POLITEKNIK MALAYSIA
BANTING

FINAL YEAR'S PROJECT 2 REPORT

DEVELOPMENT PROTOTYPE JIG AND FIXTURE FOR TEACHING AIDS IN SUBJECT (DJF51072 – JIG AND FIXTURE) AT POLYTECHNIC BANTING SELANGOR FOR AUTOMOTIVE PART

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SESSION: I 2024/2025

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In front us,

MUHAMAD SANI BIN BUANG

……

ACKNOWLEDGEMENT

We are keen to use this opportunity to express our gratitude to our parents for their sacrifices, unwavering support, and encouragement as they work with us to complete our end-of-semester project at Polytechnic Banting Selangor.

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Once again, a big thank you to all the team members who worked together to carry out this project, giving up time, money, energy, and ideas to finish it without realizing what it meant to be completely hopeless. Absolutely, our team is greatly blessed by every individual's collaboration and support, whether given directly or indirectly. Thanks to everyone personally engaged, especially Polytechnic Banting Selangor, we truly value it.

ABSTRACT

Mechanical engineering is the study of physical machines that may involve force and movement. It is an engineering branch that combines engineering physics and mathematics principles with materials science, to design, analyse, manufacture, and maintain mechanical systems. It is one of the oldest and broadest of the engineering branches. Nowadays, welding education is important in a career as a welder and an engineering student as well. Without the proper study of welding, they could not produce many buildings, gates, fences, small kitchen appliances, vehicles and even space travel would not exist. This made us think of creating a project/product which can help to improve the students' knowledge, skills, and teaching method for the lecturer. Thus, we will make a jig and fixture as a learning kit. However, our polytechnic does not own a jig and fixtures, the DTP students may find difficulties to understand the concept of jigs and fixtures while the lecturer who teaches "DJF51072 Jig and Fixture Design" subject cannot explain briefly of jigs and fixtures without having an appropriate tool as a reference. Our project will be an ideal solution for our polytechnic which can help in teaching and learning process. For this project 1, we did some research in google scholar to get more information of jigs and fixtures. We manage to do Chapter 1 until 3 of our projects. In FYP 2, we successfully completed our project which is to make jig and fixture as a learning kit. We can demonstrate how jig and fixture works and explain everything more detail to the students. In conclusion, our project meets our objective of helping the lecturers and students to practical understanding of jigs and fixture's purpose in "DJF51072 JIG AND FIXTURE" subject. We believe that this project can contribute a lot of things for semester 5 DTP' students at Polytechnic Banting Selangor.

ABSTRAK

Kejuruteraan mekanikal ialah kajian mesin fizikal yang mungkin melibatkan daya dan gerakan. Ia adalah cabang kejuruteraan yang menggabungkan fizik kejuruteraan dan prinsip matematik dengan sains bahan, untuk mereka bentuk, menganalisis, mengeluarkan dan menyelenggara sistem mekanikal. Ia adalah salah satu cabang kejuruteraan tertua dan paling luas. Pada masa kini, pendidikan kimpalan adalah penting dalam kerjaya sebagai pengimpal dan pelajar kejuruteraan juga. Tanpa kajian kimpalan yang betul, mereka tidak dapat menghasilkan banyak bangunan, pintu pagar, pagar, peralatan dapur kecil, kenderaan dan juga perjalanan angkasa tidak akan wujud. Ini membuatkan kami terfikir untuk mencipta projek/produk yang boleh membantu meningkatkan pengetahuan, kemahiran, dan kaedah pengajaran pelajar untuk pensyarah. Oleh itu, kami akan membuat jig dan lekapan sebagai kit pembelajaran. Walau bagaimanapun, politeknik kami tidak mempunyai jig dan lekapan, pelajar DTP mungkin mengalami kesukaran untuk memahami konsep jig dan lekapan manakala pensyarah yang mengajar subjek “DJF51072 Jig and Fixture Design” tidak dapat menerangkan secara ringkas tentang jig dan lekapan tanpa mempunyai alatan sebagai rujukan. Projek kami akan menjadi penyelesaian ideal untuk politeknik kami yang boleh membantu dalam proses pengajaran dan pembelajaran. Untuk projek 1 ini, kami melakukan beberapa kajian dalam google scholar untuk mendapatkan maklumat lanjut tentang jig dan lekapan. Kami berjaya melakukan Bab 1 hingga 3 projek kami. Pada FYP 2, kami berjaya menyelesaikan projek kami membuat jig dan lekapan sebagai kit pembelajaran. Kami boleh menunjukkan cara jig dan lekapan berfungsi dan menerangkan segala-galanya dengan lebih terperinci kepada pelajar. Kesimpulannya, projek kami menepati objektif kami untuk membantu pensyarah dan pelajar memahami praktikaliti jig dan tujuan lekapan dalam subjek "DJF51072 JIG AND FIXTURE". Kami percaya projek ini dapat memberi banyak sumbangan kepada pelajar semester 5 DTP' di Politeknik Banting Selangor.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND STUDY

Manufacturing engineering is the field of engineering that designs and optimizes the manufacturing process, or the steps through which raw materials are transformed into a final product. A fabrication process should occur to transform the raw materials into a final product. The process of fabrication involves construction of various components using a diverse range of materials, including metals, laminates, wood, and other solid surfaces, utilising one or more manufacturing techniques such as cutting, welding, machining, forming, and forging.

Nowadays, welding is an important component in many industries, such as automotive, construction, aviation and many more. Without this form of metalwork, so many things, including many buildings, gates, fences, small kitchen appliances, vehicles and even space travel would not exist. Thus, welding education is a very important part of a career as a welder. However, one of the common issues that can be found is that engineering students are struggling to understand the concept and uses of jigs and fixtures for welding. Moreover, the lecturer who is teaching the "DJF51072 Jig and Fixtures Design" subject can't explain more briefly about jig and fixtures for welding purpose to the students without having a proper tool as a reference. To overcome this problem, jig, and fixture for welding in the teaching and learning process are produced. This prototype helps students to understand the basic knowledge of using jigs and fixtures and it provides an ideal solution for those universities and colleges that don't have a jig and fixtures.

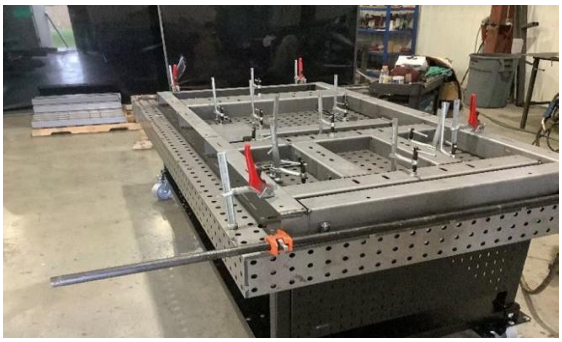

Figure 1.1: Welding jigs and fixtures (Google, n.d.)

The idea behind a jigs and fixtures for welding is derived from many conventional work holding devices are frequently used in manufacturing industry to secure workpieces and guide welders, ensuring precision and repeatability in production processes. These kinds of tool play a vital role in clamping workpieces, improve accuracy of welding, and eliminate manual marking on workpieces. They are uniquely created to be accessibility for semi-skilled

operators as tool and workpiece setup is mechanized and lowering labor costs. They are not only enhancing the accuracy and quality of finished products but also significantly reduce production time, making them invaluable assets in modern manufacturing processes.

1.2 PROBLEM STATEMENT

Professionals in the field of manufacturing have expressed deep concern about the internship students or new welders that do not have basic knowledge of using jigs and fixtures for welding purposes. Since, manufacturing engineering students must take the “Jig and Fixture” subject when they are in universities, colleges, or polytechnics, they cannot understand more about it and cannot imagine what jig and fixture look like, how they work, what jigs and fixtures are used for and why.

In addition, lecturers who teach the subject "Jigs and Fixtures" cannot briefly explain about jigs and fixtures for welding purposes to students without having the appropriate tools as a reference. For example, at the banting polytechnic, the lecturer who teaches the "DJF51072 Jig and Fixtures Design" subject for semester 5 of DTP students could not explain it in more detail to them because their polytechnic does not own jigs and fixtures like machines as other industries do. Thus, it can have several negative effects for students such as failing on this subject, can lead to higher rates of errors in welding when they are in industry for internship, lack of understanding which can slow down the welding process and can lead to unsafe working conditions which can cause accidents and injuries.

Following that, the lecturer must plan to bring the students for a study tour to the manufacturing industry to visit and observe the working principle of using jigs and fixtures. Thus, this will affect the student’s and lecturer’s schedule, time, cost and many more. For example, adjusting class schedules to accommodate study tours may interfere with other lecturers' class times or postpone classes to weekends to make up for lost time and the cost of transportation from universities or colleges to the manufacturing industry is expensive probably because it maybe involves renting a bus or van.

1.3 PROJECT OBJECTIVES

1.3.1 General Project Objectives

This project is aimed:

- To fabricate a jigs and fixtures structure suitable for teaching and learning in welding.
- To design jigs and fixtures that are cost-effective and simple compared to the industrial jigs and fixtures.
- To develop more hands-on practical skills and knowledge of using jigs and fixtures.

1.3.2 Specific Individual Project Objectives

1.3.2.1 Product Structure and Furnishing

This project is aimed:

- To design the jigs and fixtures that are stable and can withstand the forces generated.
- To demonstrate comprehensive testing that confirms the dependability of the mechanical design.
- To design the jig and fixture which can minimize the amount space of footprint required.

1.3.2.2 Mechanical and Design

This project is aimed:

- To fabricate a jig and fixture which can accurately align and hold the workpieces in the desired position.
- To reduce the amount of maintenance needed to be compared to industrial jigs and fixtures.
- To create the pin location with PLA filament by using a 3D printing machine.

1.4 SCOPE OF PROJECT

This project is aimed:

- To provide an ideal solution for those university and college doesn't have a jig and fixture.
- To provide a practical understanding to the students of jigs and fixtures for welding purposes.
- To demonstrate how jigs and fixtures improve welding accuracy and consistency.

1.5 EXPECTED OUTCOMES

This project could be very beneficial to the engineering students who are taking "Jig and Fixture" at their universities or colleges. It will improve a student's theoretical knowledge and understanding the concept of the working principle of jigs and fixtures for welding purposes. This project can also develop students' interpersonal skills including communication skills, contribution to teamwork activities and can be good leadership, whenever it comes to jig and fixture presentation, or tasks given by the lecturer. Moreover, it can help a lecturer who teaches the "DJF51072 – Jig and Fixture Design" subject can explain perspicuously about jigs and fixtures to the students.

CHAPTER 2: LITERATURE REVIEWS

2.1 INTRODUCTION

Reviewing the critical points of current knowledge along with methodological methods on a certain issue is the goal of a literature review.
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Reviews of the literature do not report any fresh or specific experimental work because they are secondary sources. A literature review typically comes before a research proposal and results section and is most frequently linked to academically oriented material, such as research papers. It serves to update the reader on the most recent research on a subject and serves as a foundation for other objectives, such as identifying possible points for future study. A consistent flow of ideas, recent and relevant references with a consistent, suitable referencing style, appropriate terminology use, and an objective, thorough assessment of previous research on the subject are all characteristics of a well-structured literature review.

Until that project is implemented, a few factors need to be taken into consideration for the report that we intend to produce. The type of material, design, component we used, framework installation, installation technique and maintenance, product safety level, structural strength, project size, and other factors must all be studied in order to produce a high-quality project outcome. All of this guarantees that there won't be any issues after the project is finished or even when it is presented.

Therefore, planned, thorough, and systematic approach is needed to achieve a complete and ideal project. The initial step we have to take, which we want to realize, is designing the real picture of the product we eventually intend to manufacture. As a result, the work design and the research that we conducted is an ongoing phenomenon which includes creative problem-solving activity with a code name literature study.

2.2 GENERAL LITERATURE REVIEW

2.2.1 Demand in Manufacturing

Jigs and fixtures are highly sought after in the manufacturing sector due to their crucial role in ensuring safe and efficient production processes. These tools are specifically designed to create interchangeable and identical components. They serve as unique devices for guiding tools and holding workpieces, tailored for tasks such as drilling, milling, welding, machining, and assembling large quantities of parts. By enabling manufacturing operators to achieve repeatability, jigs and fixtures help deliver consistent results while minimizing defects, which ultimately enhances product quality and reduces time spent on corrections. This leads to increased production rates by cutting down on setup and idle time.

Chennu (2014) identified several key purposes of jigs and fixtures, including lowering production costs, boosting production rates, ensuring high accuracy without manufacturing defects, providing interchangeability, simplifying the machining of complex parts, and reducing quality control expenses. Jigs and fixtures remove the need for a unique setup for each workpiece, streamlining production and ensuring that every piece is made within specified tolerances. Meduettaxila (2012) noted that jigs and fixtures "eliminate the necessity of a special setup for each individual part." He pointed out that once a jig or fixture is properly configured, numerous identical components can be produced without further setup. Additionally, Mechnol (2015) highlighted that the primary benefits of jigs and fixtures include "durability, reduced setup time, enhanced productivity, and decreased decision-making in operations by using standard components."

2.2.2 Types of Jigs and Fixtures used for welding

2.2.2.1 Assembly jig

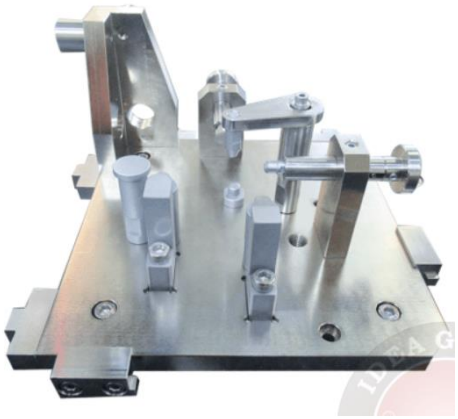

Figure 2.1: Assembly jig (Google, n.d.)

Assembly jigs are used in assembling parts together to link product assemblies. It will help products to achieve high accuracy and ensure technical requirements. Commonly used jigs are assembled in clamping product details for assembly, mounting parts to be assembled, deforming parts for welding, pressing, air compression during production.

2.2.2.2 Test jig

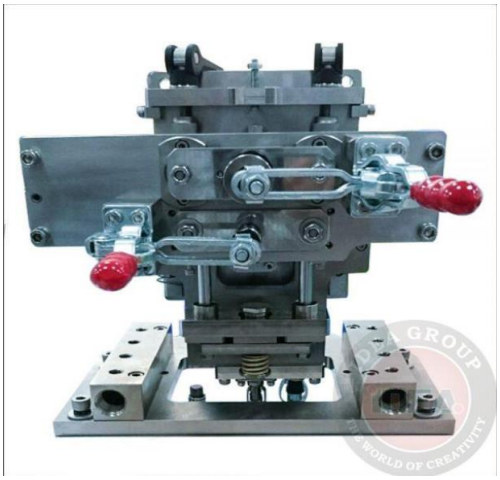

Figure 2.2: Test jig (Google, n.d.)

Test jigs are used to check product details at the beginning and end of the production process. Fix the product and check the size and thickness to ensure that the products are manufactured according to the specifications.

2.2.2.3 Compression jig

Figure 2.3: Compression jig (Google, n.d.)

The compression Jigs needs to fix the product before welding and assembling the parts together. The jigs are simple to use, easy to disassemble, and bring high efficiency in the production process. In addition, there are many other jigs such as soldering jigs, printed jigs, and many more depending on the requirements of the customer.

2.2.2.4 Milling jig

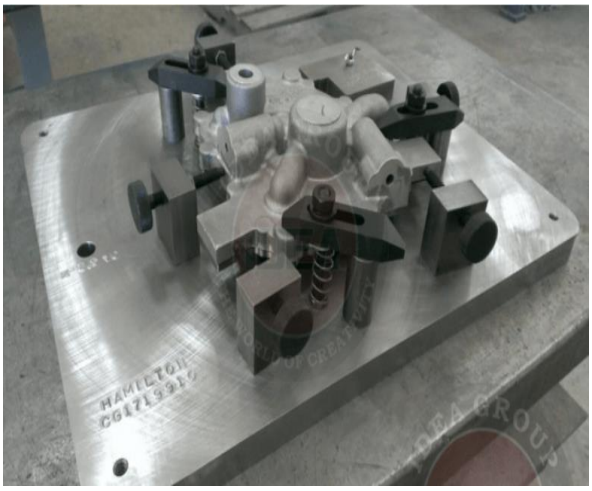

Figure 2.4: Milling jig (Google, n.d.)

All kinds of jigs used to perform detailed processing on milling machines are milling jigs. Milling jigs include locating parts, clamping parts, indicator parts (instructions), jig covers in addition to some typical details such as, alignment and gauge relative to the tool, directional pins. Because the cutting process creates a large force, the structure of the milling jig must also be large enough.

2.2.2.5 Modular Welding Fixtures

Figure 2.5: Modular Welding Fixtures (Google, n.d.)

Such one-of-a-kind devices come with several parts which can be put together in any way to achieve the required results. Their replaceable characteristic makes them economical by providing a rapid arrangement instead. They allow you to perform multiple operations such as joining small parts to intricate assemblies, among others. These aids have been developed by NASA researchers as part of the NASA Technology Transfer Program who develop and implement new technologies for this purpose. These exceptional devices solve the needs for different activities without spending.

2.2.2.6 Dedicated Welding Fixtures

Figure 2.6: Dedicated Welding Fixtures (Google, n.d.)

The dedicated welding fixtures are specially employed devices in welding operations aimed to enable more accurate and rhythmic component assembly. This benefit allows for the correct positioning of the welded parts on the table while welding. A dedicated welding fixture has a purpose of making the welded parts stationary. This will do away with the need for manual adjustments and lessen mistakes to achieve welded joints that will meet high quality standards.

2.2.2.7 Manual Welding Fixtures

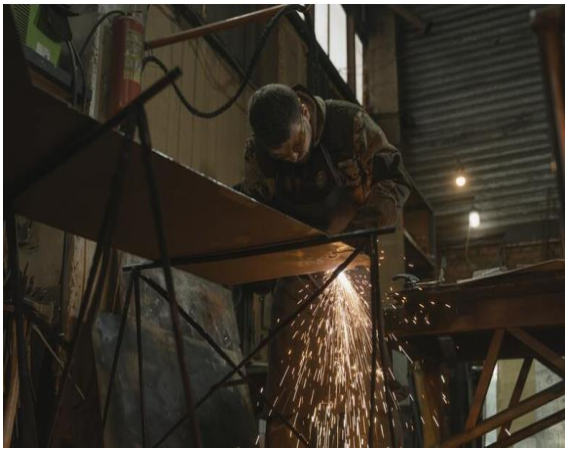

Figure 2.7: Manual Welding Fixtures (Google, n.d.)

For producing strengthen or complex welds, manual welding fixtures are useful instruments. By offering a steady controlled welding environment, manual weld fixtures avoid these problems. They reduce the possibility of welding errors. But without help, you have to manually position the workpieces on manual fixtures. The materials used to make these fittings are stiff and resistant to high welding temperatures. They enhance the quality of the weld and lower the chance of accidents.

2.2.2.8 Hydraulic and Pneumatic Welding Fixtures

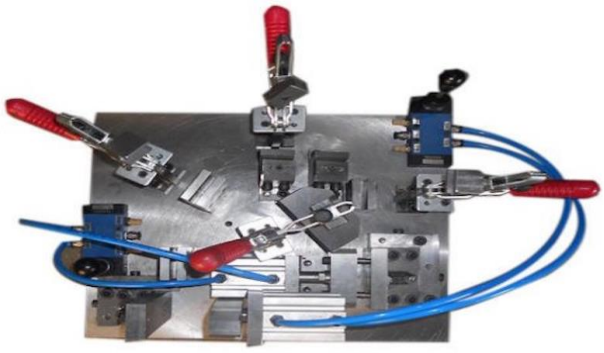

Figure 2.8: Hydraulic and Pneumatic Welding Fixtures (Google, n.d.)

Hydraulic cylinders are used by hydraulic welding fixtures to clamp the workpiece into place. A strong and controlled force is produced by the hydraulic system's fluid pressure. Clamps

and other support structures are used to apply this force, which keeps the workpiece stationary while welding. Both gas metal arc welding (GMAW) and gas tungsten arc welding (GTAW) apply these welding fixtures.

In addition, pressure is also used by pneumatic welding fixtures in their operations. Compressed air is used in this kind of fixture to position the welded components. They are used in flux-cored arc welding (FCAW) and shielded metal arc welding (SMAW). Pneumatic welding fixtures function by use of cylinders, valves, and hoses. Together, these elements provide you the clamping force you desire.

2.3 SPECIFIC LITERATURE REVIEW

2.3.1 Types of Material for Product Structure

2.3.1.1 Plywood

Figure 2.9: Plywood (Google, n.d.)

Plywood is a construction material made from thin sheets of wood veneer glued together. It is an inexpensive alternative to solid wood boards, and it can be used for a variety of applications. Plywood is strong and durable, and it is resistant to warping and cracking. It also can be cut and shaped easily. Plywood plays the role of fixture which is to hold the jigs in the jig and fixture project.

2.3.1.2 PLA Filament

Figure 2.10: PLA Filament (Google, n.d.)

PLA is an easy-to-process thermoplastic with a higher strength and stiffness than both ABS and nylon. As a low melting point material with minimal warping, PLA can be 3D printed quite easily.

2.3.1.3 Welding Fixture Table

Figure 2.11: Welding Fixture Table (Google, n.d.)

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Welding fixture tables offer a flat and stable surface that ensures precise alignment of workpieces, reducing errors and rework. They enable consistent weld quality, leading to improved efficiency, faster and repetitive production cycles. The size of the welding fixture table is size (90cm x 60cm).

2.3.2 Accessories and Furnishing of the Product

The accessories and furnishings in Fabrication of Jigs and Fixtures for welding project are intended to improve the function of the product.

2.3.2.1 Anti rust lubricant spray

Figure 2.12: Anti rust lubricant spray (B mart)

The anti-rust spray is vital to the Jigs and Fixtures project. It will protect the lower arm from rust and corrosion, penetrates stuck parts, displaces moisture, and lubricates almost anything.

2.3.2.2 Wood Stain Gloss

Figure 2.13: Wood Stain Gloss

The shiny coat on wooden surfaces refers to the glossy finish on their upper layer. This preserves the wooden element from deteriorating. This also makes the wood seem fine and fresh.

2.3.2.3 L Bracket

Figure 2.14: L Bracket

L-shaped brackets play a vital role in furniture assembly and reinforcement. They are commonly used in the construction of cabinets, desks, tables, or other furniture pieces. L-shaped brackets provide structural support, ensuring the stability and longevity of furniture. Thus, this L-shaped brackets used to support the base of jigs and clamps on the plywood.

2.3.3 Product Mechanism (Mechanical)

These deliberately designed mechanical parts play an important role in optimizing the whole product process, demonstrating the company's dedication to ongoing improvement and refinement.

2.3.3.1 Toggle Clamp

Figure 2.15: Toggle Clamp

A toggle clamp is a highly flexible work holding device that can clamp a stationary workpiece in an engaged position. The main benefit for injection moulding, manufacturing lines, applications of welding and so forth. Toggle clamps are fast acting clamping devices that function via an over-centre securing mechanism of a "toggle action. Using a system of levers and pivots, the clamping handle advances a linkage to central position and the clamping arm advances to central point to clamp the fixture or workpiece in a locked state.

2.3.3.2 Plunger stroke push-pull toggle clamp

Figure 2.16: Plunger stroke push-pull toggle clamp

Push-pull toggle clamps incorporate a sliding plunger to provide a straight-line clamping action. The toggle action moves and locks the plunger in either the pushing or pulling direction.

2.3.3.3 Wheel Locking Brake

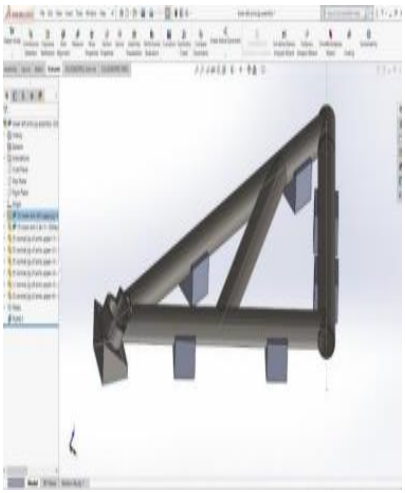
Figure 2.17: Wheel Locking Brake

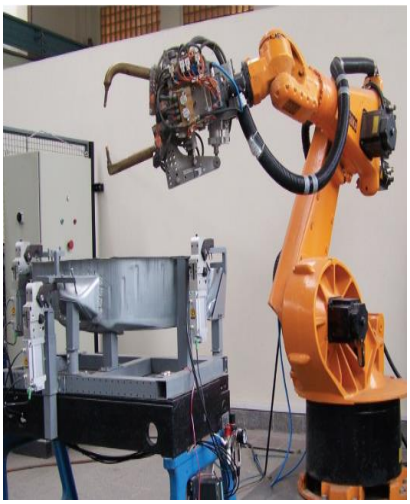
The heavy-duty wheel locking brake is a type of tread lock brake which is pushed down from above and firmly holds the wheel from moving by resting against the tread of the wheel. Since the wheel tread is intended to be able to grip the floor, this is an ideal place to grip with the brake. It also used to make the user to move the table easily and can be locked to prevent the table from moving during performing the welding.

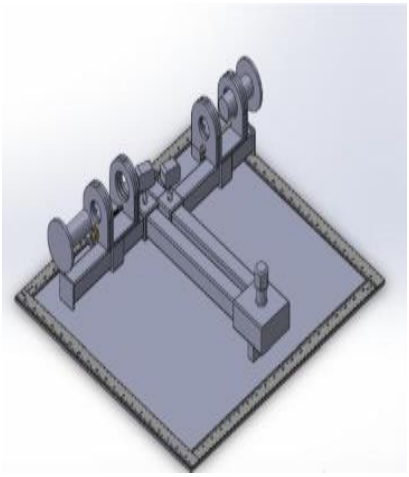
2.4 REVIEW ON RECENT RESEARCH / RELATED PRODUCTS

Table 2.1: List of Jigs and Fixtures in welding / Patented Products

NO	PATENT PRODUCTS	PATENT SUMMARY
1		**Patent Title:** Adopting the Innovated Jigs and Fixtures for Pipe Welding Process **Patent Country**: Department of Education, Schools Division of Toledo City, Philippines **Year:** 2023 **Inventors:** Nemuel Janery V. Abalde **Abstract:** This research adopting the innovated jigs and fixtures for pipe welding process for students and teachers of General Climaco National High School, in Toledo City, during the school year 2023-2024 as basis for technology adoption. The project is intended for Metalworks inside and outside the laboratory. It used the device comfortably during the welding project and design the workpiece and other areas. The Innovated Jigs and Fixtures for Pipe Welding Process comprises the accessories such as Angle bar which guide the pipe, Flat bar which the wing nut lies on, Bolt with a wing nut at the top of it so that it easy to turn the bolt by hand that presses the pipe into steady and the Steel plate which is the main base of the jigs and fixtures that support all the load on it. The device has also 5 lines as the output. The users can use the device simultaneously with confidence during workshop operations. The top view has dimensions of 13 inches as width and 12 inches as length with mixed materials and accessories attached. The front view has 11 inches in height fixed.

2		**Patent Title:** 3D printed jigs and fixtures Application in manufacturing of suspension arm for ATV **Patent Country**: Department of Mechanical Engineering, Delhi Technological University, Delhi, India **Year:** 2021 **Inventors:** Rohit Paliwal, Rahul Saini, Rohit Kumar Mishra, Samrat Tiwari, A.K. Madan. **Abstract:** Tooling, such as jigs and fixtures are a fundamental aspect of manufacturing technology providing quality control and production efficiency. Jigs and fixtures are commonly employed to immobilisation, alignment and assembly various parts and sub-parts during the manufacturing process. Their contribution is virtually negligible when production is working normally, but it is significantly more apparent when there are breakdown. In order to circumvent the causes of production flaws or factory stops, manufacturing tools need to be continuously iterated and advanced by rapid prototyping, manufacturing and deployment. In this innovation report we have described how we designed and made use of 3D printed jigs and fixtures to enhance the manufacture of maybe the most critical component of the ATV (All-Terrain Vehicle), that is. the suspension arms.

3		**Patent Title:** Design of the Welding Fixture for the Robotic Stations for Spot Welding Based on the Modular Concept **Patent Country:** Technical University of Kosice, Slovakia **Year:** 2023 **Inventors:** Mikula´ s Hajduk, Jan Semjon, Marek Vagas **Abstract:** This article explains the methodological basis of the design of welding fixtures for robotic cells according to principles of modularity. In other states the fundamental constituents of a preparation, their roles and potential board shape and dimensional properties are outlined. A presented approach was evaluated for robotic training workstation using robot KUKA for spot welding of body car parts. Modularization in the design of welding fixtures can improve the overall system adaptability of the working station and at the same time reduces design activities for a fixture and its realization. The individual modules can be repeatedly exploited. In order to determine the required kind and dimensional arrangement of the single modules, possibly by taking advantage of the group technology principles, it may indeed be the case that the whole number of elements of fixture is decreased. For the developed methodology, software support was provided for each step, along with the created database of the designed modules and commercially available components.

4		**Patent Title:** Design of a Versatile Jig and Fixture for Welding of Suspension Arms **Patent Country**: Department of Mechanical Engineering (SMEC), Vellore Institute of Technology, Chennai, India **Year:** 2020 **Inventors:** Anuj Shrivastava, N. Jayanth Shyam **Abstract:** This research adopting the design of a versatile jig and fixture for welding of suspension arms. The fixture is to be designed for the welding of suspension arms for any passenger vehicle. Efficient designs reduce material and manufacturing labour costs. In this we aim to design an adjustable fixture and jig for welding suspension arms, which can be adjusted according to the required dimensions of the a-arm lengths. The purpose of this welding fixture is to conduct proper welding of sub – component, cost efficient, productive, and safe. This includes basic study of fixtures. Moreover, the aim of the project is to design a versatile fixture and jig suitable to weld the components of an a-arm to complete its assembly. The versatility of the fixture corresponds to the design feature of the fixture that certain components of the fixture can be adjusted in a way such that the fixture adapts to the dimensions of the suspension arms being welded. Hence all the different configurations of a-arms for front wheels and rear wheels can be assembled using one fixture and jig design improving productivity and all the hassle.

2.5 COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT

2.5.1 Adopting the Innovated Jigs and Fixtures for Pipe Welding Process vs Fabrication Jigs and Fixtures in welding for lower arm vs 3D printed jigs and fixtures Application in manufacturing of suspension arm for ATV

Table 2.2: Adopting the Innovated Jigs and Fixtures for Pipe Welding Process vs Fabrication Jigs and Fixtures in welding for lower arm vs 3D printed jigs and fixtures Application in manufacturing of suspension arm for ATV

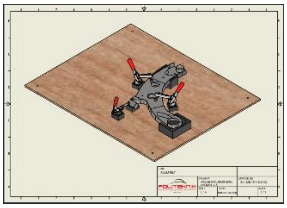
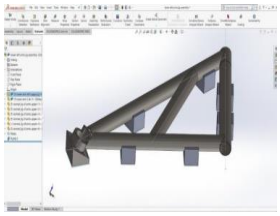
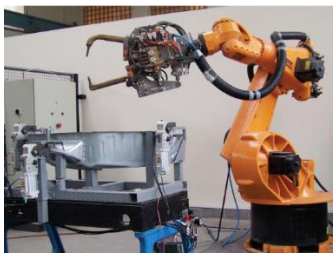
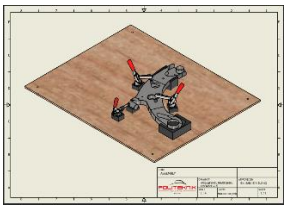
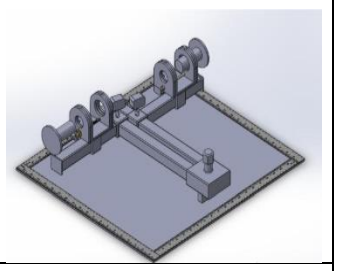
Product	Adopting the Innovated Jigs and Fixtures for Pipe Welding Process	Fabrication Jigs and Fixtures for welding in teaching and learning process	3D printed jigs and fixtures Application in manufacturing of suspension arm for ATV
Design			
Capable of being clamped	Yes	Yes	Yes
Methods of working principle	Manually	Manually	Manually
Shapes that can use	Cylinder (pipes)	Lower control arm	Suspension arm for ATV
Size of the worktable /clamping tool	13 inches as width x 12 inches as length x 11 inches as height fixed	110cm x 90cm x 65cm	N/A
Features	-Flat bar -Steel Plate -Easy to maintain	- Jigs and Pin location made by 3D printing - Easy to maintain - Can bring to anywhere since it's a 2 in 1 worktable	- Lightweight - Jigs are made by 3D printing

Table 2.3: Design of the Welding Fixture for the Robotic Stations for Spot Welding Based on the Modular Concept vs Fabrication Jigs and Fixtures for welding in teaching and learning process vs Design of a Versatile Jig and Fixture for Welding of Suspension Arms

Product	Design of the Welding Fixture for the Robotic Stations for Spot Welding Based on the Modular Concept	Fabrication Jigs and Fixtures for welding in teaching and learning process	Design of a Versatile Jig and Fixture for Welding of Suspension Arms
Design			
Capable of being clamped	Yes	Yes	Yes
Methods of working principle	Robotic	Manually	Manually
Shapes that can use	various profiles or cubes or rectangular consoles (parts of car body)	Lower control arm	vehicle suspension a-arms shape (350mm x 175mm x 391.2mm)
Size of the worktable /clamping tool	1000mm x 2500mm	110cm x 90cm x 65cm	550mm x 500mm
Features	-Vertical and Horizontal clamping track -Positioning element	- Jigs and Pin location made by 3D printing - Easy to maintain - Can bring to anywhere since it's a 2 in 1 worktable	-Mild steel - Adjustable Extension to the Bearing Hole Mount with Screw Clamp - Millimetre Scale

2.6 CONCLUSION

Based on the literature review, the existing projects is focused on solving the problems of desired shapes for example pipe, suspension arms and many more. Since our project is mainly focused on solving for Polytechnic Banting Selangor who doesn't have the jigs and fixtures as an education utility where the lecturers face difficulities when teaching "DJF51072 JIG AND FIXTURE" subject to the students. Thus, we doesn't need to fabricate jig and fixture to use for various shapes. The cost of our project is cheaper compared to existing project. Moreover, we create the jigs and pin location with PLA filament by using 3D printing because it's expensive and it is unable to find in our area and online platform. Finally, our project is moveable, easy to use, less maintenance required and can use various type of clamps to clamp the lower control arm. It is also can use with or without table since we are using 2 in 1 concept.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 PRODUCT DESCRIPTION

3.1.1 Product Objective / Purpose of Product

The objective of the product is to improve the current system. For example, the Polytechnic Banting Selangor community often experiences difficulties in the integration of work. Therefore, with this jig & fixture innovation, it can help the PBS community in implementing the integration of work more easily and quickly. It is well known where this jig & fixture is used by the industry. Therefore, we inspired the concept to be adopted by the PBS community.

3.1.2 Utilization of Polytechnic's Facilities

To use all the Polytechnic's facilities, such as equipment, consumable materials and tools, authorization must be obtained from the supervisor and workshop coordinator by filling out some of the required paperwork**.** This form will detail the tools and equipment that are required to accomplish the project.

Several facilities were used by our group, including:

- General PBS workshop
- 3D printing lab
- Workshop table

3.1.3 Material Sponsorship / Donation by NAMICOH SURIA SDN BHD (NSSB)

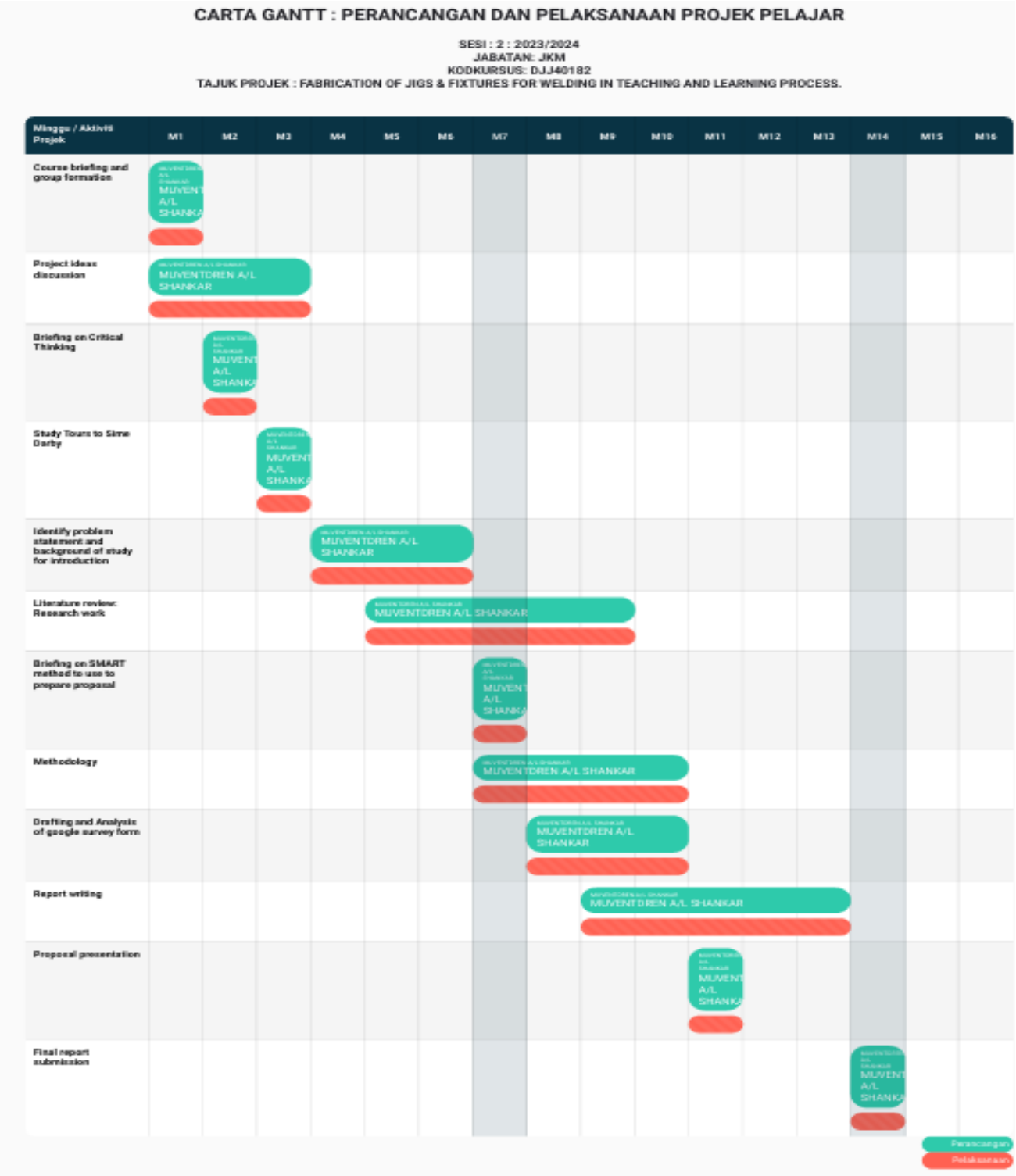
NAMICOH SURIA SDN BHD (NSSB) is a company who exports, imports and manufactures parts and accessories for motor vehicles. It is also a wholesale and retail sale of all kinds of parts, components, supplies, tools and accessories for motor vehicles. We went to their manufacturing site to observe the implementation of jigs and fixtures in their production which they use automatic jig and fixture to perform welding on the lower arm. They taught us the design of jig and fixture and how does it work. After we had a small discussion with them about our FYP project, they advise us to use different workpiece to show where does the welding should be done by using jigs and fixtures. Thus, they gave 2 set of their lower arm to use it as reference workpiece for our project.

Figure 3.1: Lower Control Arm from NSSB

3.2 OVERALL PROJECT GANTT CHART

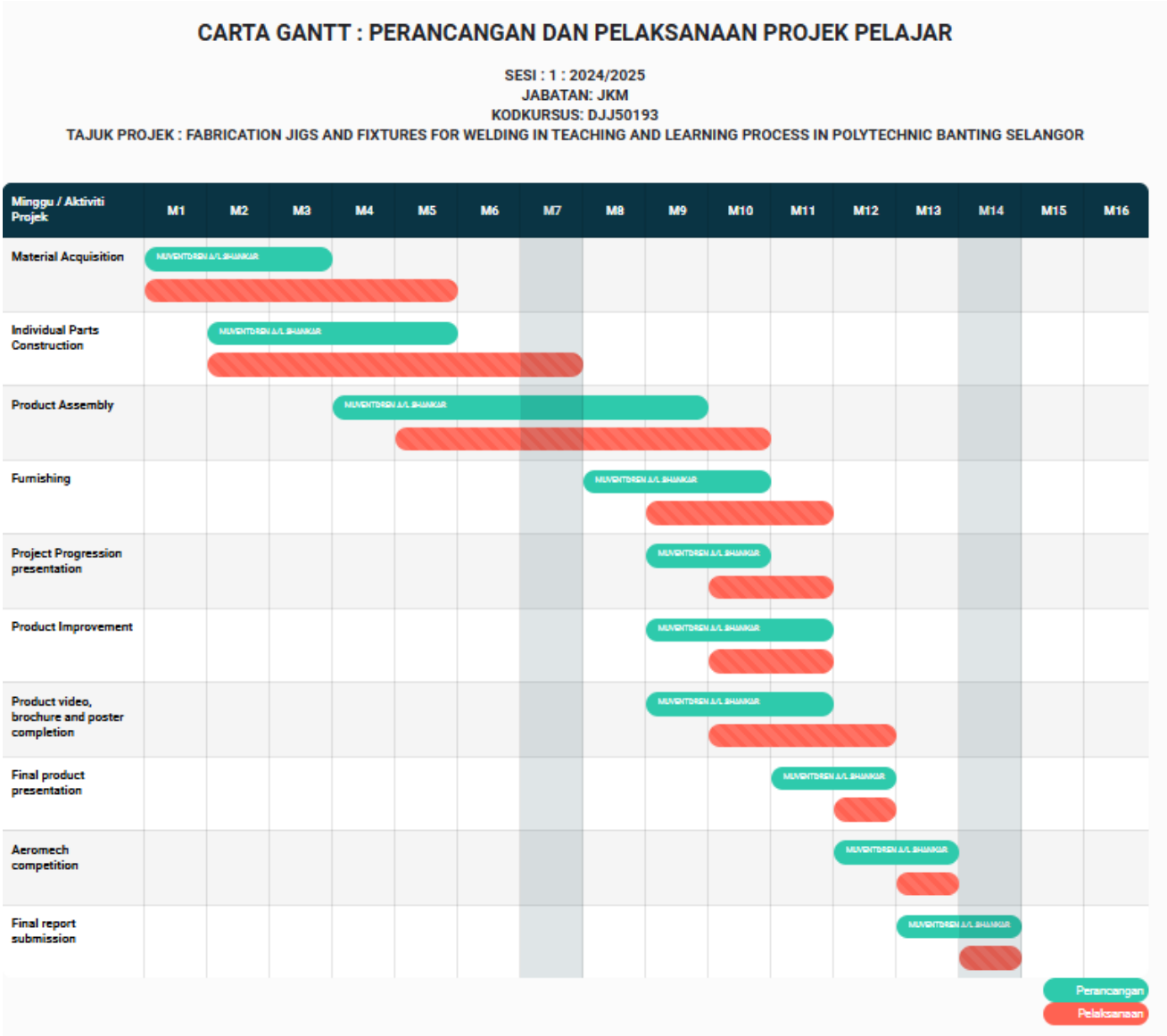
3.2.1 Gantt Chart for Final Year Project 1

Table 3.1: Final Year Project 1 Gantt Chart



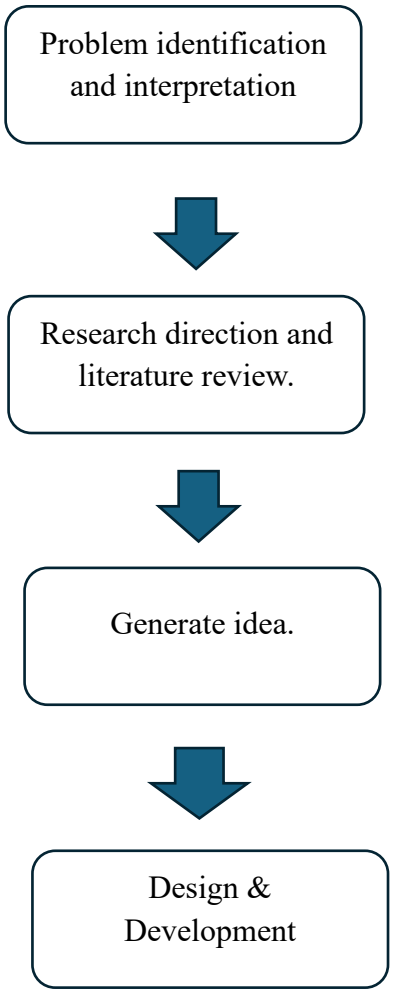
3.2.2 Gantt Chart for Final Year Project 2

Table 3.2: Final Year Project 2 Gantt Chart

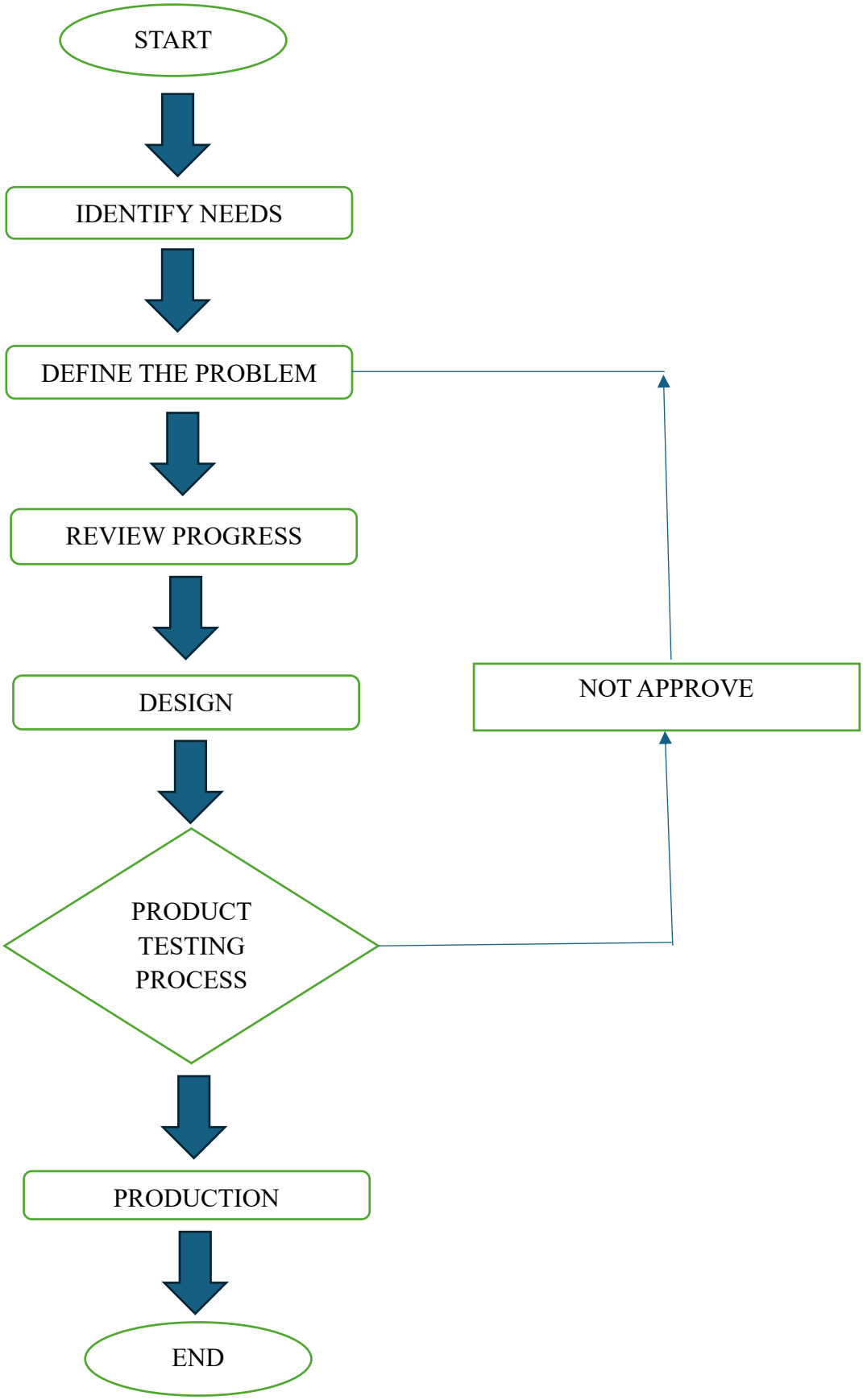


3.3 FLOW CHART /PROCESS FLOW

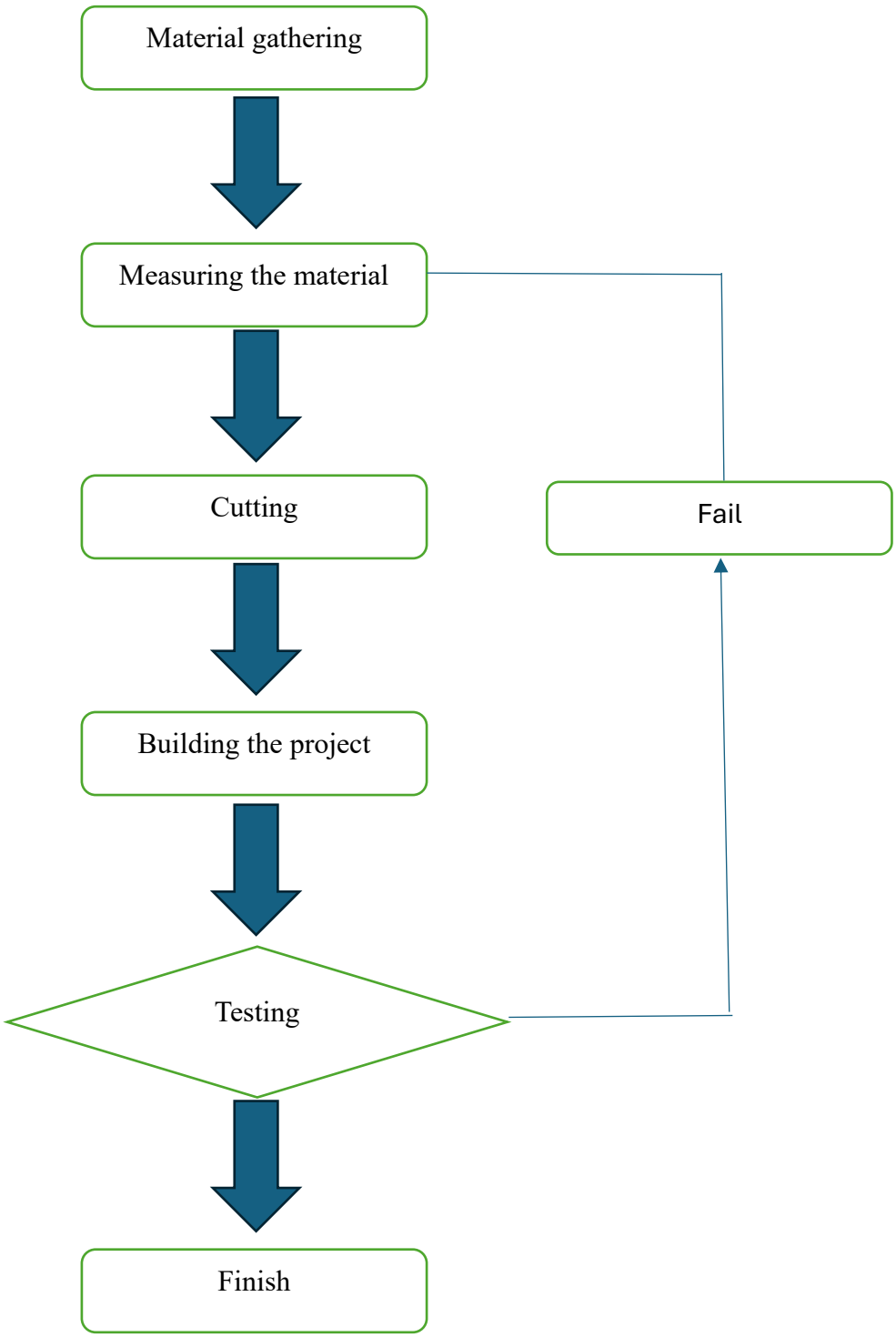
3.3.1 General Flow Chart/Process Flow



3.3.2 Specific Flow Chart/Process Flow



3.3.3 Fabrication Process Flow Chart



3.4 QUESTINONNAIRE SURVEY

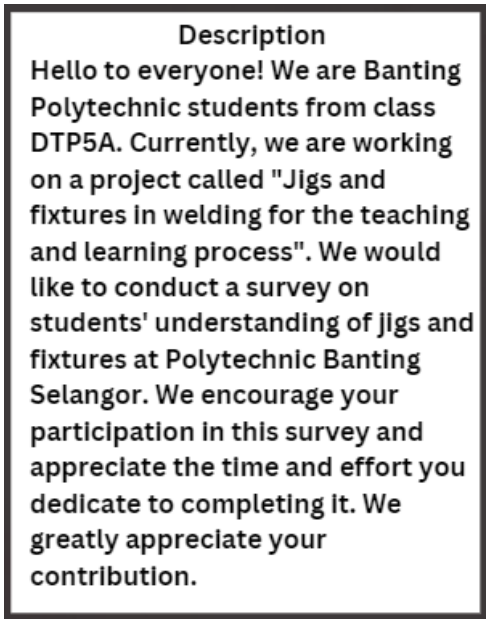


Figure 3.2: Questionnaire Survey through Google Form

The survey was carried out using Google Forms and delivered to lecturers who are teaching "DJF51072 JIG AND FIXTURE" subject and semester 5 DTP students of Banting Polytechnic in Selangor. There is main 5 questions to answer in this survey.

3.4.1: Position of the responses

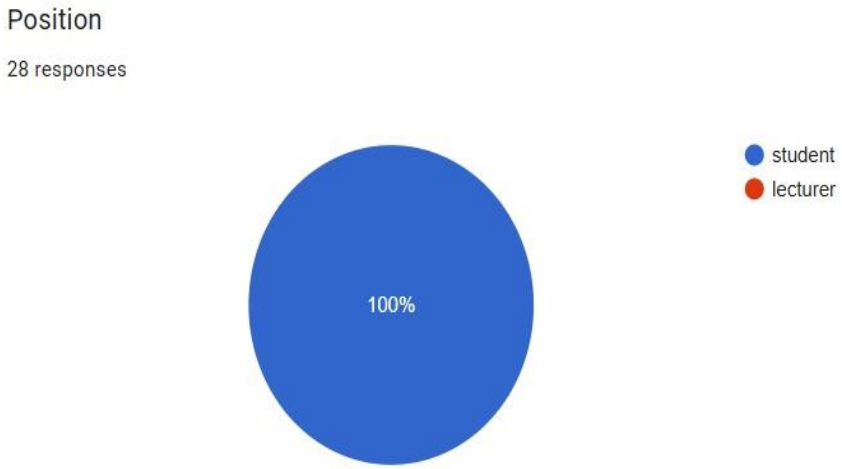


Figure 3.3: Position of the responses

3.4.2: About jig and fixture

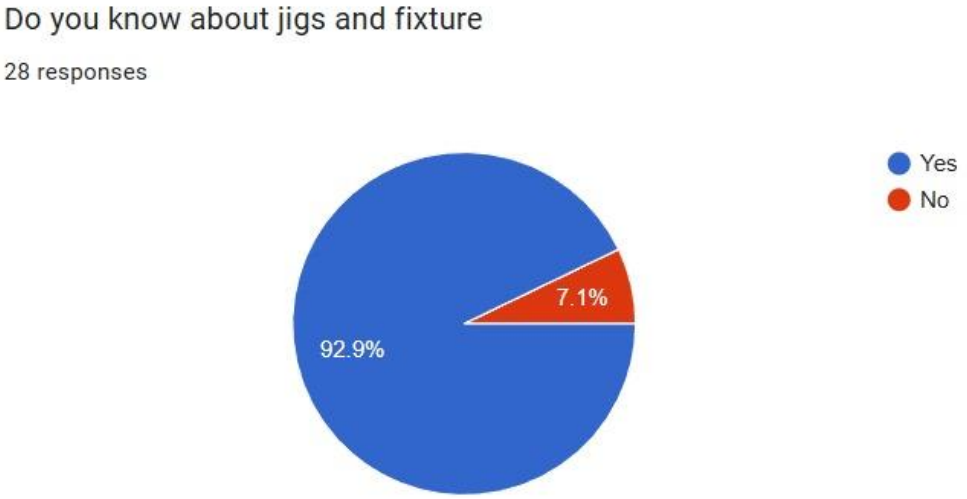


Figure 3.4: About jig and fixture

3.4.3: Basic knowledge of jig and fixture

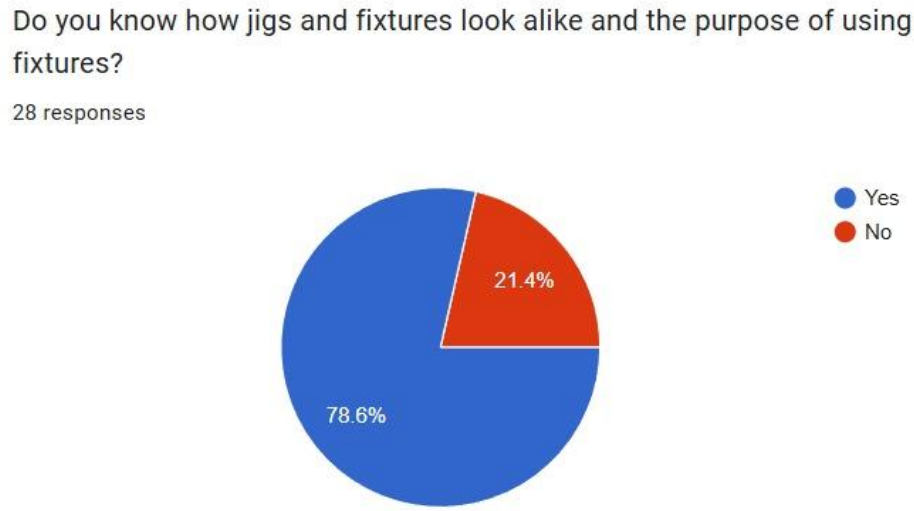


Figure 3.5: Basic knowledge of jig and fixture

3.4.4: Facing any difficulties with the jigs and fixtures subject

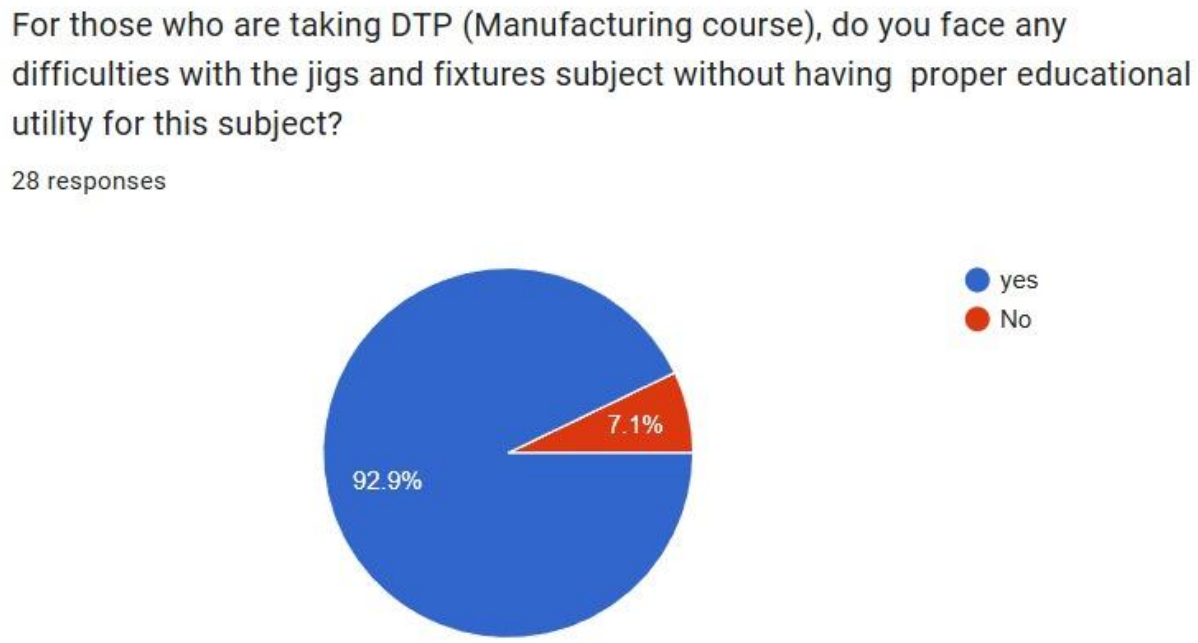


Figure 3.6: Facing any difficulties with the jigs and fixtures subject

3.4.5: Voting to make one type of jig and fixture from various operation

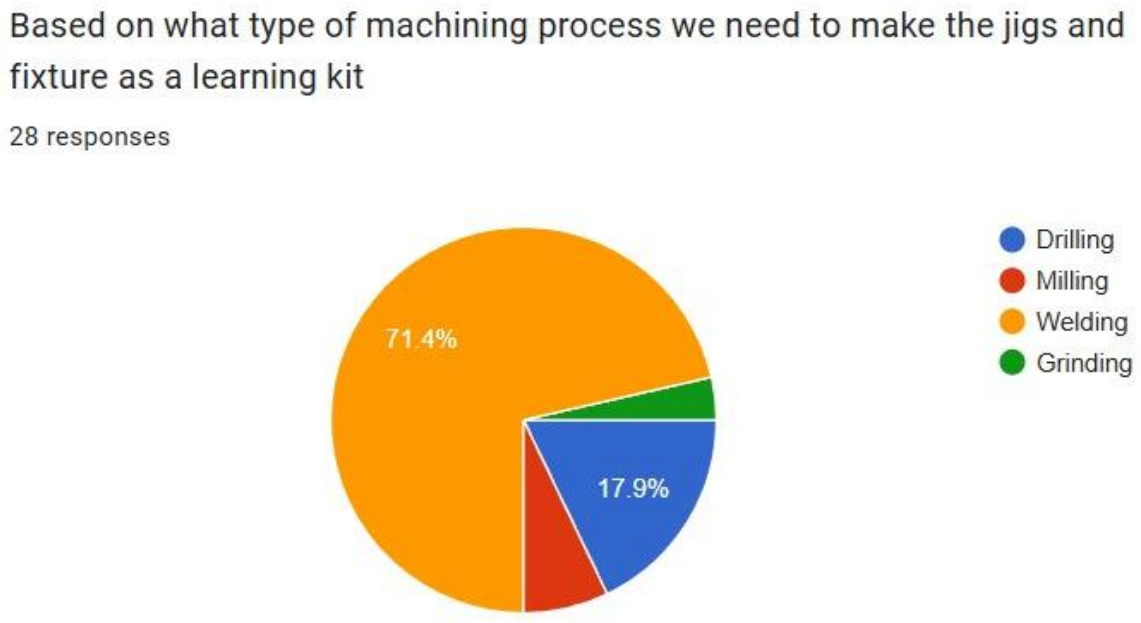


Figure 3.7: Voting to make one type of jig and fixture from various operation

3.4.6: Do they use it as a learning kit

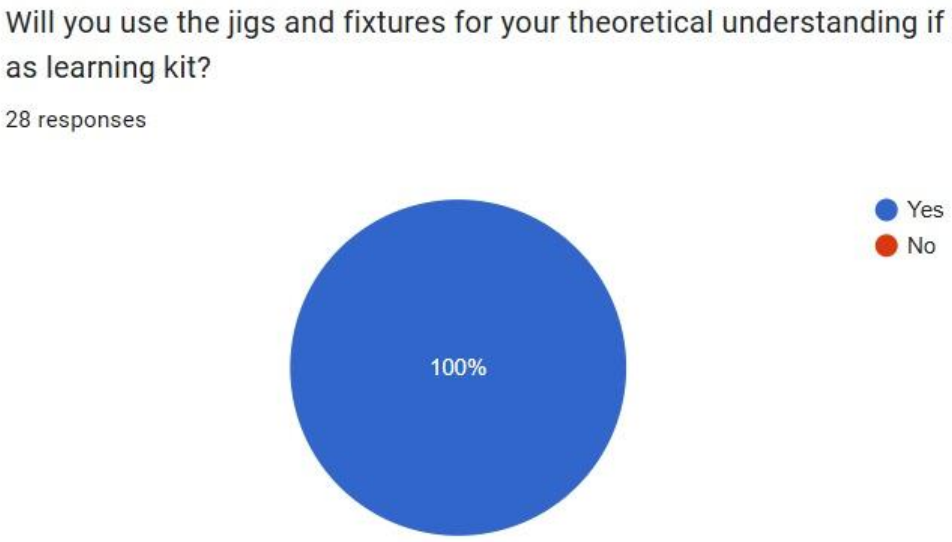


Figure 3.8: Do they use it as a learning kit

3.5 DESIGN PROCESS/ PRODUCT DRAWING

3.5.1 Proposed design / Sketching

The diagram shows the initial design that we will implement for our jig & fixture project.

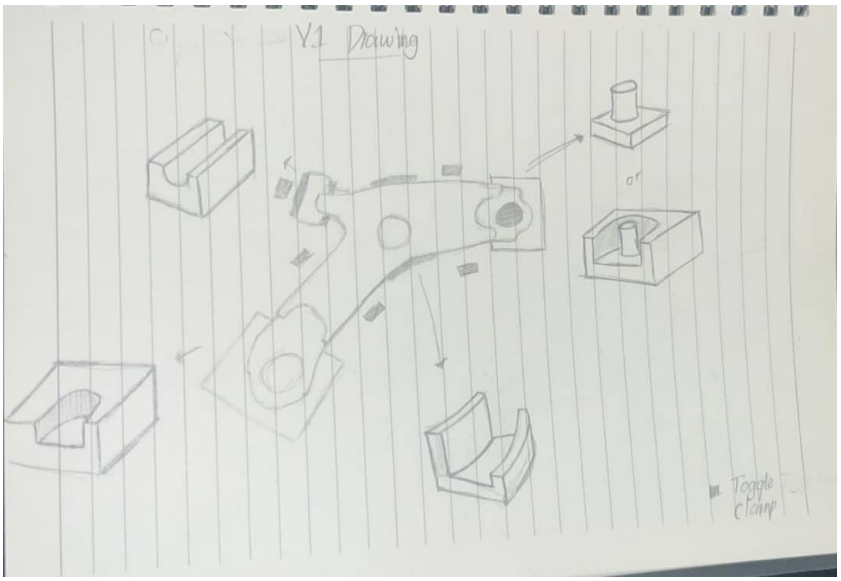


Figure 3.9: Proposed design / Sketching

3.5.2 Assembly drawing of our product

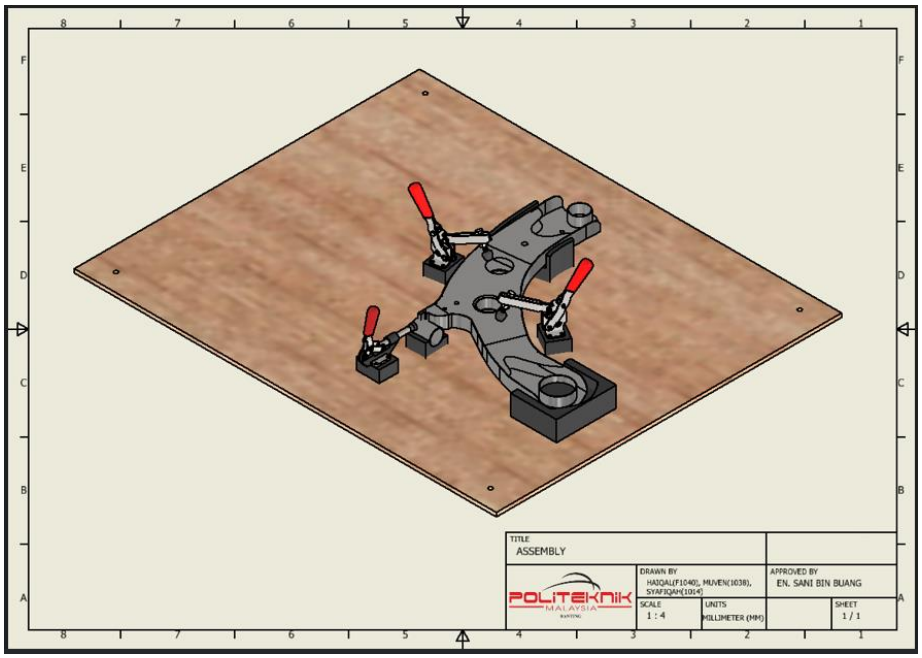


Figure 3.10: Assembly drawing of our product

3.5.3 Orthographic drawing of our product

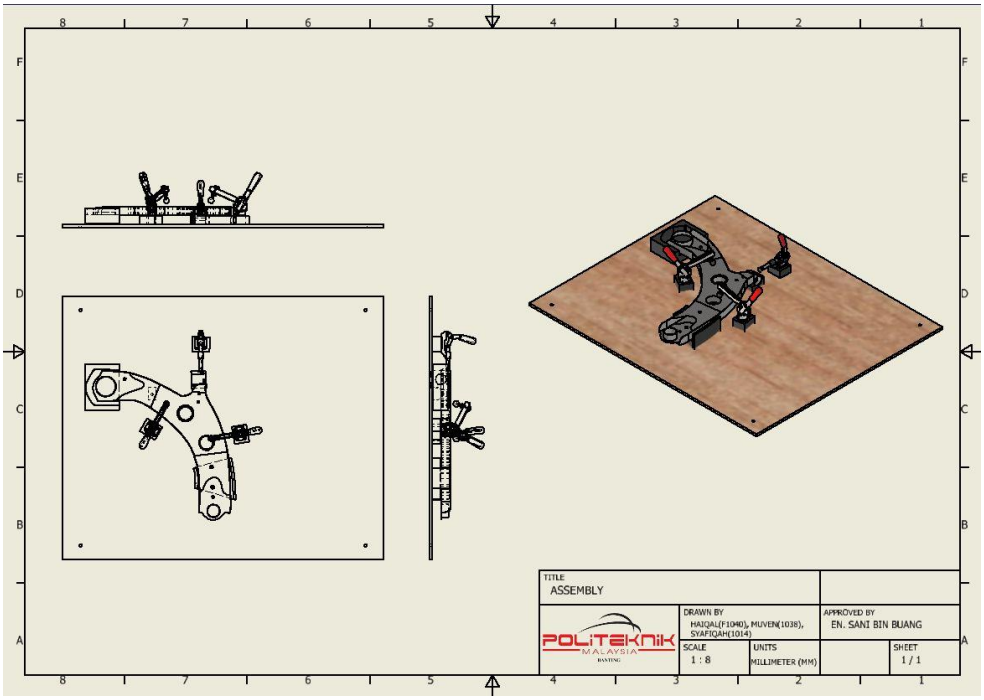


Figure 3.11: Orthographic drawing of our product

3.5.4 Exploded view / Part list of our product.

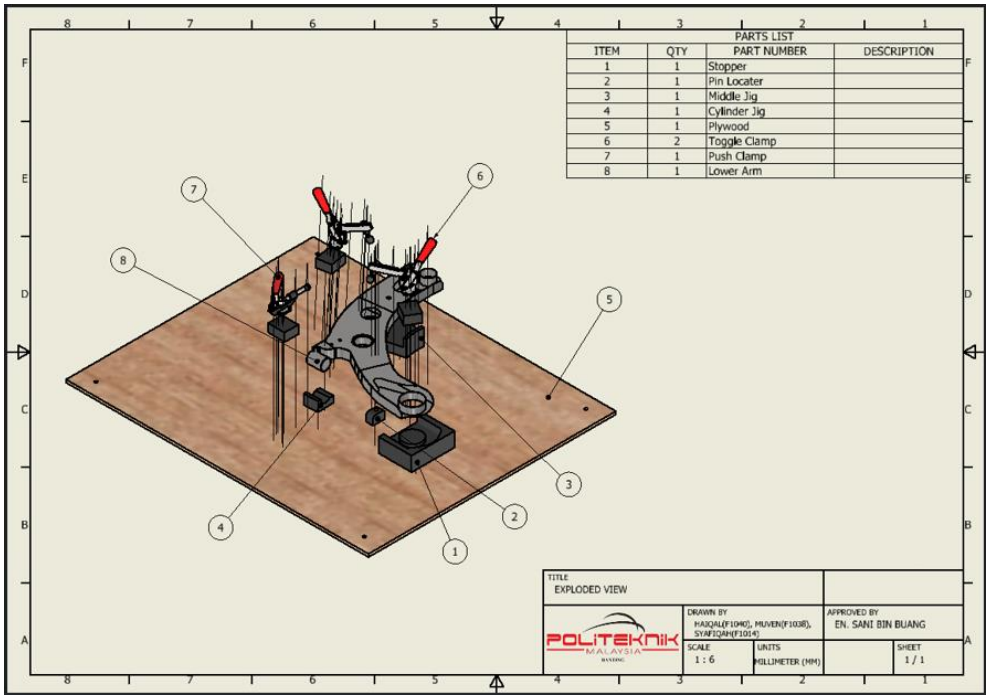


Figure 3.12: Exploded view / Part list of our product.

3.5.5 JIGS

3.5.5.1 Stopper / Head Jig

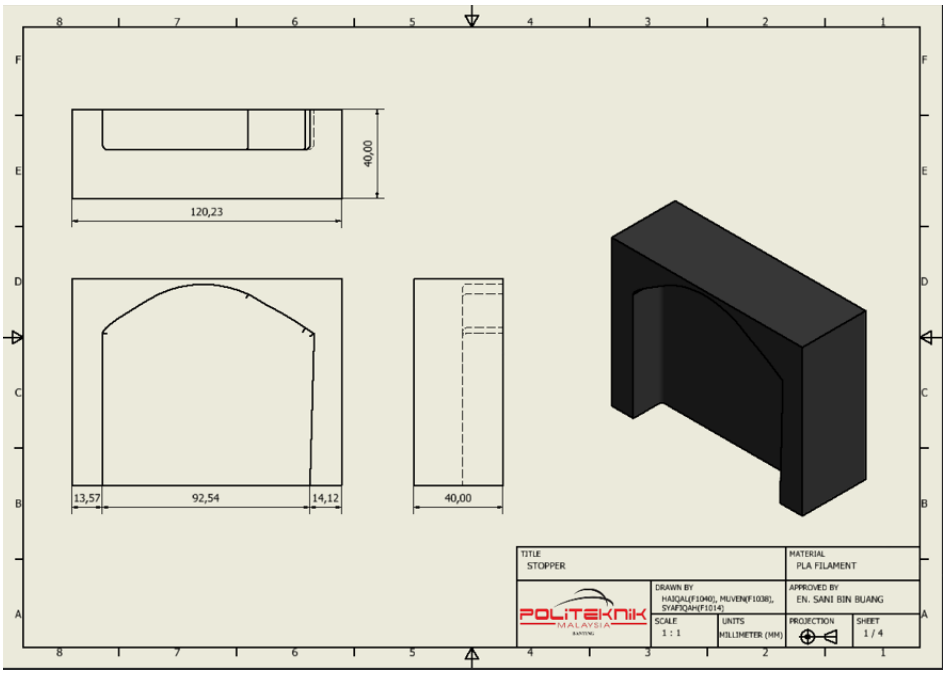


Figure 3.13: Stopper / Head Jig

3.5.5.2 Middle Jig

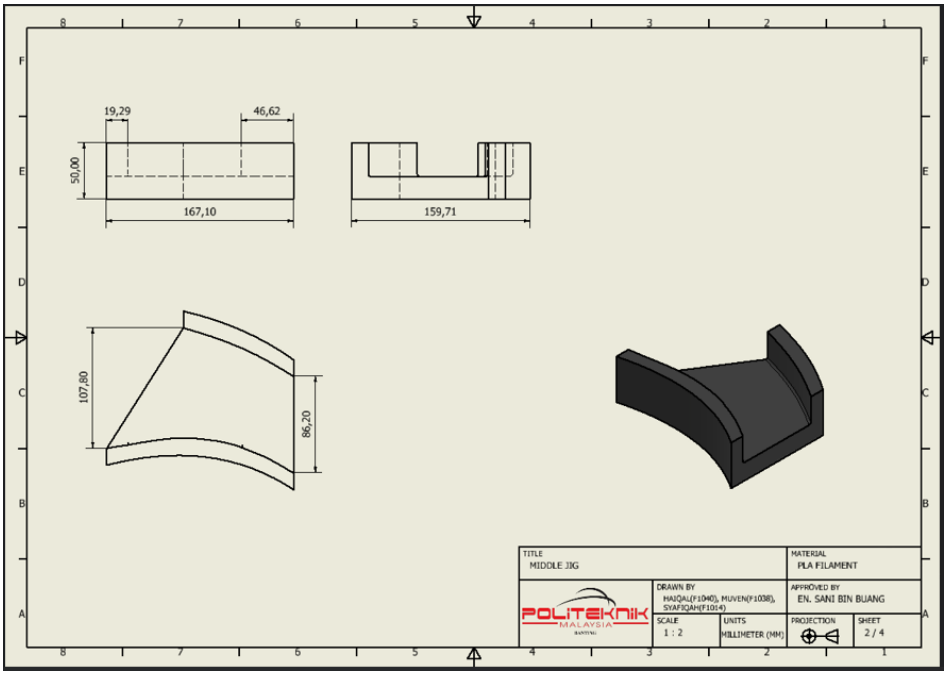


Figure 3.14: Middle Jig

3.5.5.3 Cylindrical Jig

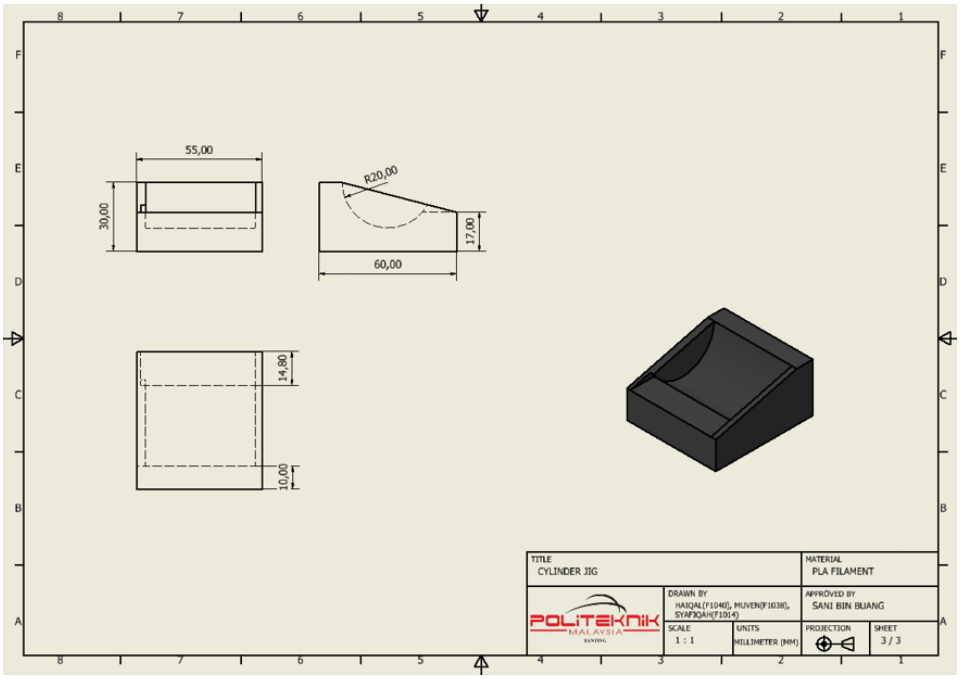


Figure 3.15: Cylindrical Jig

3.5.5.4 Pin Location

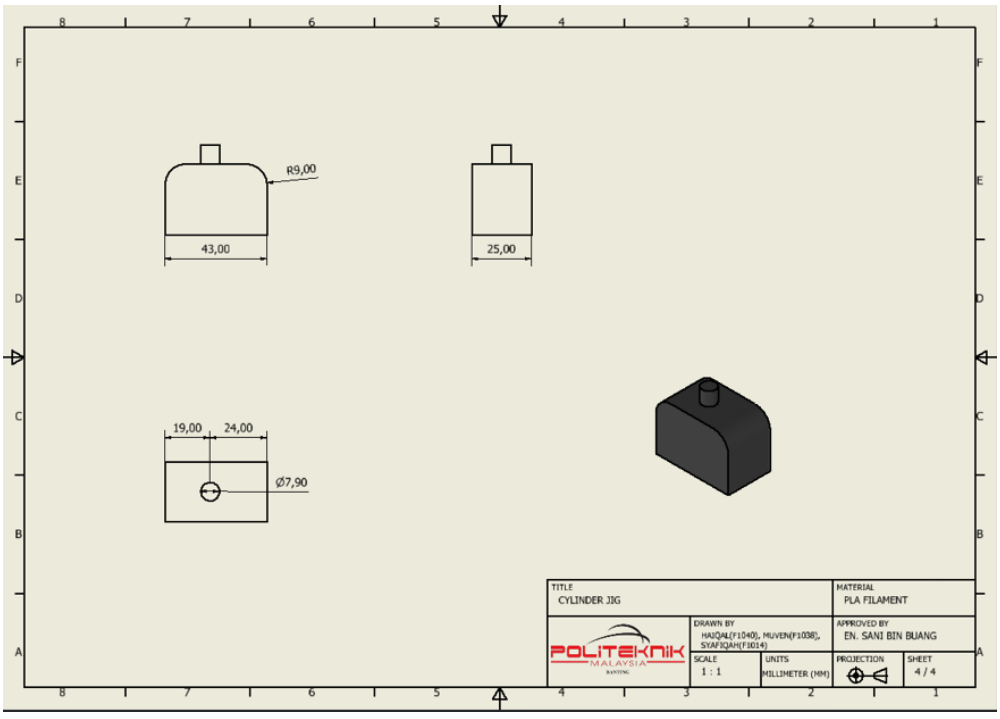


Figure 3.16: Pin Location

3.6 DEVELOPMENT OF PRODUCT

3.6.1 Material acquisition

Table 3.3: Material Acquisition

No	Picture	Description
1	**Toggle clamp.**  (size 201C spindle supplied=m6 x 45)	To hold the z-axis of workpieces in place during operation
2	**PLA Filament** 	Use to make the jigs and pin location according to the size we need by using a 3D printing machine.
3	**Wheel Locking Break**  (size 6 inch with brake)	Used to make it easy for the user to move the table and can also be locked to prevent the table from moving during welding work
4	**Plywood** 	Use as fixtures which is to hold the jigs. It is strong and durable, and it is resistant to warping and cracking. It also can be cut and shaped easily.

5	**Table**  **(size 90cm x 60cm with diameter of the hole on the welding table is 1cm)**	The fixture is placed on top of table to make it moveable.
6	**Anti rust lubricant spray** 	Used to protect the lower arm from rust and corrosion
7	**Plunger stroke push-pull toggle clamp** 	To hold the x or y-axis of workpieces in place during operation
8	**Wood Stain Gloss** 	To enhance the natural colours of the bare wood.
9	**L Bracket** 	Used to support the base of jigs and clamps on the plywood.

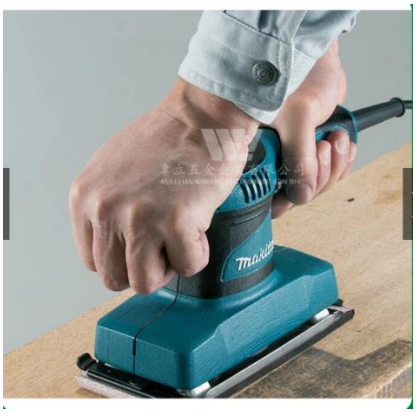
10	**Glue** 	Used to connect parts together.

3.6.2 MACHINES & EQUIPMENTS

Table 3.4: Machines & Equipment

1	**Welding machine** 	Used to assemble the wheel locking brake on the bottom of the table.
2	**Wood Cutting Machine** 	Used to cut the plywood desired sizes and shapes.
3	**3D printer machine** 	Used to make the jigs and locating pin according to the sizes and shapes that we want by using 3D printer.

4	**Measuring tape** 	Used as measuring project materials accurately.
5	**Bastard Files** 	To make sure the edges of plywood and base of the jigs have a perfect finishing.
6	**Portable electrical drill** 	Used to attach plywood with L brackets by drilling screws on it. .
7	**Bench Drilling Machine** 	Used to drill holes on the edges of the plywood.

8	**Wood Grinding machine** 	Used to protect the wood surface from dirt and moisture.

3.6.3 Specific Project Fabrication

3.6.3.1 Base Structure

Table 3.5: Project Fabrication for Base Structure

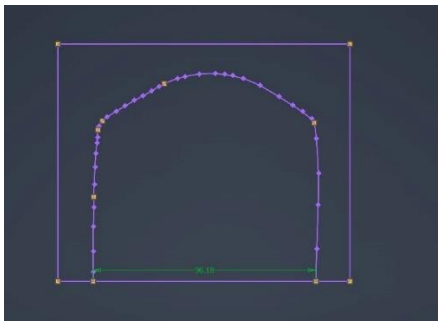
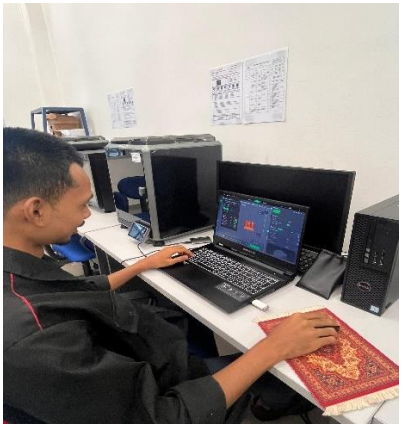
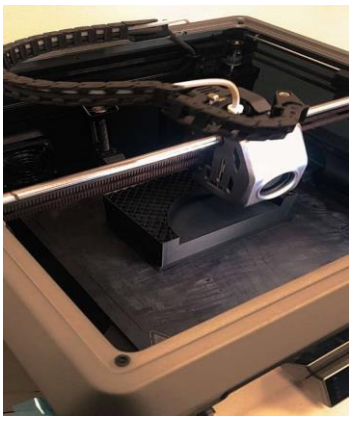
No	Fabrication Process	Description
1	 Material acquisition	Plywood bought to attach in our product.
2	 Measuring	Measure the length and width of the PBS workshop table which is already approve by Encik Khairi (Ketua Jabatan of Kejuruteraan Mekanikal at PBS) to use their table for our project purpose.

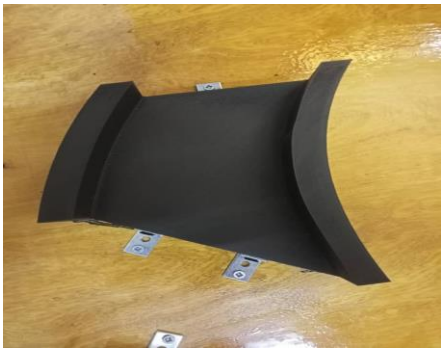
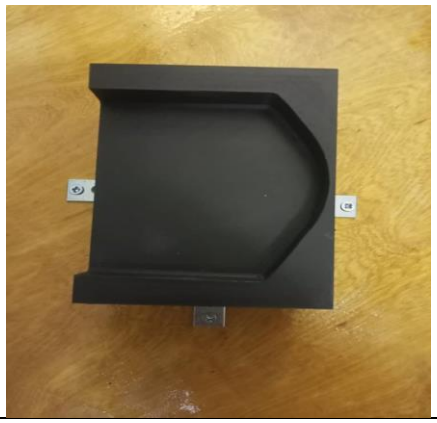
3	 Marking	Mark the desired size or dimensions of plywood that we need to cut after we make the measurements.
4	 Cutting	After we marked, we cut the plywood desired size by using wood cutting machine to speed-up our cutting progress instead of using hacksaw.
5	 Drilling	Holes in the edge of plywood are drilled to match the size of the table holes to lock it to the table.
6	 Finishing	To make sure the edges and side of plywood have a perfect finishing by using bastard files.

7	 Finishing	Perform a finishing on the top of the plywood by using wood grinding machine to make the wood surface cleaner.
8	 Coating	After finishing, we must apply wood stain gloss to enhance the natural colours of the bare wood.

3.6.3.2 Designing and Printing

Table 3.6: Project Fabrication for Designing and Printing part

No	Fabrication Process	Description
1		Sketching our jigs by using an Inventor software app to make our drawing more detail and clearer.
2	 Designing	After design the jigs by using an Inventor software, we use Creality software app to make some adjustment of the design before we start to print using 3D printer.
3	 Printing	Producing the jigs by using 3D printer machine.

4	  	The final look of our printed jigs by using 3D printer which are fit or accurate to the lower arm size.

3.6.3.3 Assembly

Table 3.7: Project Fabrication for Assembly part

No	Fabrication Process	Description
1		Applying glue on the plywood to stick with the base of the jigs.
2		Next, we assemble all the jigs which are already stick with small size of plywood and connect it with big size of plywood by using L-Bracket.
3		Following that, by using MIG welding to assemble the wheel locking brake on the bottom of the table.

4	 	The final look of our product after we done all the assembly process.

3.7 PRODUCT TESTING / FUNCTIONALITY TEST

After we are completing our project, we all did a lot of testing and inspection to ensure that our project works smoothly and functional. The first step is testing the accuracy of the jigs to hold the lower arm, and it suits so well without damaging the wall of 3D printed jigs. Next, we all tested our jigs in term of weight, and it can withstand the weight of the lower arm.

Following that, when it comes to durability by clamping test, we were scared that the clamping force may damage the 3D printed jigs but unfortunately it can be able to withstand, and the workpiece doesn't move when we clamp on the workpiece. Thus, this can help welders to perform welding on the workpiece more accurately and smoothly without making an error during welding process.

The pictures below show how to demonstrate our product to the students.

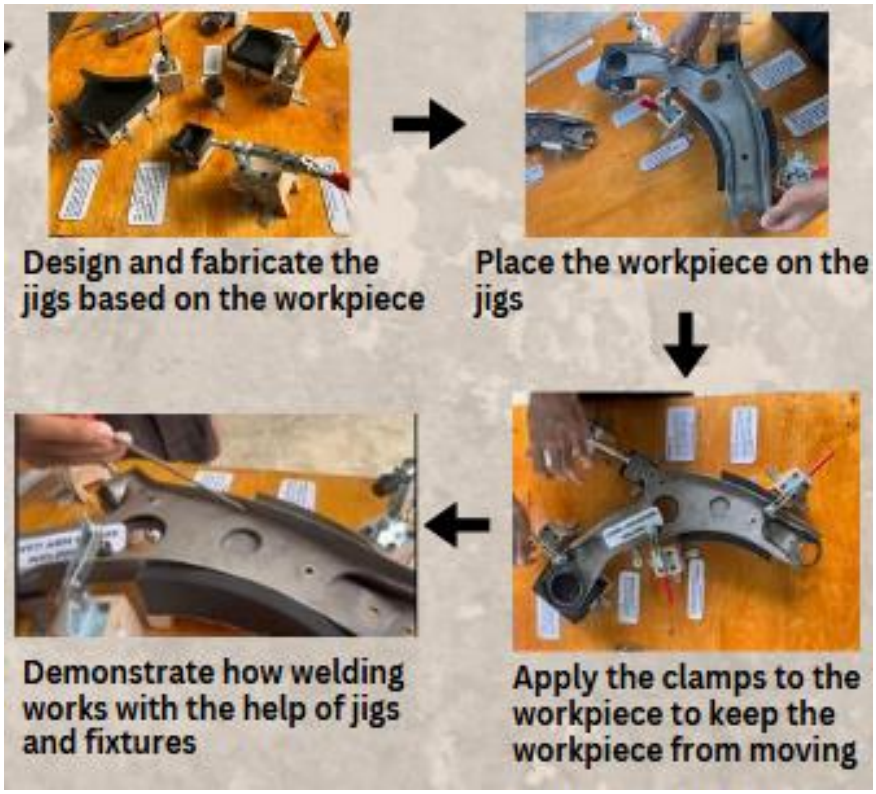


Figure 3.17: Product demonstration and testing

CHAPTER 4: RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter discusses the development of prototype produced by our group to help the learning process among students, thus the development of this prototype explains one way of using jigs and fixtures for the welding process, in this way students see and understand more clearly about the functions of jigs and fixtures**.**

4.1.1 GENERAL PRODUCT FEATURES & FUNCTIONALITIES

In general, this development prototype jigs and fixture in welding for an automotive part feature with plywood acts as a base or fixture, PLA filament to make jigs by using 3D printing, clamps such as toggle clamp and plunger stroke push & pull clamp. In addition, we add a QR code on the edge of the plywood which is contained with jigs and fixtures, notes and videos.

The major goal of this prototype is to provide an ideal solution for lecturers who are teaching the “DJF51072 JIGS AND FIXTURE” subject at Polytechnic Banting Selangor. With having this prototype, the lecturers can explain more detail about jigs and fixtures. For example, the working principle of using jigs and fixtures and so on.

Moreover, it can develop a student’s theoretical and practical understanding of using jigs and fixtures. Thus, this can help students carry out the task or assignments given by lecturers based on jigs and fixtures. They can also scan the QR to look at the e-book which was provided by our group.

Finally, it aims at other colleges and universities for those who don’t have jigs and fixtures as a reference tool to teach the jigs and fixture subject.

4.1.2 PRODUCT OVERVIEW

Figure 4.1: General view of finished product

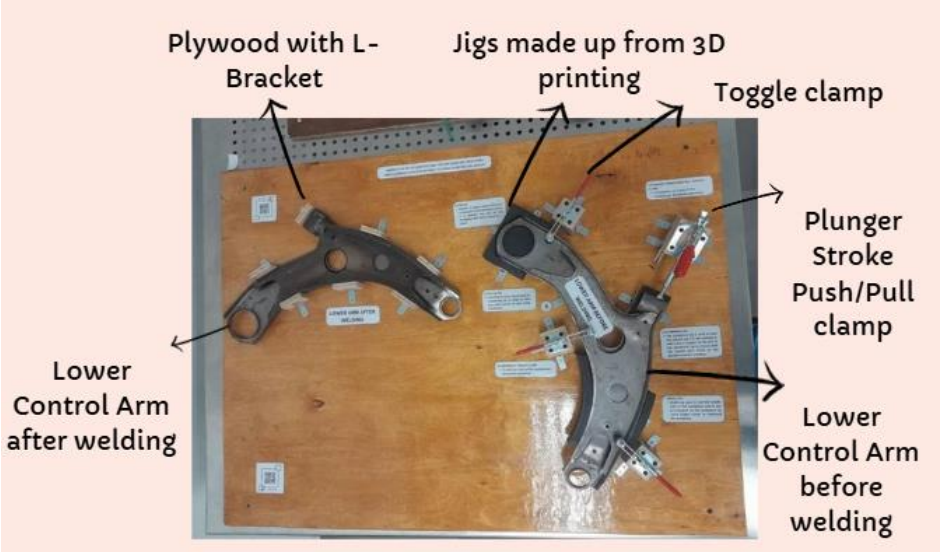


Figure 4.2: Top view of finished product with labels

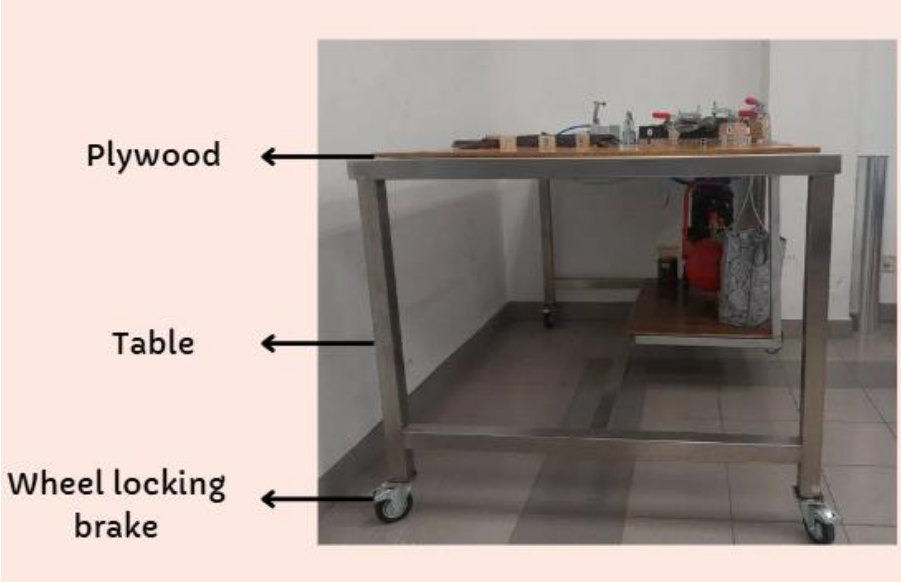


Figure 4.3: Side view of finished product with labels

4.2 ANALYSIS OF PROBLEM ENCOUNTERED & SOLUTIONS

The table shows the time, material weight and filament length used to produce one type of jig.

Type of jig	Cylinder jig	Middle jig	Pin locater	Stopper
Time	19m36s	1h48m1s	15m31s	1h11m18s
Material length	5.72 m	41.43 m	3.28 m	27.90 m
Material weight	17.06 g	123.58 g	9.78g	83.21g

Table 4.1: Time taken, material weight and filament length used to produce the types of jigs

4.2.1 JIG STRUCTURE

One of the difficulties we had in completing the project on time was making the jigs based on the lower control arm using 3D printing. We didn't have proper or accurate dimensions for the lower arm because the design of the lower arm was too complex to draw it exactly to its original shape and dimensions. Thus, it may take a long time to design the jigs based on a lower arm shape. As a first step, we designed the jigs based on the lower arm, and we got 4 types of jigs from there. We start to print everything according to the actual size of the lower arm without hesitation, but unfortunately, it doesn't fit to the lower arm size and takes a long time to print and wastes a huge amount of our PLA filament.

Therefore, we observe the problems that we faced and do an analysis to minimize the time and materials to print the jigs. We started to make a thinner, smaller and design a hole in the middle of the jigs to try out whether it fits for the lower arm size. Once we get the actual size, we print the jigs according to the height and thickness that we need to hold the lower arm.

4.2.2 OPERATING TIME OF SAVING UP

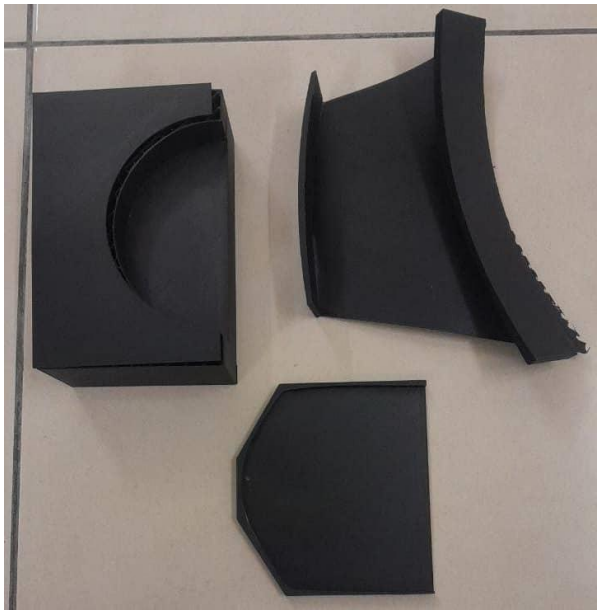
Two series of tests have been done to get the right size for jig production using 3d printer filament. The first operation shows the time taken to produce the jig according to the set design, but the size of the printed jig is not fixed to the product. Operation 2 shows the changed size to get a fixed jig. Therefore, we minimize the size to save on the jig making process.

Operation	**Time**			
	Cylinder jig	**Middle Jig**	**Pin Locater**	**Stopper**
Operation 1 (non-fix Size)	17m 36s	28m	10m	40m 35s
Operation 2 (fix size)	19m36s	20m	15m31s	25m 30s

Table 4.2: Operation time of saving up (operation 1 vs operation 2)

4.2.3 JIG STRUCTURE BEFORE & AFTER OPTIMIZATION FOR 3D PRINTING

Table 4.3: Jig structure before & after optimization for 3D printing

Before	After
	

4.3 LIST OF MATERIALS AND EXPENDITURES

	Product Structure and Furnishing			
No.	Item	Quantity	Price per unit	Total cost
1	Filament PLA	1	Rm 69.00	Rm 69.00
2	Wood Stain Gloss	1	Rm 25.00	RM 25.00
3	Plywood	1	Rm 55.00	Rm 55.00
4	Spray anti-rust	1	Rm8.00	Rm 8.00
5	L bracket + screw	7	Rm 4.10	Rm 28.70
6	Glue	1	Rm 20.00	Rm.20.00
	Product Mechanisms			
1	Toggle Clamp	3	Rm 3.79	Rm 11.37
2	Wheel Locking Break	4	Rm 10.99	Rm 43.96
3	Plunger Stroke Push Pull Toggle Clamp	1	Rm 8.80	Rm 8.80
	Others			
1	Sandpaper	2	Rm 2.00	Rm 4.00
2	PP round container	1	Rm 4.80	Rm 4.80
3	Brush	1	Rm 2.10	Rm 2.10
4	Selleys Supa Glue	2	Rm 2.50	Rm 5.00
	Grand Total			**Rm 285.73**

Table 4.4: List of materials and expenditures

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Throughout this product and testing conducted in this research, it can fulfill the aim and objectives which are highlighted in the beginning of the research are successfully accomplished. The implementation of development prototype jigs and fixture for teaching aids in “DJF51072 Jig and Fixture” subject at PBS for an automotive part provides a comprehensive understanding of the principles behind tool design in manufacturing, emphasizing the importance of precision, efficiency, and repeatability. Through this project, learners or students developed skills in design, material selection, and problem-solving, while also recognizing the practical challenges faced in real-world manufacturing. Moreover, this research stimulated creativity and critical thinking in the field of manufacturing technology, establishing a solid foundation for future technical applications.

5.2 RECOMMENDATION

Recommendation for fabrication of jig and fixture

Observations for this project led me to the conclusion that I strive to achieve the objective of helping the lecturers and students to practical understanding of jigs and fixtures for teaching aids in “DJF51072 JIG AND FIXTURE” subject. Unfortunately, our jigs cannot be flexible and adjustable to hold a various type of shapes of the workpiece. We planned to make jigs by 3D printing which can rotate to 360 degree and adjustable from small to average sized workpiece, but it is hard and impossible to make it as a manually. Thus, we suggest making a simple jig based on lower arm because it is just a teaching material or learning kit. Apart from that, the jig and fixture for teaching and learning kit can be made portable as a future improvement. We believe that this project can contribute a lot of things for semester 5 DTP’ students and lecturers who are teaching “Jig and Fixture” subject at Polytechnic Banting Selangor.

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APPENDIX A: DECLARATION OF TASK SEGREGATION

SUB-CHAPTERS	DESCRIPTION
MUVENTDREN A/L SHANKAR (24DTP22F1038)	
1.1	BACKGROUND OF STUDY
1.2	PROBLEM STATEMENT
1.4	SCOPE OF PROJECT
2.2.1	Demand in manufacturing
2.2.2.1	Assembly jig
2.2.2.3	Compression jig
2.4	REVIEW ON RECENT RESEARCH / RELATED PRODUCTS
2.5	COMPARISON BETWEEN RECENT RESEARCH AND CURRENT PROJECT
2.6	CONCLUSION
3.1.2	Utilization of Polytechnic's Facilities
3.3.2	Specific Flow Chart/Process Flow
3.3.3	FABRICATION PROCESS FLOW CHART
3.4	QUESTINONNAIRE SURVEY
3.5.4	Exploded view / Part list of our product
3.5.5.3	Cylindrical jig
3.6.3.1	Base Structure
3.7	PRODUCT TESTING / FUNCTIONALITY TEST
4.1.1	General Product Features & Functionalities
4.2.1	Jig structure
5.2	RECOMMENDATION

MUHAMMAD HAIQAL QAYYUM BIN ZULKEFLI (24DTP22F1040)	
1.3.1	General Project Objectives
1.3.2.1	Product Structure and Furnishing
2.1	INTRODUCTION
2.2.2.2	Test jig
2.2.2.8	Hydraulic and Pneumatic welding fixtures
2.3.1	Types of Material for Product Structure
3.1.3	Material Sponsorship / Donation by NAMICOH SURIA SDN BHD (NSSB)
3.2.1	Gantt Chart Project 1
3.3.1	Work material
3.5.1	Proposed design
3.5.2	Assembly drawing of our product
3.5.3	Orthographic drawing of our product
3.5.5.1	Stopper / Head jig
3.5.5.2	Middle jig
3.6.1	Material Acquisition
4.1	INTRODUCTION
4.1.2	Product Overview
4.2.2	Operating time of saving up
4.3	LIST OF MATERIALS & EXPANDITURES
NUR SYAFIQAH BT MUSTAFA (24DTP22F1014)	
1.3.2.2	Mechanical and Design
1.5	EXPECTED OUTCOMES
2.2.2.4	Milling jig
2.2.2.5	Modular welding fixtures

APPENDIX B: TURNITIN SIMILARITY REPORT

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by Muven tdren

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NSSB
NAMICOH SURIA SDN BHD (1226680-M)

Lot 42558, 43559, 42560
Jalan 2C, Kampung Baru Subang
Seksyen U6, 40150 Shah Alam,
Tel: 03-7832 6474
Fax: 03-7832 6854

POLITEKNIK BANTING SELANGOR
PERSIARAN ILMU,
JALAN SULTAN ABDUL SAMAD,
42700 BANTING,
SELANGOR

DELIVERY ORDER
NSSB 24958

Date : 28.08.2024
Order No :
Term : NON BILLING

Please received the undermentioned goods in good order and condition by signing and returning the attached copy of the delivery order to us.

Item No.	Description Of Goods	Quantity
1	PLATE INNER LWR ARM	1 PCS
2	PLATE OUTER LWR ARM	1 PCS
3	TIUB LWR ARM	1 PCS
4	4 Lower Arm (L27 Left	1set

PIC
EN MUHAMAD SANI BIN BUANG
016 6682002

TRACEABLE NO	POLYBOX	IRON BOX	PALLET

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Category of Work	:	**FILM**
Date of Notification	:	**30 OCTOBER 2024**
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APPENDIX E: AEROMECH COMPETITION

We got 3rd place in the AEROMECH competition under DTP (Manufacturing engineering course) category