



POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

**DEVELOPMENT OF SPOTWELD JIG TO AID
THE HOUSE GRILL MANUFACTURE PROCESS**

MUHAMMAD FAIZ AKMAL BIN NORAZMI

08DKM20F2022

MUHAMMAD HAFIZ IMRAN BIN KAMARULZAMAN

08DKM20F2034

MUHAMMAD SYAZWAN BIN ISMAIL NORDIN

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JABATAN KEJUTERAAN MEKANIKAL

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Laporan ini dikemukakan kepada Jabatan Kejuruteraan Mekanikal sebagai memenuhi sebahagian syarat penganugerahan Diploma Kejuruteraan Mekanikal.

JABATAN KEJURUTERAAN MEKANIKAL

SESI 2 : 2022/2023

AKUAN KEASLIAN DAN HAK MILIK

DEVELOPMENT OF SPOTWELD JIG TO AID THE HOUSE GRILL MANUFACTURE PROCESS

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2. Saya mengakui bahawa Development Of Spotweld Jig To Aid The House Grill dan harta intelek yang ada di dalamnya adalah hasil karya/ reka cipta asli saya tanpa mengambil atau meniru mana-mana harta intelek daripada pihak-pihak lain.
3. Saya bersetuju melepaskan pemilikan harta intelek Development Of Spotweld Jig To Aid The House Grill kepada Politeknik Sultan Salahuddin Abdul Aziz Shah bagi memenuhi keperluan untuk penganugerahan Diploma Kejuruteraan Mekanikal kepada saya.

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ACKNOWLEDGEMENT

First of all, we would like to express our gratitude to Allah SWT for the chance to complete this Final Year Project. We would also want to extend special thanks towards Politeknik Sultan Salahuddin Abdul Aziz Shah for providing us the opportunity to complete our Diploma in Mechanical Engineering courses and without their resources then none of what is seen now could have been possible in terms of creative or intellectual development. This project has been a lot of work, but we couldn't do it without the support and guidance from some very important people. We would like to thank Mr. Mohd Shahrom Bin Ismail, for all his help with this project; they provided us with resources as well as essential information that was needed to complete our task successfully. Thank you also goes out to our parents and friends for their unwavering support, love and prayers which has been our main source of strength for us. Last but not least, we want to thank ourselves, Faiz Akmal, Hafiz Imran and Syazwan for all the hard work, for never having days off, for never quitting in completing this Final Year Project. We would like to express our gratitude to everyone who supported us in this project.

ABSTRACT

The welding jig is one of the necessary support equipment in the assembly line especially for those related to the heat joining process. The use of this equipment as a working device is to ensure that product quality can meet certain standards, especially for high repetitive assembly processes. The main objective of this product is to facilitate the work of welding the door grill. Second, to speed up the work process. In addition, to solve the problem of eye pain and back pain. This problem occurs due to welding too close and inappropriate body posture. It is also to improve the quality of work. For example accurate measurements and neat welding results. The sketch for this jig was created using AutoCAD Inventor software. The use of Inventor can make the sketching process easier and easier to understand. The size of this jig sketch is according to the result of the measurement on the door grill. This jig design resulted from the discussion, and was agreed upon by the majority. For the product production process, among the materials used are C channel, mild steel flat bar, thread bar. C channel used as the main body for the jig and measuring 61.26cm. Mild steel flat bar is used as a base to place the door grill frame and measures 66.34cm. The thread bar is used to fasten the jig to the table and fasten the door frame grill iron to the jig. The size of the thread bar used is 3 inches equal to 7.62cm.

As a result of the production of this jig, many problems can be solved. The first is to facilitate the work of welding the door grill. With this jig, it can also speed up the work process. In addition, it can solve the problem of eye pain and back pain. It can also improve the quality of work. For example accurate measurements and neat welding results. This welding jig is suitable for marketing to the manufacturing industry or iron workshop. This is to facilitate their installation work so that they can do work faster and they can focus on other work. This welding jig is very useful for iron shops because they will always use it to do connection work, for example, the work of making floor grills, house fences and so on. The result of this welding jig is from a "C" shape. The original shape of this weld is "C" shaped. This is because, it is easier for the user to tie the jig to the table and the welding work process.

ABSTRAK

Jig kimpalan adalah salah satu peralatan sokongan yang diperlukan dalam talian pemasangan terutamanya bagi mereka yang berkaitan dengan proses penyambungan haba. Penggunaan peralatan ini sebagai pegangan kerja peranti adalah untuk memastikan kualiti produk boleh memenuhi standard tertentu, terutamanya untuk proses pemasangan berulang yang tinggi. Objektif utama produk ini adalah untuk memudahkan kerja mengimpal grill pintu. Kedua, untuk mempercepatkan proses kerja. Selain itu, untuk menyelesaikan masalah sakit mata dan sakit belakang badan. Masalah ini berlaku kerana mengimpal terlalu rapat dan postur badan yang tidak sesuai. Ia juga untuk mempertingkatkan kualiti hasil kerja. Contohnya ukuran tepat dan hasil kimpalan yang kemas. Lakaran untuk jig ini dihasilkan menggunakan software AutoCAD Inventor. Penggunaan Inventor dapat memudahkan proses lakaran dan mudah difahami. Ukuran lakaran jig ini mengikut hasil ukuran pada grill pintu. Design jig ini terhasil daripada perbincangan, dan dipersetujui oleh majoriti. Untuk proses penghasilan produk, antara bahan yang digunakan ialah C channel, mild steel flat bar, thread bar. C channel yang digunakan sebagai main body untuk jig dan berukuran 61.26cm. Mild steel flat bar digunakan sebagai base untuk meletakkan frame grill pintu dan berukuran 66.34cm. Thread bar pula digunakan untuk mengikat jig pada meja dan mengikat besi frame grill pintu pada jig. Ukuran thread bar yang digunakan adalah 3 inch bersamaan 7.62cm.

Hasil daripada penghasilan jig ini, banyak masalah yang dapat diselesaikan. Yang pertama adalah dapat memudahkan kerja mengimpal grill pintu. Dengan jig ini, ia juga dapat mempercepatkan proses kerja. Selain itu, dapat menyelesaikan masalah sakit mata dan sakit belakang badan. Ia juga dapat mempertingkatkan kualiti hasil kerja. Contohnya ukuran tepat dan hasil kimpalan yang kemas. Jig kimpalan ini sesuai dipasarkan ke industri perkilangan ataupun bengkel besi. Hal ini untuk memudahkan kerja pemasangan mereka supaya dapat melakukan kerja lebih cepat dan mereka dapat focus kepada kerja lain. Jig kimpalan ini sangat berguna bagi kedai besi kerana mereka akan selalu menggunakannya untuk melakukan kerja penyambungan contoh kerja pembuatan grill tingkat, pagar rumah dan sebagainya. Terhasilnya jig kimpalan ini daripada berbentuk "C". Aslinya bentuk kimpalan ini berbentuk "C". Hal ini kerana, lebih memudahkan pengguna untuk mengikat jig pada meja dan proses kerja welding.

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CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

Over the past half century, manufacturing has made great strides. New machine tools, high-performance cutting tools, modern manufacturing processes and creative management tools have been combined to enable today's industry to make parts faster and more accurately than ever before. Although workholding methods have also advanced significantly, the basic principles of clamping and tracking are still the same. The first manufactured products were made one by one. Early makers started with little more than raw materials and a rough idea of the finished product. They produce each product piece by piece, making each part individually and fitting the parts into the finished product. This process takes time. Also, the quality and consistency of the product varies from one artisan to the next. As they worked, early manufacturing pioneers recognized the need for better methods and developed new ideas. Finally, they discovered the secret of mass production: standard parts. Standard parts not only speed up production, they also ensure part interchangeability. This idea may be obvious today, but in its day, pioneered by Eli Whitney, it was revolutionary. A jig is basically a tool that helps repeat the same action over and over again with precision. By holding the workpiece at several points or allowing the workpiece to be clamped together, the jig allows the user to drill holes, removing material precisely. In other words, a jig is a workholding device that holds, supports and positions a workpiece to guide one or more tools. The main purpose of the jig is to provide repeatability, accuracy, and interchangeability in the manufacturing process. This makes it easier for manufacturers because they don't have to reinvent their machines every time they make a new part. Jigs can also be used to create alternative product layouts that may provide more efficient manufacturing than would originally be possible using only tools with limited range and accuracy (eg, welding machines). Jigs are indispensable in the machining process. They help guide and hold the workpiece by ensuring that any jointing is accurate. This device can also have a clamp on it to hold the object firmly while doing the work. The welding jig is one of the necessary support equipment in the assembly line especially for those related to the heat joining process. The use of this equipment

as a working device device is to ensure that product quality can meet certain standards, especially for high repetitive assembly processes. In addition, the existence of the welding jig can also be attributed to the reduction process cycle times thus saving production costs and increasing productivity

1.2 PROBLEM STATEMENT

- **Making a grill takes a long time.**
 - Because every installation for a single connection must be measured, it takes a long time, and our project can speed up the measuring work because our project has the specified measurements available.
- **Grill accuracy is not very accurate.**
 - There are some connections that are inaccurate because the connection point is not even. As a result of our project, each connection will be more precise because the measurements have been established, and the material will not run away because it has been tied.
- **Manufacturing results are less beautiful.**
 - Because the manufacturing method does not use the appropriate tools, the connection result is inaccurate and less beautiful when connected.

1.3 OBJECTIVE

For this final year project, we are going to make an new development of spotweld jig with some changes that might solve problems from the existing jig .Our main objectives are:

1. Can speed up work in one time for fabricate the standard house door grill

- We can speed up the grill fabrication process and produce more grills in large quantities by using this jig.

2. Can measure the standard house door grill accurately.

- If you used to measure the fence with only a measuring tool, our jig comes with a predetermined size, so you don't have to measure and the size is accurate.

3. This project can help welding workers lighten their burden such as not getting tired easily.

- Existing workshops typically perform fabrication work on the floor without the use of special tools. As a result, the workers will experience back pain as well as vision problems. Workers will be more comfortable doing grill fabrication work with the help of this jig.

1.4 SCOPE

- Ability to get regular & accurate distance.
- Ability to produce neat products.
- This product can make a grill in a short time.
- Made of light material

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

It is a work-holding gadget that hold, uphold and find the work piece and guides the cutting device for a particular activity. Jig are usually fitted with hardened steel bushings for guiding or other cutting tools. It is a is a type of tool used to control the location and motion of another tool. A device that can do both functions it will be holding the work pieces and guiding a tool know as jig. A jig's basic function of it that is to provide interchangeability, accuracy, repeatability, and in the manufacturing of products.

Jig:

- It is a work holding device that holds, supports and locates the workpiece but also guides the cutting tool for operations. It is a device that can do both functions (holding the work and guiding a tool) is called a jig.
- Jig should be clamp properly to the table while machining.
- Jig is lighter in weight

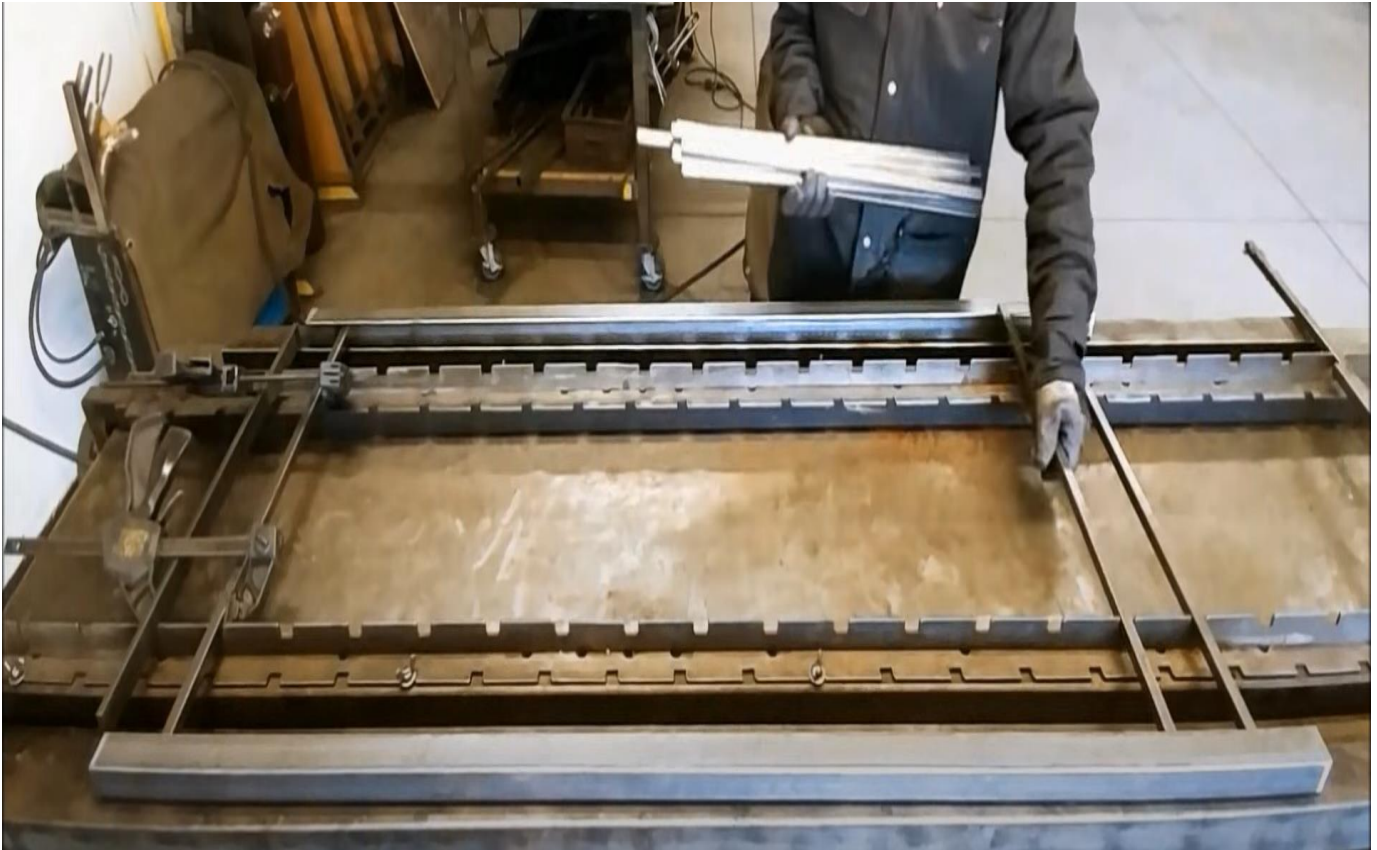
Jigs are special devices for different operations like drilling, reaming, boring, tapping etc.

2.2 HISTORY OF JIG

The most important factor which is firstly considered in every operation is the clamping mean and hence the clamping force. This is done to make sure the machining is as per designed with minimal work piece material loss. At the beginning the mechanical means of clamping was preferred such as vice. Vice provide a greater resistance force against the machining operation force. It is simply structured and easy to maintain and operate without the skill operator to be acquired. The demand of the material and hence the geometry with the design changes as more the complexity of the products.

To overcome such factors the change of the clamping method is brought under consideration. The clamps were introduced to be used for a wider range of the work pieces, so the machine structure modification is not required according to the operation. Introduction of the magnetic clamps were the first step towards the innovation. As identified by the name the clamp holds the workpiece with magnetic force. The force is controlled as the temporary magnet phenomena, the more the electric flow through the coils of fixture the more the clamping force is generated. These fixtures were adapted at larger scale as it was quite simple and more effective. Though having some limitations, it was also thought to be modified or to fabricate the fixture as it was unable to grip the paramagnetic and nonmagnetic materials such as wood, Aluminum, plastic block, etc

The fixture was fabricated, and the vacuum suction is used for the clamping means. The phenomena of suction power are used for getting the job done for the fixture. A suction pump is used to suck down and grip over the workpiece. The force is produced enough to clamp the workpiece, but it is quite simple to be operated. The complicated geometry can also be gripped with the advantage of the thin and nonmagnetic materials hence overcoming the deformation efforts which are produced with the over clamping force. It just made the force to be simple and according to the requirement which is defined accordingly in the design and operation requirement.



- The jig is too large because many components were used to create it, making the jig expensive.
- The jig is non mobile and static
- Can use just one design

SUMMARY

As mentioned in Chapter 2, we discuss the history of the jig we will use to make our products. A thorough investigation is conducted to identify the shape used to make our products appropriate for the costs we estimate. The shape that we identify is affordable in terms of the money that we will spend.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter will provide a through overview of the approach used to complete and successfully complete the project. Many of the discoveries in this discipline came from research conducted by others to advance this effort.

The process of getting ready to start a project is called methodology. One of the strategies used in creating or designing a project is the design methodology. To attain production goals in the finished project, a creative and innovative project is created with the aid of the approach.

This jig design considers all factor and must also satisfy user requirement for spot welding in industry. To make the learning session easier, the project's size and balance have also been taken into consideration.

3.2 FLOW CHART

The diagram shows the flowchart of the process for the success of this project. In addition, there are also several steps to be taken as well should be followed in implementing this project. The step is as shown in figure. From the charts of this flow, the activity record for the success of this project can be done smoothly and consistently.

3.3 METHODOLOGY

This section explains how the "Smart Jig" was created. Figure 2.1 shows a flow chart of the project development process to demonstrate how this project was created. The process begins with the creation of the product. The process of identifying appropriate and accurate materials, components, and measurements to meet the project's needs follows. Next, determine methods for product development, fabrication, and testing. It will then proceed to the finished product and data analysis.

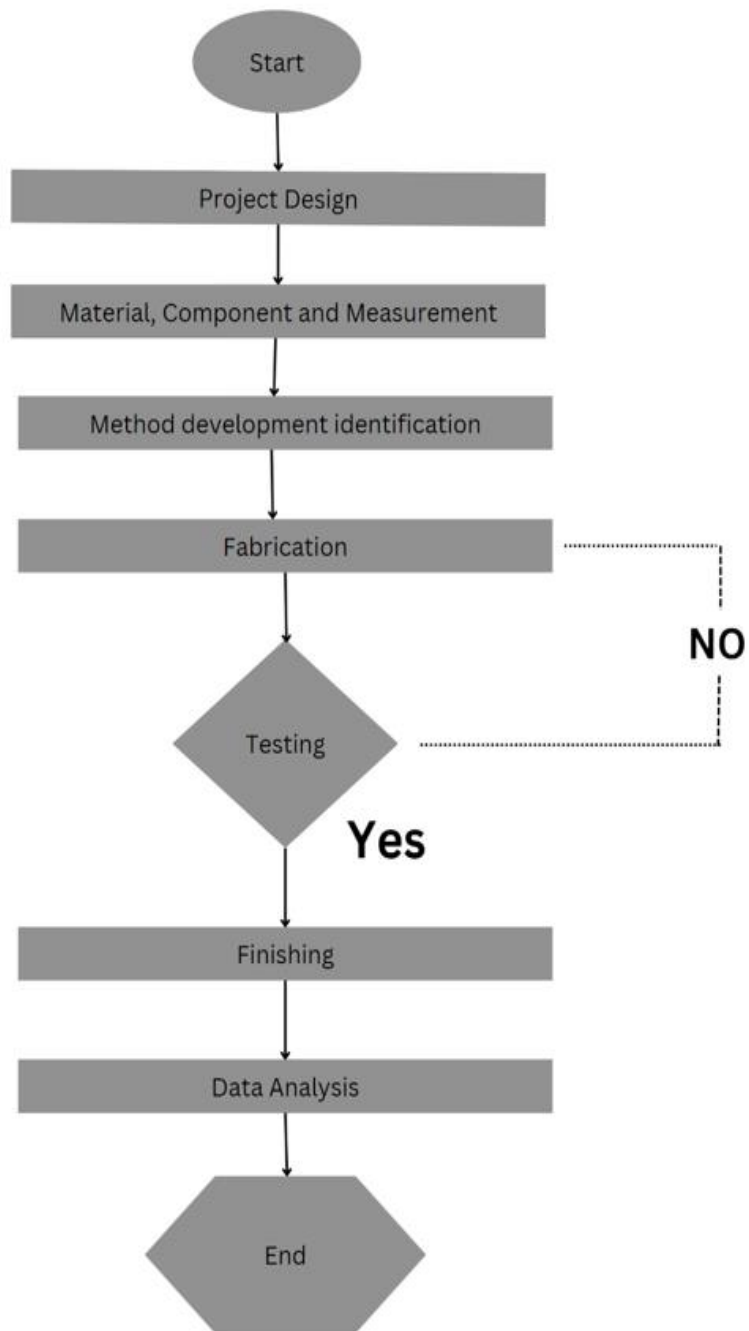


Figure 2.1 : Project Flow Chart

3.3.1 DESIGN PROCESS

The inventive process is part of the work which needs to be done to create a new project or modifications to a project or better known as process improvements. Some of the necessary steps done in the inventive process are:

- i. Identifying problems.

- ii. Creating ideas

- iii. Design and selection of projects.

- iv. Project planning

3.3.2 Project selection

In the process of project selection, criteria and certain factors should be emphasized in terms of selection of materials, costs, and security. The material used must match with the product generated.

3.3.3 Project Planning

The process of forming the appropriate framework and manufacturing techniques as well need careful planning and planning because of its structural to be made in line with the product among which review the requirements appropriate equipment and materials, material selection of the economy, and quality and user-friendly. To plan a project-making process this requires a neat plan to be able to confirm to what is required in addition to saving costs so there is no available a faulty execution or purchase of excessive equipment implementation of this project.

3.3.4 RESEARCH DESIGN

3.3.5 FIRST DESIGN (CONCEPT A)

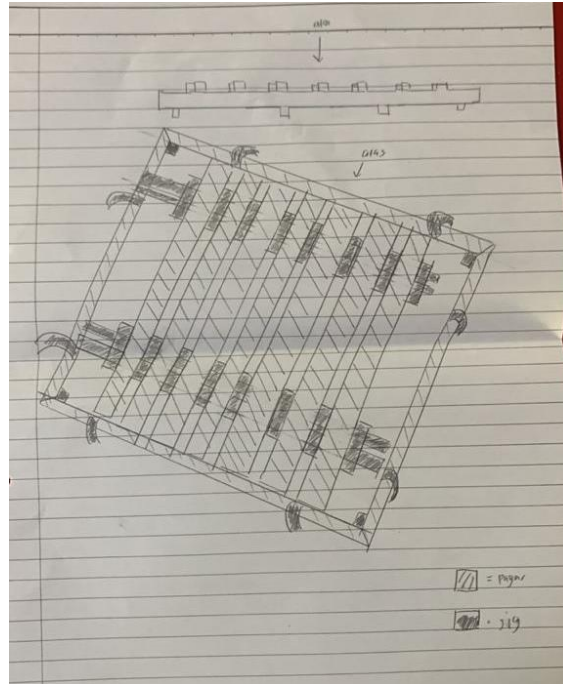


Figure 3.1 First Design

This is the first design of our project. But after having a discussion with our supervisor, this design is irrelevant to being created because this jig is too big to make. Other than that, this design is non-mobile and static.

(CONCEPT B)

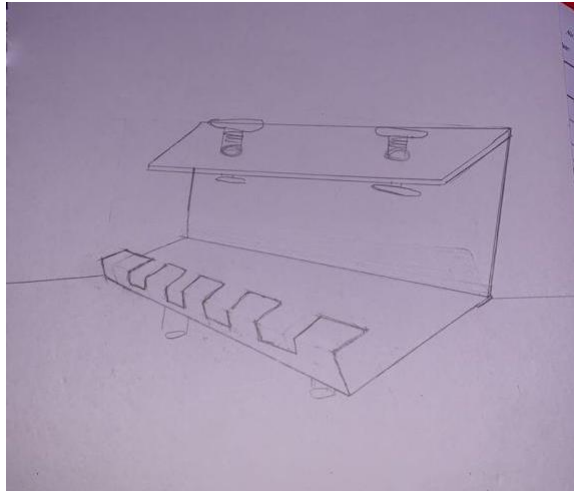


Figure 3.2 Second Design

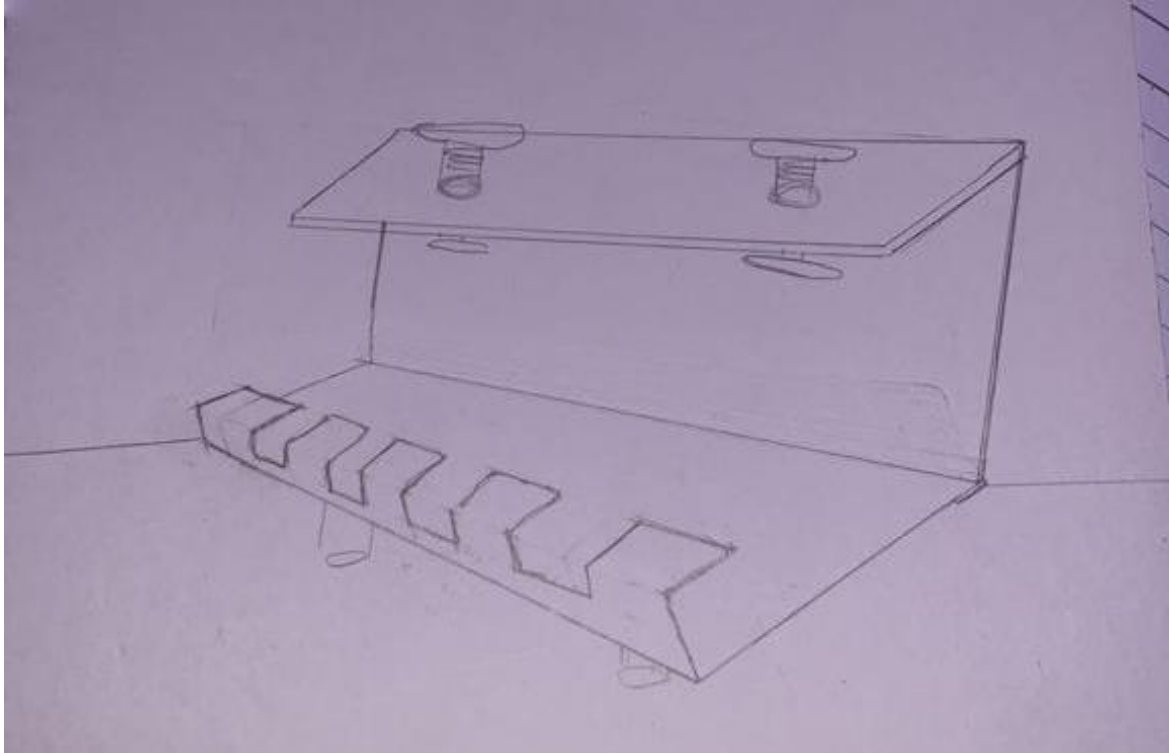
This is the second design for our project. There have been improvements made for this second design. Once we reviewed it carefully, we decide to use this design for our project

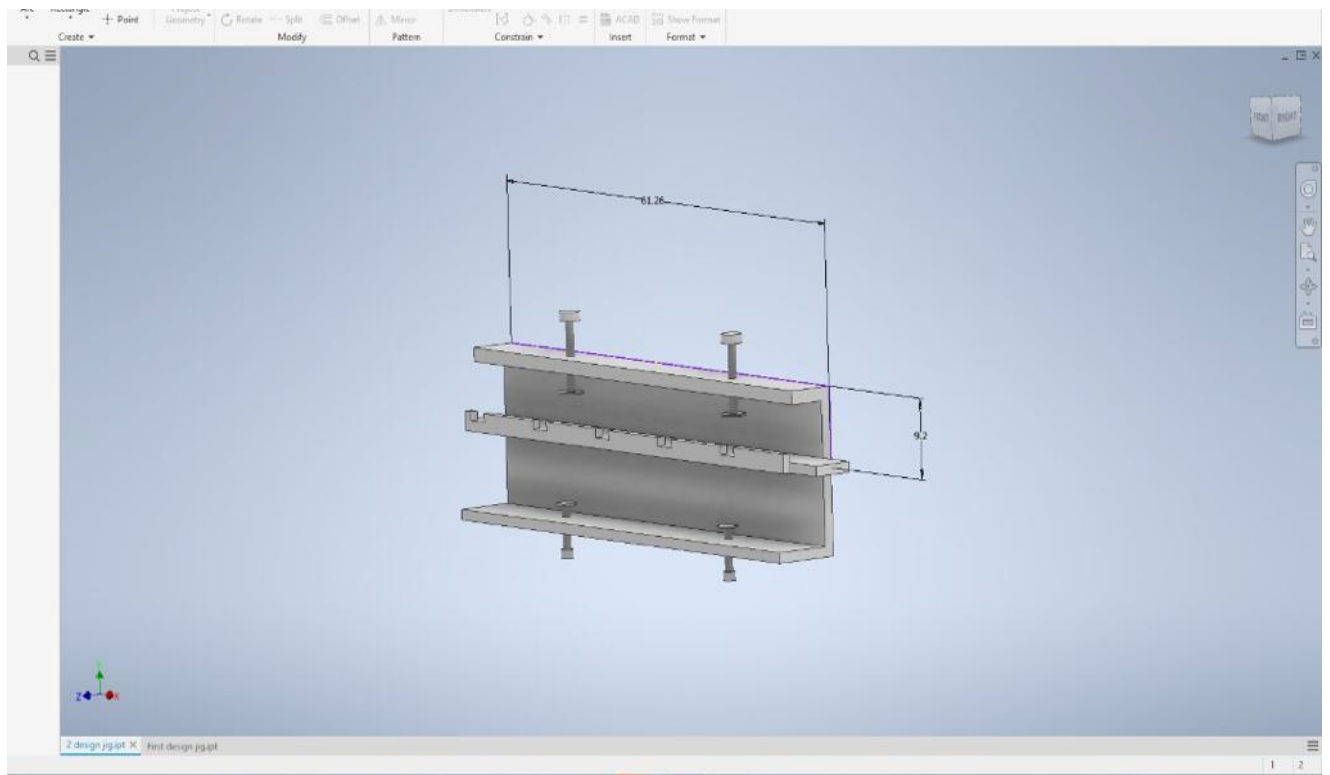
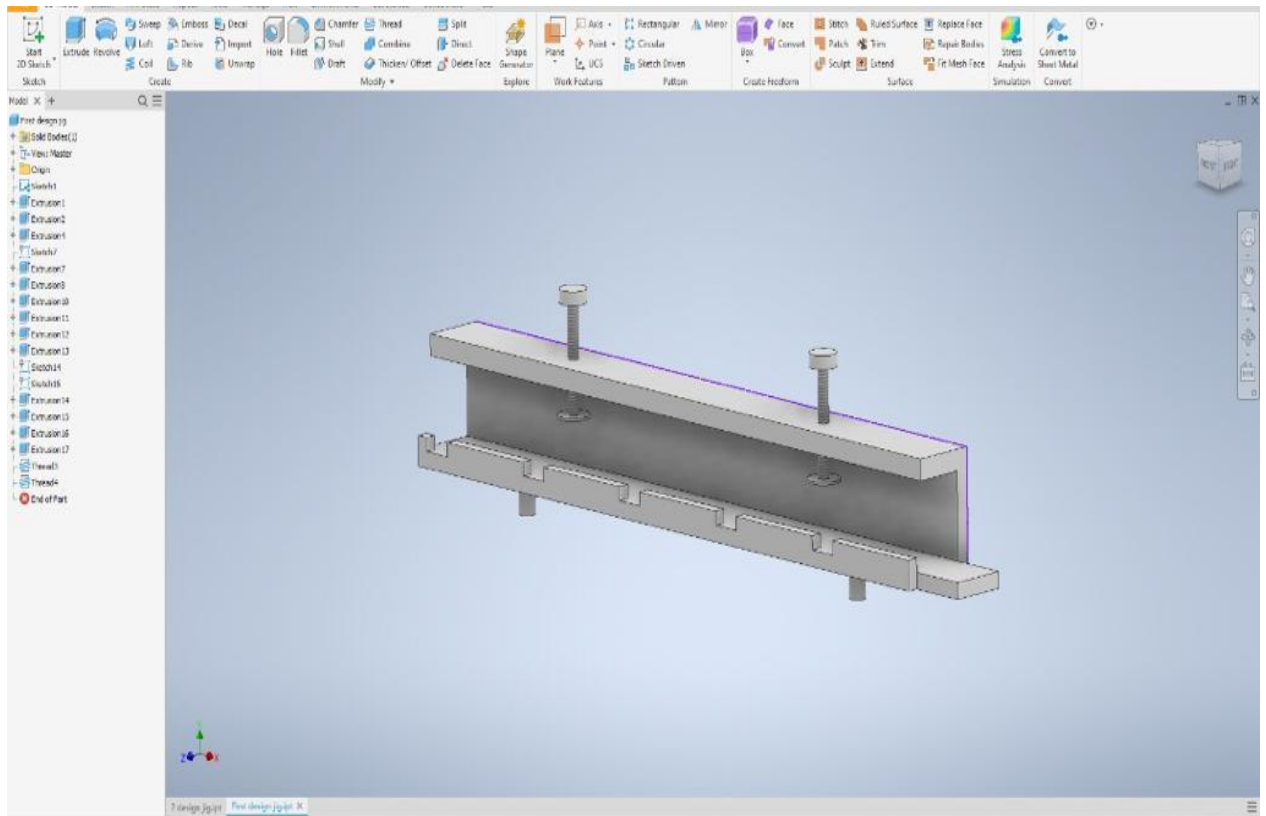
COMPARISON TABLE

IDEA CATEGORIES	Concept "A"	Concept "B"
DURABILITY	✓	✓
USER FRIENDLY		✓
COST (LOW TO HIGH)	✓	
MAINTAINENCE		✓
SIZING		✓
TOTAL	2/5	4/5

DESIGN

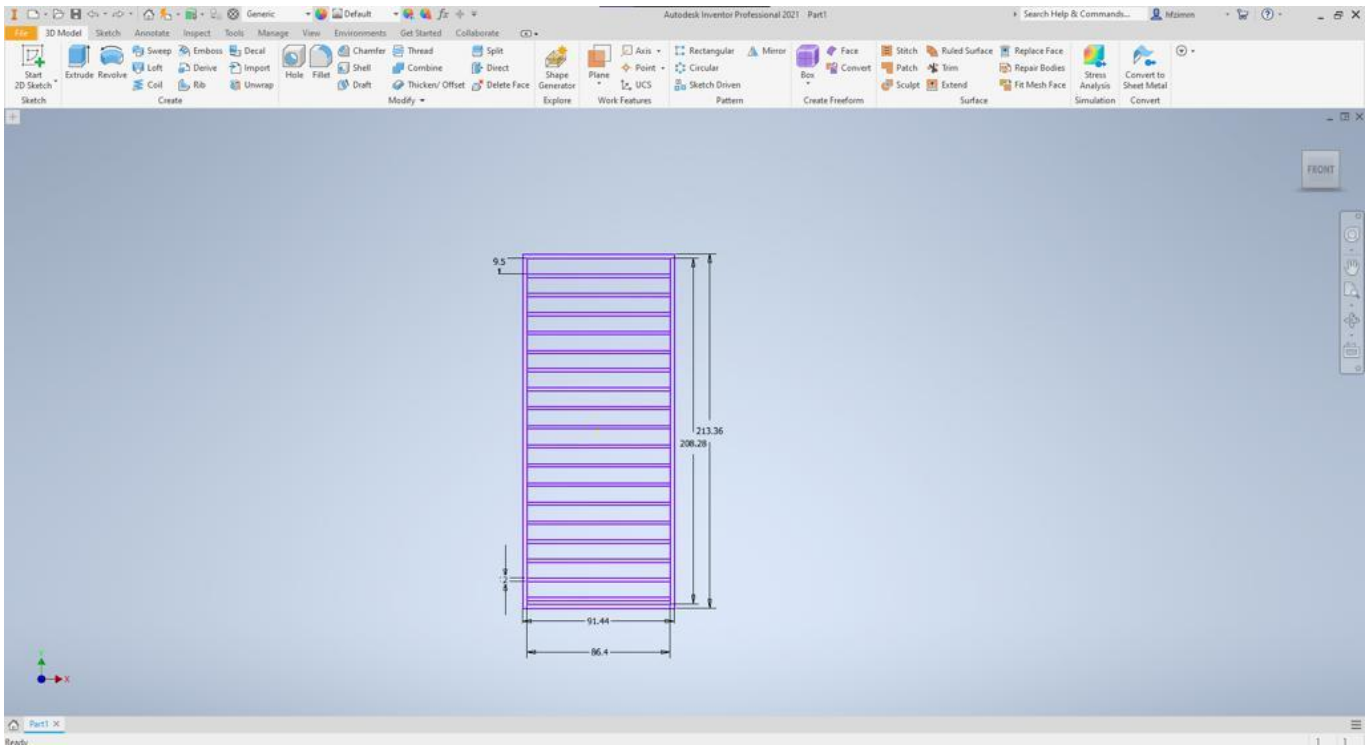
PROCESS 1





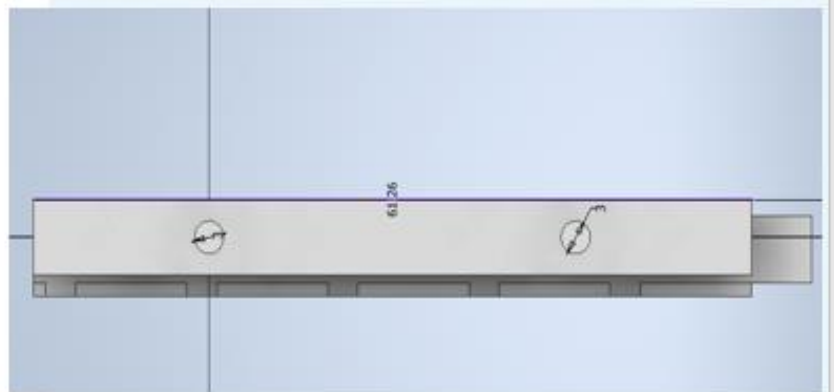
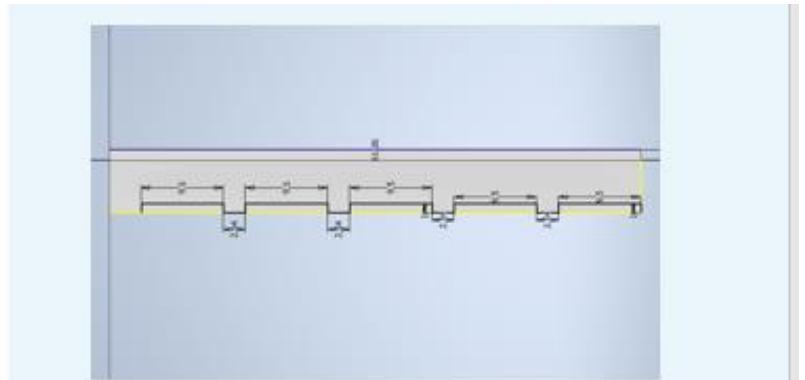
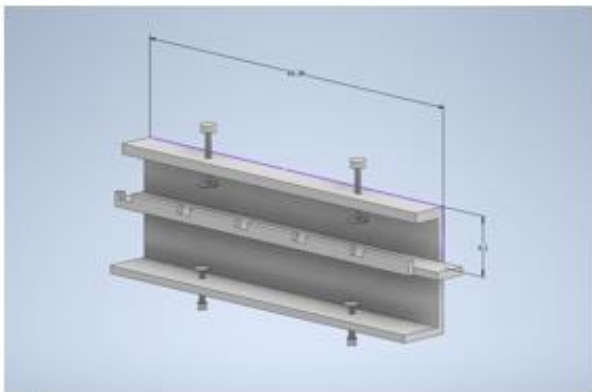
PROCESS 2

SIZING OF GRILL STANDARD HOUSE



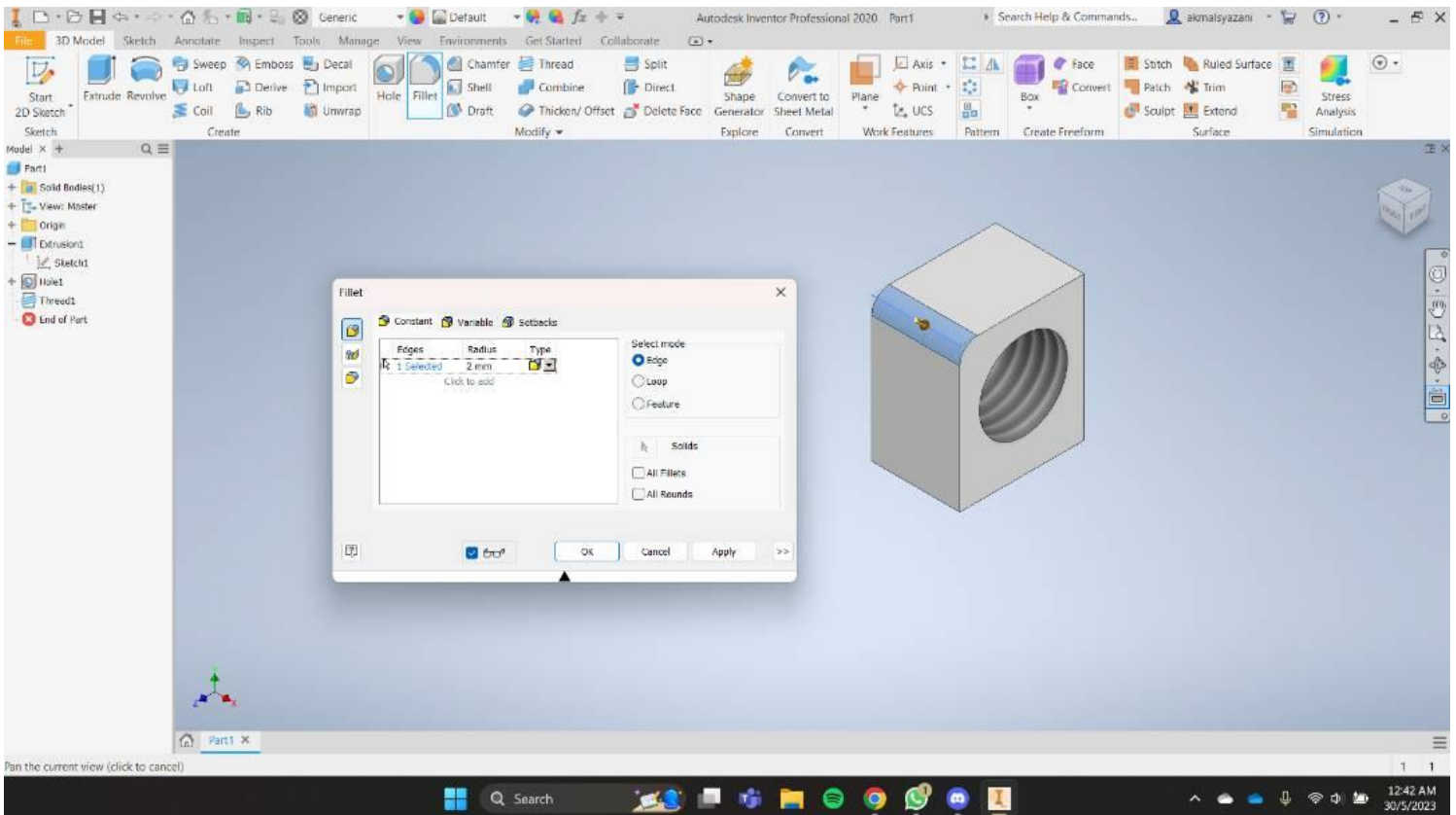
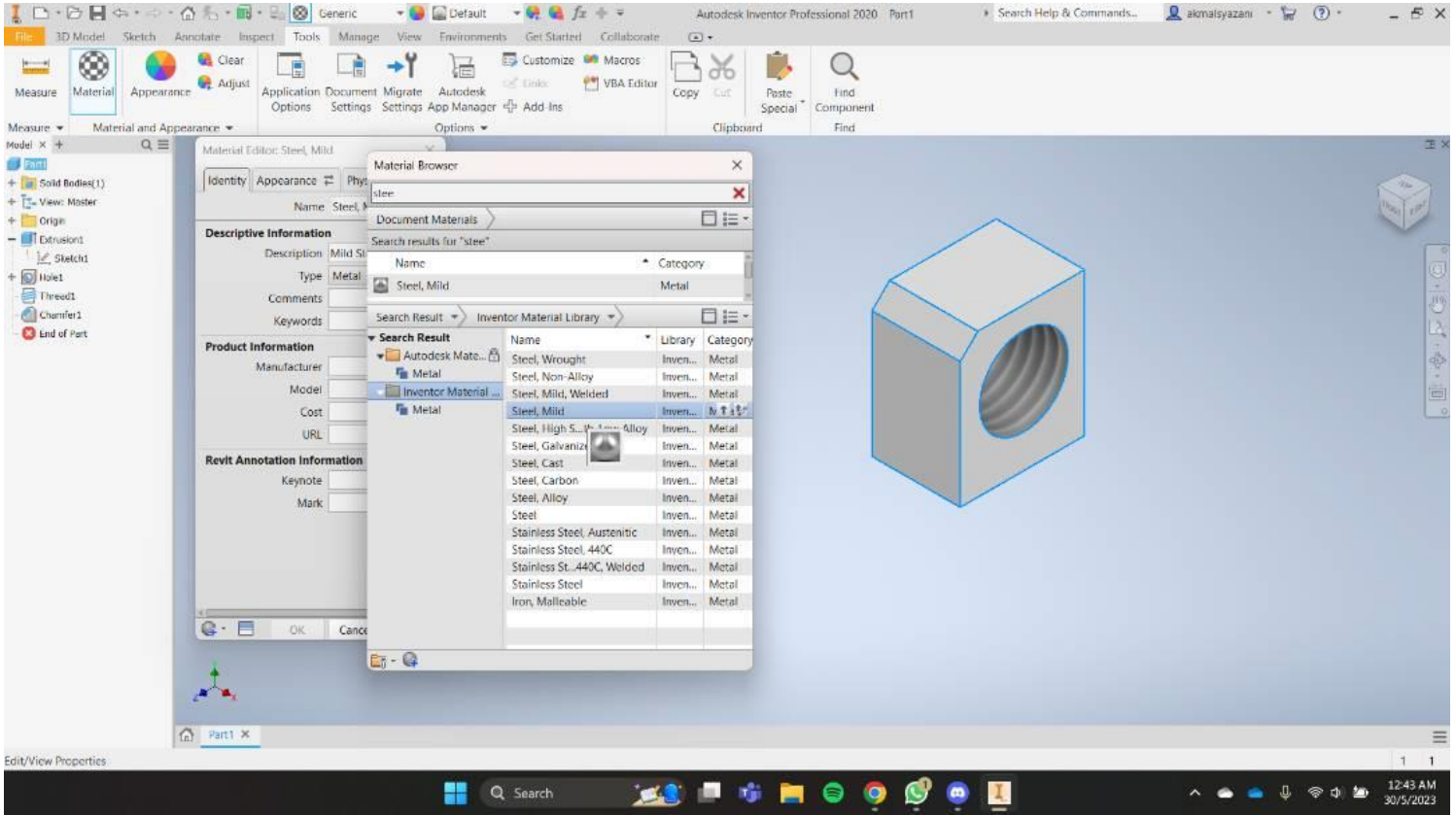
SIZING OF JIG

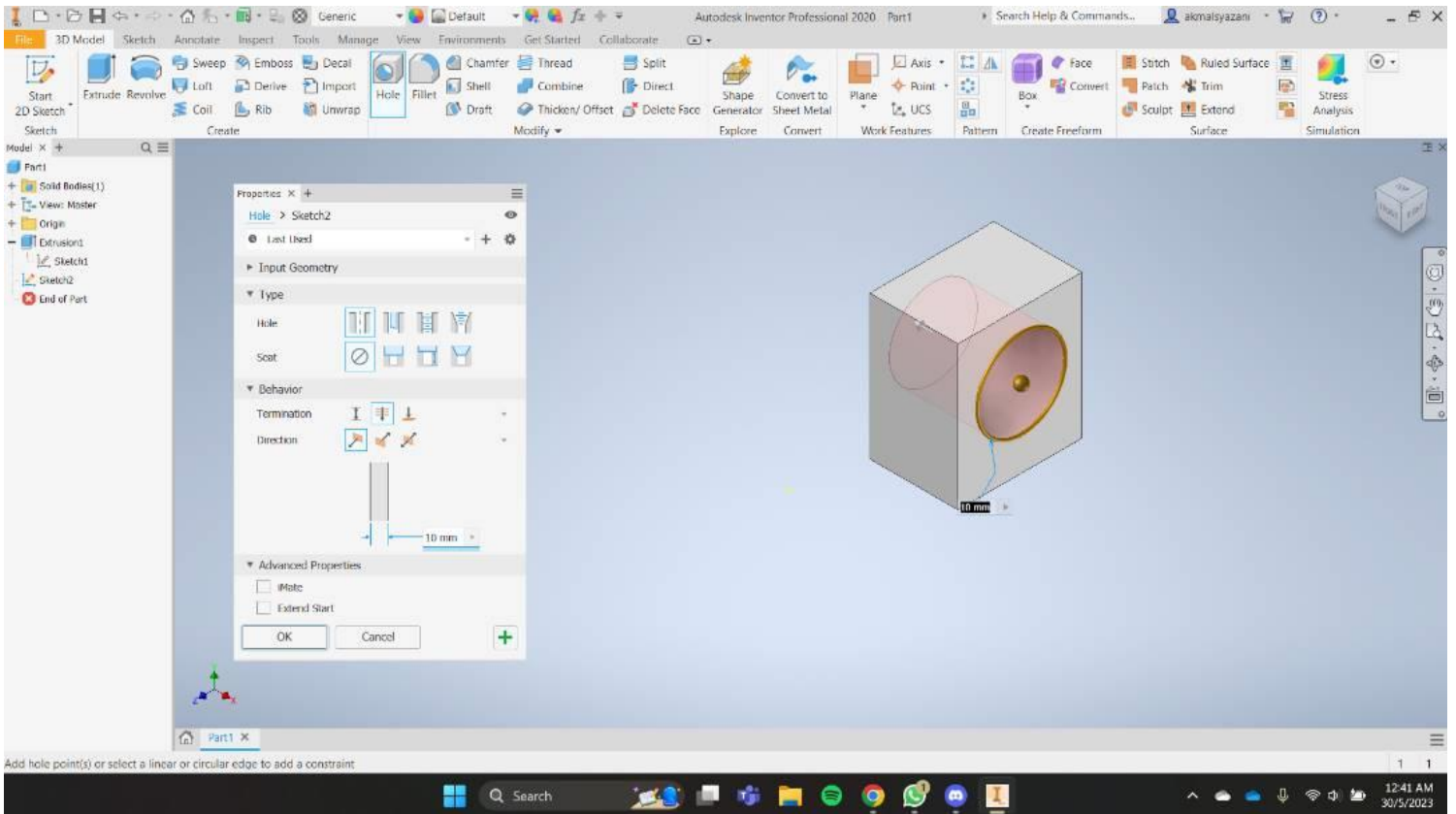
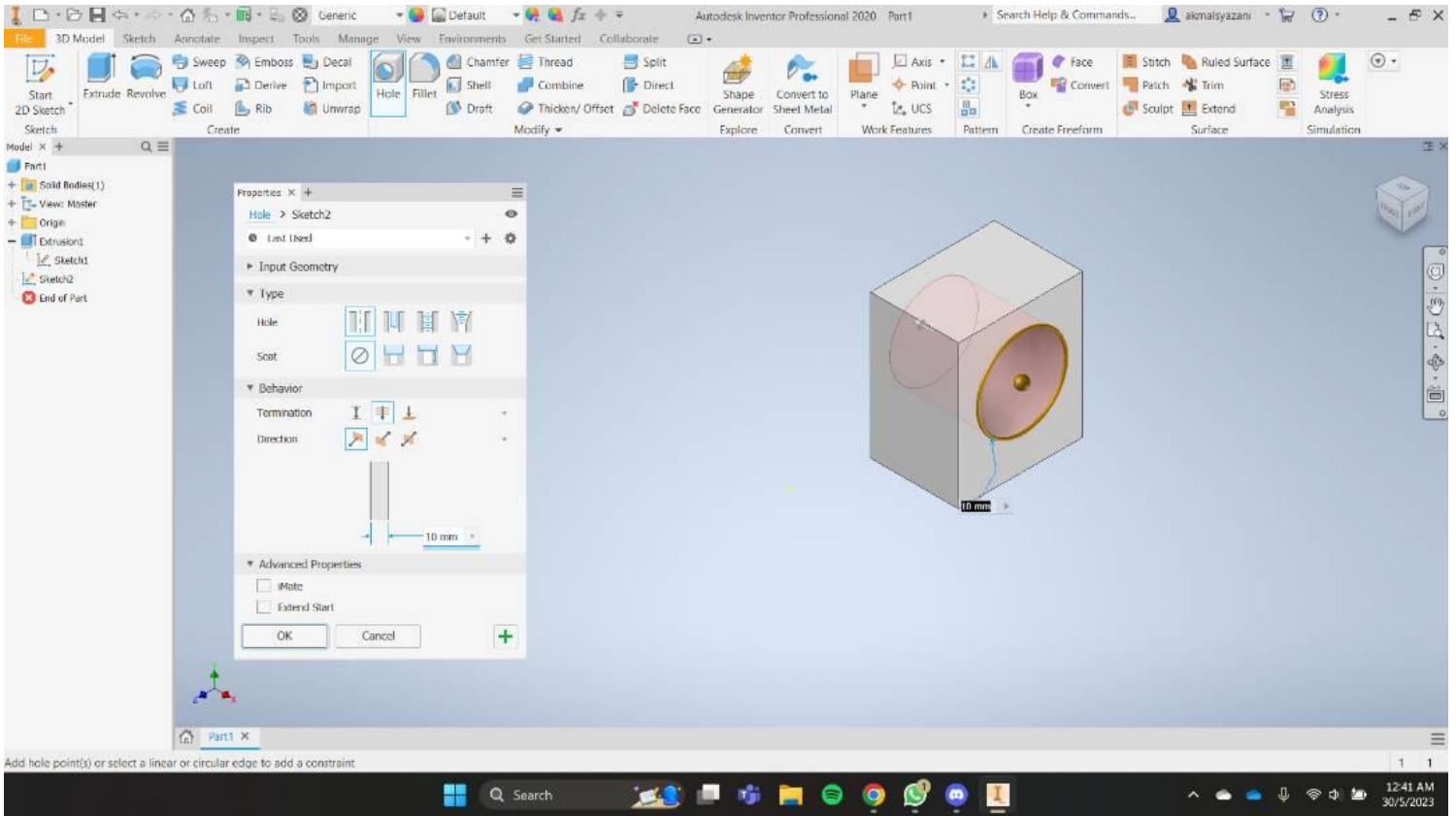
DESIGN JIG

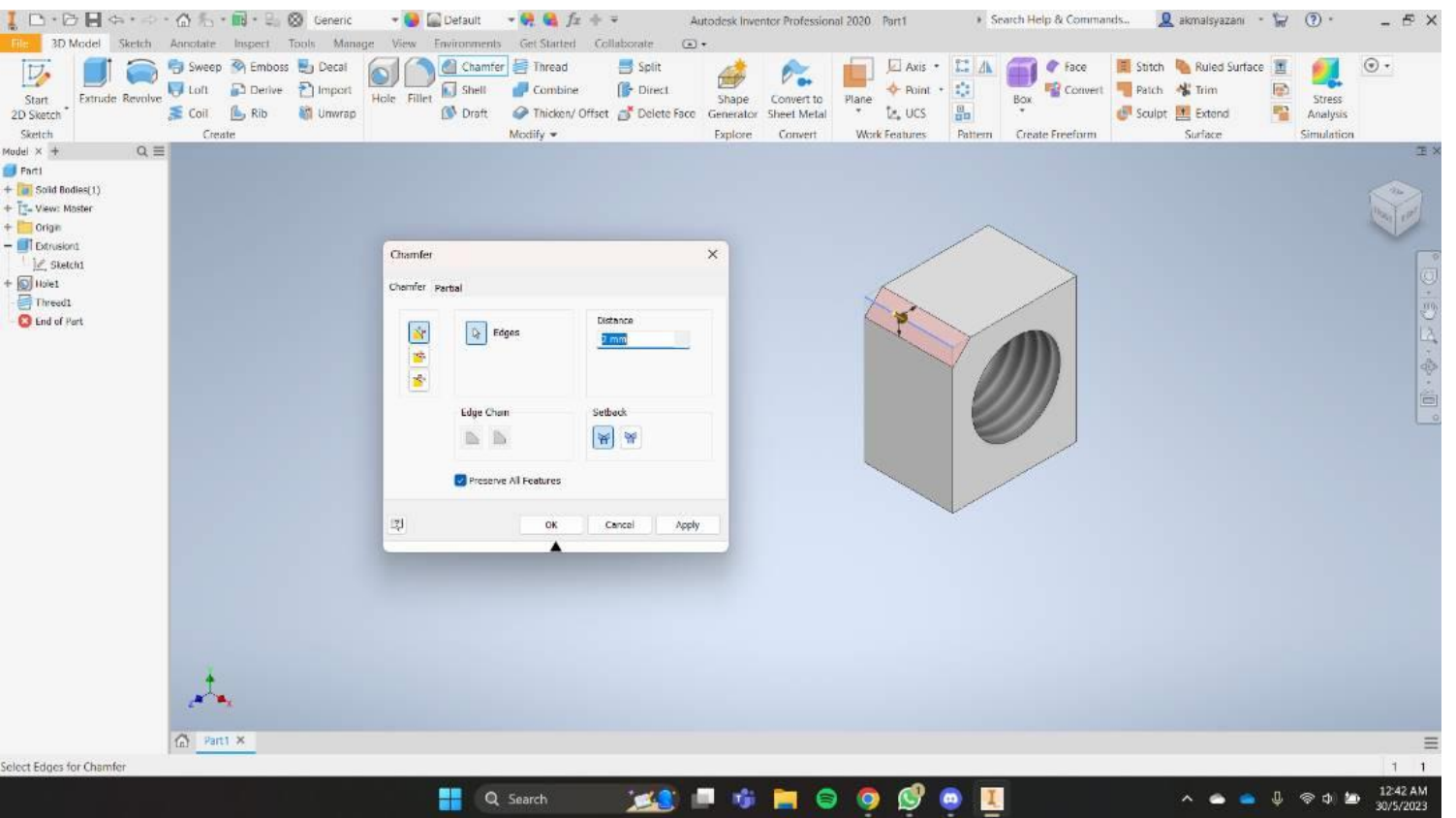
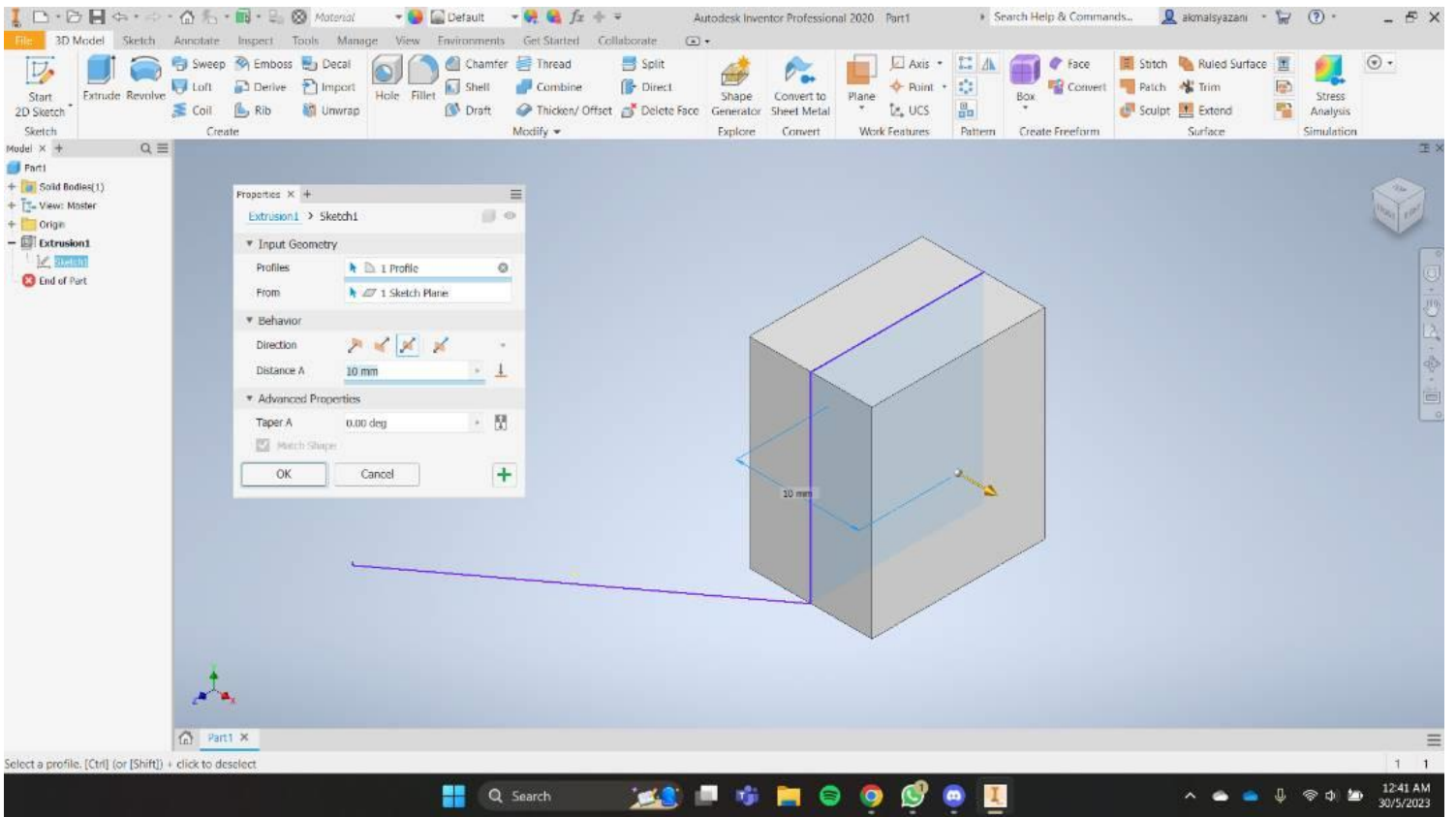


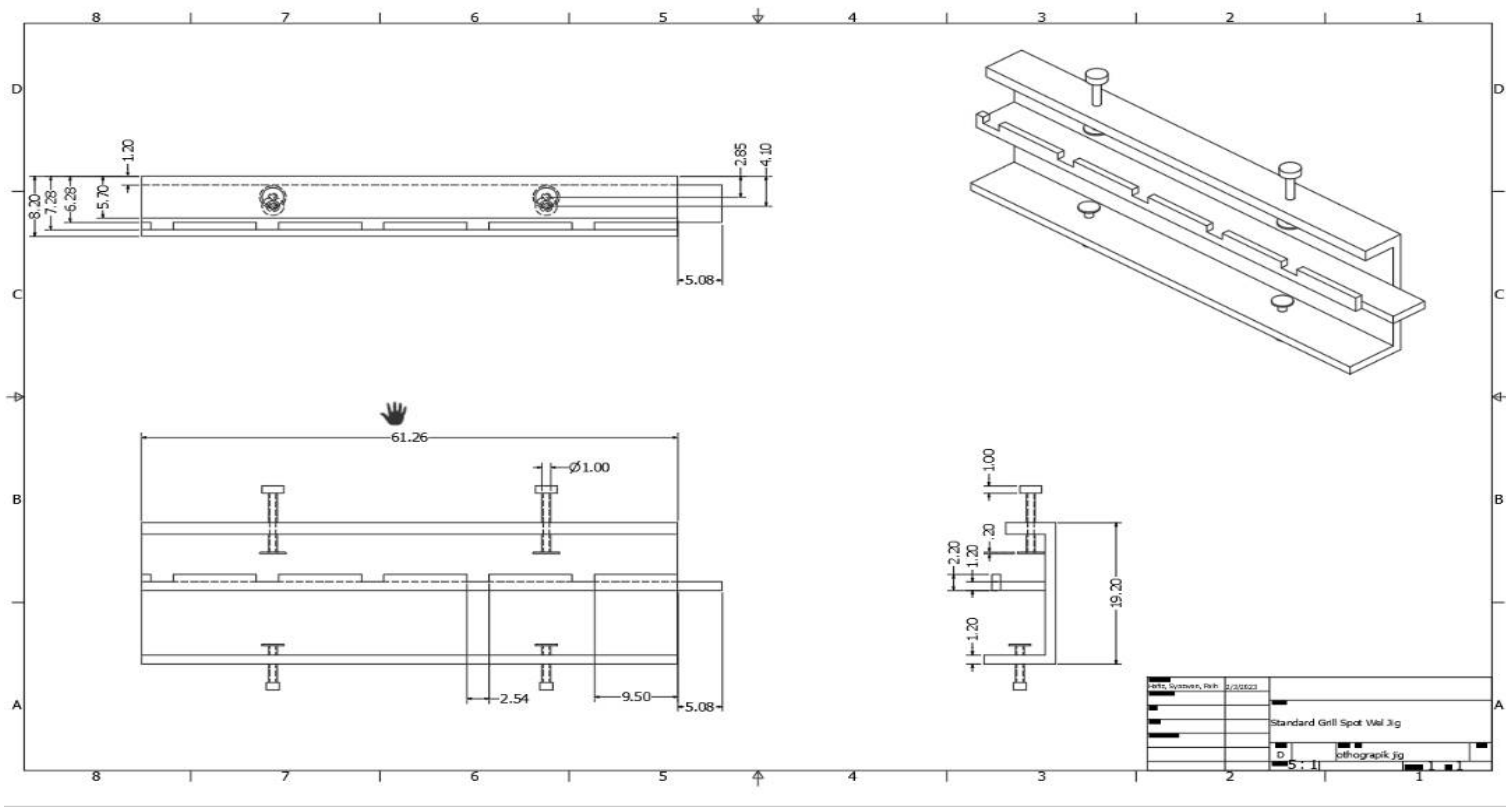
PROCESS 3

Material Tools









Following the selection of the second concept design as our final product design, we drew the product plan in greater depth and with more precise measurements, such as height, size, area, and diameter, to speed up the production process for project 2. These specifications, which are requested and not overly difficult, were also decided by the survey we conducted.

The selection of materials is very important to ensure the durability of the product to be produced as well as the safety of the user to prevent accidents from occurring when the product is used. The selection of the appropriate metal for the product frame, base, handle screws, etc. is a priority in the selection of materials

MATERIAL SELECTION

Before beginning the fabrication process, we must decide what material will be used for each component. Material selection is critical because it influences the product's resilience after fabrication. The product's strength and durability are considered to prevent it from failing during project 2 testing and data collection. These are the parts and the materials used to make them:

a) Mild steel

Mild Steel is a type of low-carbon Steel that is commonly used in construction. It is an alloy made up of a combination of iron and carbon, and it has been used for centuries in the production of various items such as tools, automobiles, and even buildings. Let's take a closer look at this material to understand why it has become so popular.

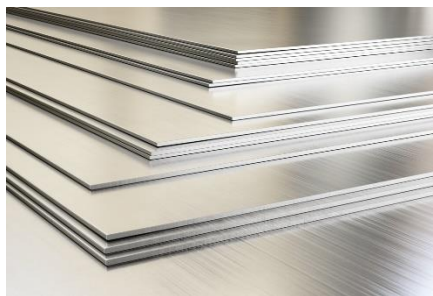


Figure 3.5 Mild steel

b) C channel

Channel steel is a conventional production component that is generally manufactured from hot-rolled steel. It has a wide and flat surface and also has flanges at right angles on both sides. The outer edge of C channel steel is clearly angled and has radius corners. The channel steel offers durability, and its broad and flat surface is perfect for attaching items and offering support

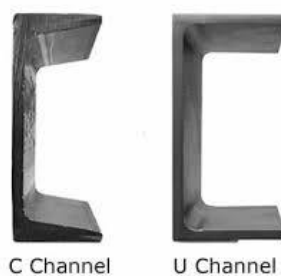


Figure 3.6 C Channel

c) Aluminium

Aluminium is a silvery-white metal, the 13 element in the periodic table. One surprising fact about aluminium is that it's the most widespread metal on Earth, making up more than 8% of the Earth's core mass. It's also the third most common chemical element on our planet after oxygen and silicon.



Figure 3.7 Aluminium

d) Screw and Nut

A nut is a component that fits over the end of a bolt and helps it hold objects in place. A bolt is a non-tapered fastener that uses a washer and nut to hold objects together. A screw is a tapered fastener that mates with an existing thread or creates its own thread in a material as it turns.

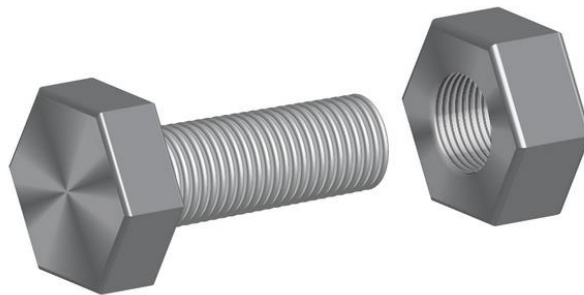


Figure 3.8 Screw and Nut

12 COMPONENTS

Mild Steel

Aluminium



C channel

Screw
and
Nut

Fabrication

Mechanical Parts

- Cutting plate

Below show how Hafiz Imran and team cutting c channel to make the frame to get dimension correctly using grinder to cut.



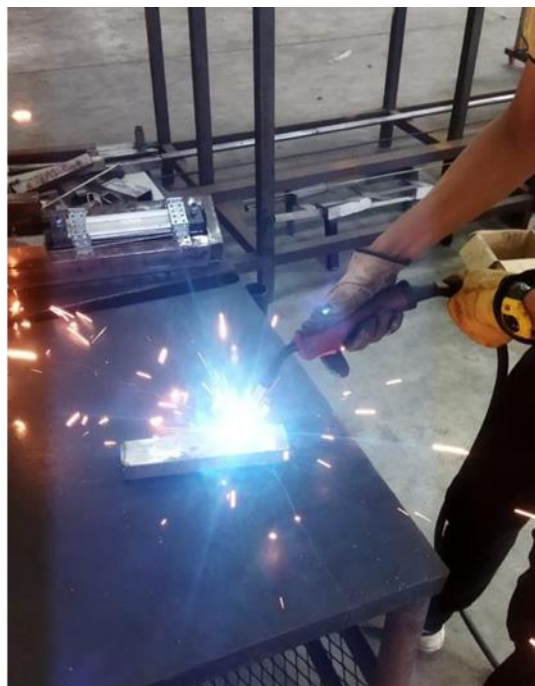
- Measurement process

Do the measurement process according to the set size before doing the welding process.



- Welding frame

The picture below shows us welding using mig welding and welding plates to form our jig frame.



- Drill and thread

Faiz Akmal drill a hole and thread on the product to fasten the screw to hold our jig



- Polish and painting

Our group painted and finished our products to be displayed at Mice



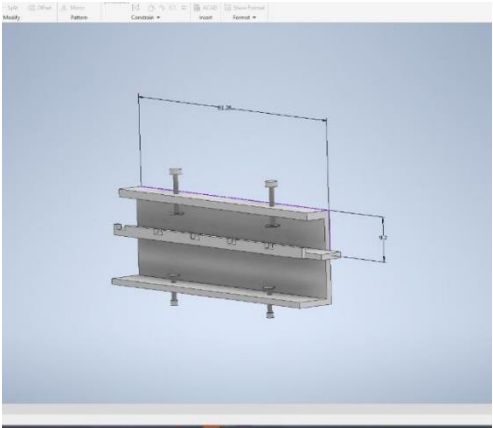

Finished product



CHAPTER 4 : ANALYSIS AND RESULT

INTRODUCTION

This chapter covers all of the "Development of Spotwelding Jig to Aid The House Grill Manufacturing Process" important data and analysis. The data is very important to ensure that the project's objective and scope are achieved. If the data analysis meets the objective, it indicates that our project was success. So, in order for this initiative to go properly, we've decided to gather all relevant data to investigate each case in order for this project to go off without a hitch.

Comparison	Drawing	Fabrication
Product		
Size	Slot for grill frame : 70mm Distance between small slot : 93mm Slot size : 25.4mm Slot for clamp : 70mm	Slot for grill frame : 50mm Distance small between slot : 94mm Slot size : 25.4mm Slot for clamp : 65mm
Type of material	Frame : mild steel Small slot : mild steel	Frame : Aluminium, c channel Small slot : mild steel

After completing the fabrication process, there are some differences or changes in terms of size and type of material that we get from the product. According to what we analyze, the size difference is due to design and fabrication differences because when we cut, there are parts that require more cutting because there is an angle when fabricating it will interfere with certain angles. We use the material listed in the table because it is easier for us to make cuts to form the product, the price of the product is lower, and we use a thinner iron size but the hardness is the same as in the design.

STANDARD OPERATION PROCEDURE (SOP) / FUNCTION

1. First, tie jig to the table



2. Take the iron pieces that have been cut according to the measured size and arrange in the slot that has been prepared at the jig



3. Besides that, we need to tie the frame of the grill side with fasteners so that it does not move grill frame when welding



4. After that, we can continue by doing spot welding to join the grill part



5. After finishing, we lift and continue to connect the other part until finished



CHAPTER 5

Discussion & Conclusion

Introduction

This chapter explain about the project that has successfully completed in about 6 month equivalent to one semester. Besides that, there were some problems that we have to face along our process to installation and testing for our product. Therefore, there have some suggestions to improve our project in the future that will give benefits to the users. In this chapter, the decision has been made based on the overall decision that we got from the research and discussion in the previous chapter before this. Besides that, in this chapter also, the related matters that are relate to the objective and also the suggestion from the research that we have made. With that, the conclusion has been made to our research.

Discussion

For our project, Development of Spotwelding Jig to Aid The House Grill Manufacturing Process, this product was tested by industry metal fabrication worker. When our product was tested, our product can produce a good result as well. Our products are successfully to achieve the objectives that we have been set. As a result of discussions and comments from our products, we were able to save time when doing fabrication work. Standard operation without jig usually takes 3 hours to prepare a grill. By using this jig, we were able to complete the job in just 2 hours. After calculate the process, this jig can save 40% time to fabricate the standard house door grill. Quality is also different when comparing the results of work between using a jig and not using a jig. If using this jig, we can improve the quality of work, work is easier to implement, correcting body position and posture, and can help employees to perform high repetitive work processes.

Suggestion

After us running this project, we found that our project can give benefits to the users because this product can make work easier for employees in many aspects. Besides that, finishing that we do to our product is more neat and productive.

To overcome the weaknesses of this project, several suggestions have been made:-

- Reduce the size so that it is easy to carry anywhere
- More flexible design
- Diversify the use of this jig

Conclusion

Every project that is done have their own benefits and objectives. Same like our project 'Development of Spotwelding Jig to Aid The House Grill Manufacturing Process'. There were no troubles when we do this project and the objective for this project finally can we achieve. Based on the result of research in creating and finishing this project, we found that the project's objective for this product have achieved with successfully.

Based on the data we gathered, this jig has the potential to alleviate industrial challenges by making the task easier. This jig allows for the manufacture and completion of items in a tidy and ordered way. Because the worker does not need to measure and hold the work result, this jig may aid a lot of work. It can make the job easier and the work result faster and more precise. Lastly, we hope this project can be fully utilized, accepted and can be applied. Besides that, we also hope that this product will give the best result to the users and it can fulfil the requirement of all users.

APPENDIX

1. List of component
2. Collaboration letter
3. Drawing & design
4. Gantt chart

List of component

- Mild steel
- C channel
- Aluminium
- Screw & nut

1. Collaboration letter



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Ruj. Kami : liaison/activity/03
Tarikh : 15 Mei 2023

(NAMA PENYELIA: DR. MOHD SHAHROM ISMAIL)

MUHAMMAD HAFIZ IMRAN BIN KAMARULZAMAN (08DKM20F2034)
MUHAMMAD SYAZWAN BIN ISMAIL NORDIN (08DKM20F2037)
MUHAMMAD FAIZ AKMAL BIN NORAZMI (08DKM20F2022)

Ybrs. Dr. / Tuan / Puan,

PENGHARGAAN DAN PENGGUNAAN INOVASI EASY CLAMP

Dengan hormatnya saya merujuk kepada perkara di atas.

2. Sehubungan itu, kami ingin mengucapkan jutaan terima kasih di atas kejayaan pihak tuan menghasilkan inovasi Easy Clamp Inovasi ini sangat memberi manfaat kepada syarikat kami dalam kerja-kerja fabrikasi dan pemasangan. Namun sebegitu terdapat beberapa saranan dan komen yang boleh dipertimbangkan bagi penambahbaikan produk ini:

- Saiz produk ini perlu lebih kecil agar mudah untuk dibawa kemana-mana
- Kerangka sudut yang bermagnet perlu dibuat untuk memastikan tidak berlakunya kegelinciran yang mengakibatkan ketidaktepatan sambungan spot weld

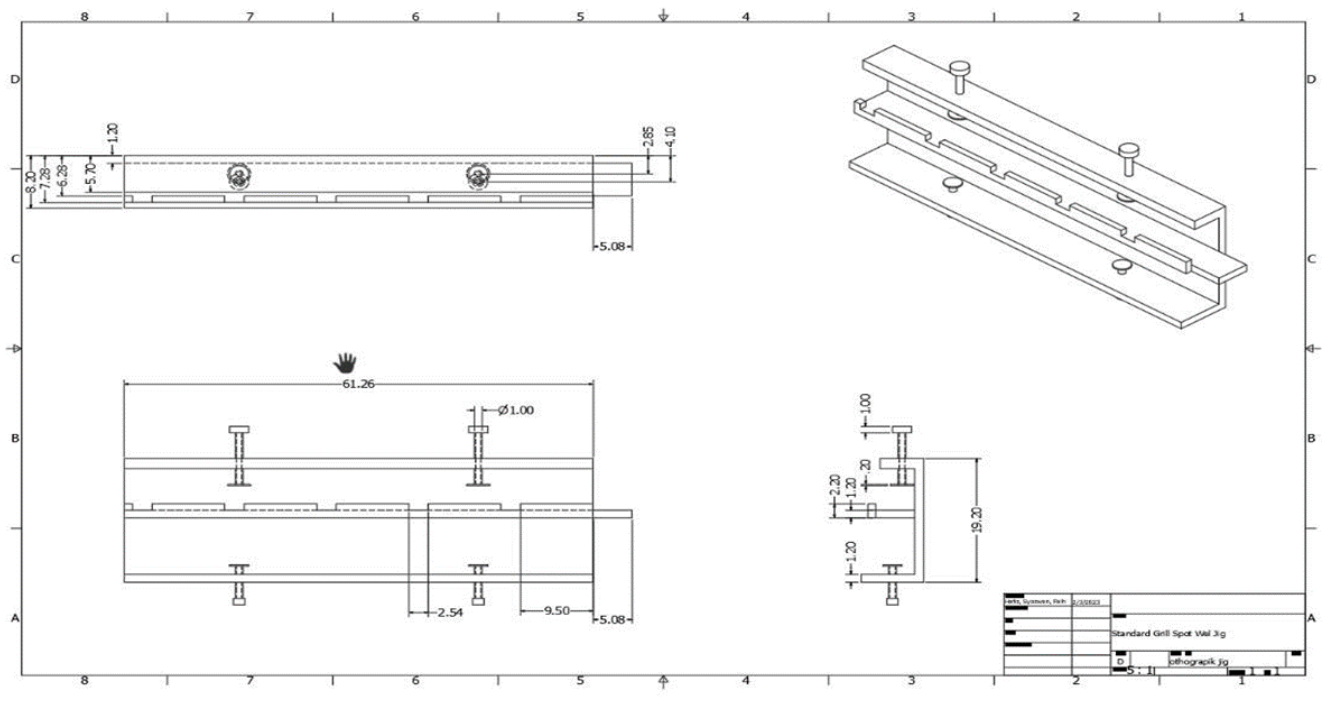
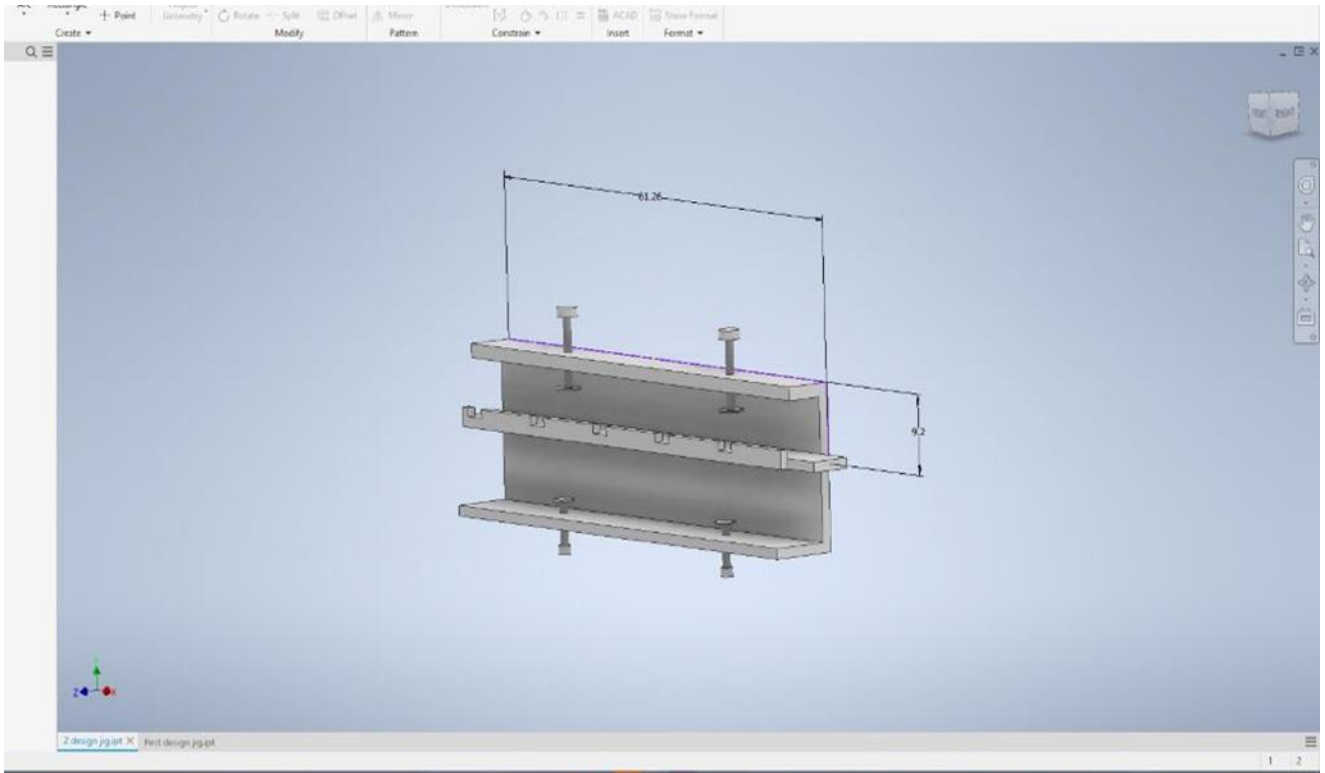
3. Kami berharap agar inovasi ini dapat ditambah baik dan disebarluaskan kepada pemain industri yang berkenaan.

Sekian, terima kasih.

Yang benar,

(MOHAMAD RAFIZI BIN ABDUL MOTHALIB)
(Juruteknik Assembly Department)

2. Drawing & design



3. Gantt chart

Project 1

GANTT CHART PROJECT 1 (2022)																
Week /	Status	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Activities Status																
Student	P	█														
Registration	C	█														
Presentaion of	P		█	█	█	█										
Ideas	C		█	█	█	█										
Preparing	P				█	█										
Proposal	C				█	█										
Survey	P						█	█								
	C						█	█								
Literature	P							█	█	█						
Review	C							█	█	█						
Methodology	P									█	█					
	C									█	█					
Writing	P											█	█			
Proposal	C											█	█			
Presentation	P													█	█	
Proposal	C													█	█	
Submission	P															█
Proposal	C															█

P	PLANNING
C	COMPLETE

Project 2

Week / Activities	Status	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
ASSEMBLING	P	█	█	█	█	█									
	C	█	█	█	█	█									
TESTING	P					█	█	█							
	C					█	█	█							
DATA & ANALYSIS	P						█	█	█						
	C						█	█	█						
VIDEO & SLIDE PRESENTATION	P									█	█				
	C									█	█				
TECHNICAL REPORT	P										█	█			
	C										█	█			
POSTER	P											█	█		
	C											█	█		
PRESENTATION	P													█	█
	C													█	█
SUBMISSION REPORT	P														█
	C														█

P	PLANNING
C	COMPLETE

References

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