sprocket is that the sprocket would be located at the middle layer of the sprocket and would be covered with top and bottom layer to ensure the sprocket would not be loose. Then the screw would be inserted and tightened up at each sides of the hexagonal jig. The holes of the jig would be used to guide a driller to drill the holes for the sprocket for other functions.

Entrepreneurship is very important in economic development as it had been highlighted by a lot of researchers [16]. By associating entrepreneurship with innovation, a lot of other agencies already adopted policies in the hope of assisting in the economic growth [17]. Thus, entrepreneurship is very linked to jig and fixture due to the innovation that is implemented on the product by the researcher and the researcher intended to sell the product to the public. So it opens the door to become an entrepreneur.

Table 2: Bill of Material (BoM)

Part	Material	Dimension (mm)	Quantity	Cost/Unit (RM)	Total cost (RM)
Top cover	Acrylic perspec	200 x 200 x 5	1	8.00	8.00
Middle part	Acrylic perspec	200 x 200 x 5	1	8.00	8.00
Bottom cover	Acrylic perspec	200 x 200 x 5	1	8.00	8.00
Screw	High carbon steel	20 x 8.5 ø	6	2.00	12.00
Bolt	High carbon steel	8.5 ø	6	0.58	3.48
					39.48

Table 3: Overhead Cost

Process	Cost (RM)
CNC Process	40.00
Drilling Process	18.00
Milling Process	10.00
	68.00

4. Conclusions

The product of this study can be used in small industry and big industry which is to guide the drilling machine to drill the sprocket. The detailed information about the basics of sprockets was discussed at the beginning of the study. Based on the findings obtained through a process carried out revealed that sprocket alone cannot be drilled accurately, but with this portable sprocket maker, drilling the sprocket more accurately is made possible.

Table 4: Duration Time in Making a Portable Sprocket Maker

Step	Task	Time (hours)
1	Final Ideation and Design	2
2	Selecting and buying the material	2
3	Making the 3D model in SolidWorks Software	4
4	Referring the 3D model to Instructor	2
5	Measuring and cutting the Acrylic Perspex	4
6	Milling and Drilling the Perspex	4
7	Typing and Inserting the G Code in the CNC Machine	4
8	Cutting the middle part of the Perspex using the CNC machine	4
9	Finishing the product (spray and remove the sharp edge	4
		30

Acknowledgements

The author wish to thank the other members of Universiti Sultan Zainal Abidin for their help of this work. Special thanks to Dr. Noraini Hamzah from National University of Malaysia as a supervisor provided many useful discussion. The research was supported by a Ministry of Higher Education (MoHE) by SLAB scheme. The data presented, the statements made, and the views expressed are solely the responsibility of the author.

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