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MULTI-PURPOSE HYDRAULIC PULLER FOR UNDER-CHASSIS SERVICING

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Abstract

This applied research advances from conventional methods or procedures for disassembling components into a system that incorporates teaching and learning and offers an efficient tool for end-users. (1) The Multi-Purpose Hydraulic Puller for Under-Chassis Servicing was developed in response to the need to strengthen and enhance the pulling down of an automobile's under-chassis components, such as the steering wheel, tie rod, and ball joint. The study's primary objective is to create a piece of equipment that benefits end-users, especially automotive technology. Additionally, it sought to provide a unique device for under-chassis activities to minimize harm and error in that particular automotive system. The unstoppable technical advancements in steering, the under-chassis suspension system, and the vehicle as a whole prompted this. The prototype's fabrication and construction were made possible using locally sourced materials, equipment, and technical expertise. Between April and November 2020, the study was conducted at Bulacan State University's Bustos Campus's College of Industrial Technology. (2) The Multi-Purpose Hydraulic Puller for Underchassis Servicing is a solution tool to ease the students' hardness to pull down the steering wheel, tie rod, and ball joint when they perform wheel alignment. In the Under Chassis Steering and Suspension System, they will learn the actual scene of a problem and the proper way to pull down the underchasssis parts and correct the toe-in and toe-out, camber, and caster correction in the tires and wheel. The study is applied research innovating the conventional type steering wheel and suspension puller in convenience and a friendly tool for the users. (3) The MultiPurpose Hydraulic Puller for Under-Chassis Servicing received an overall computed mean of 4.66, translated verbally as "excellent." With the technical evaluations of the respondents in hand, it is reasonable to conclude that the Multi-Purpose Hydraulic Puller for Underchassis Servicing is of high quality in terms of functionality, workability, durability, safety, and instructional applicability. (4) Considering the objectives of the study and the technical evaluation of the respondents, it is concluded that the Multi-Purpose Hydraulic Puller for Underchassis Servicing has a high quality in terms of functionality, workability, durability, safety, and instructional applicability. The Multi-Purpose Hydraulic Puller for Underchassis Servicing is excellent. The Multi-Purpose Hydraulic Puller is recommended to be used as a teaching tool for faculty and students and a powerful power tool for local auto mechanics.

Keywords: Hydraulic, Instructional Materials, Multi-Purpose, Puller, Under-Chassis.

INTRODUCTION

An automobile is a self-propelled vehicle that travels on land. It usually has four wheels which carry people primarily for their transportation. Automotive vehicles are produced in various sizes and shapes, all having the same basic parts and systems (Womack et al., 2019). It has the underchassis unit, which has three components. These are the steering system, the suspension system, and the braking system. The underchassis also covered the chassis, which serves as the automobile's skeletal parts and makes that the steering, braking, and suspension system are attached properly and fixed without any movement (Ragaai, 2018). Most of the vehicles were designed with a steering system. These are used to manipulate cars in a different direction than the drivers want. The good quality steering system has good traction between the tire and the road. It will have a great effect if the system has troubles (Zhang et al., 2017). When the wheel's

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wheel alignment is incorrect, it affects the vehicle's driving ability, especially when it is at high speed. To make Pascal's law useful in practice, it was important to have a perfectly matched piston. It was not until the late eighteenth century that manufacturing snugly fitting parts that needed a hydraulic system was discovered. This was achieved through the invention of machines capable of cutting and shaping the necessary closely fitting components, most notably through the development of gaskets and packaging. Since then, components such as valves, pumps, actuating cylinders, and motors have been developed and improved to make hydraulics an efficient means of transmitting electricity (www.tpub.com). In this regard, Francisco Felizardo (2002) asserts that the under-chassis is a structure in an automobile that can cause driving problems if the components are not maintained properly. One thing is that if the under-chassis components are not properly maintained, uneven tire wear results. Accidents occur when safety precautions are not followed, faulty components are ignored, and the vehicle unit is overworked. It results in an accident for the drivers and operators of the vehicle unit; it results in injuries when the part is struck, particularly when the person involved is exhausted and working under an exhausted condition. A hydraulic cylinder is an indispensable unit of a hydraulic circuit responsible for converting hydraulic energy to mechanical energy. The cylinder serves as a connection between the hydraulic motor and the cylinder. The hydraulic motor performs rotary movements by performing translator (linear) movements by which forces are transferred (Wiley, 2009). Asserts that an iron alloy containing 0.2 percent to 2.1 percent carbon acts as a hardening agent. Apart from carbon, it includes a variety of other metals. Chromium, manganese, tungsten, and vanadium are among them. The mildest grade of carbon steel, or soft steel, is usually the variety with the least amount of carbon (0.05 percent - 0.26 percent) (Schmitt Vernonce, 2012). According to the research, Development of Hydro-Mechanical Valve Spring Remover, various arms and adaptors are used to isolate the brand of the other engine in either eight valves or the maximum number of valves the instructional system may use. This system is referred to as universal because it enables various engine brands to precisely close the valve, thus conserving energy and time (Morenos, 2011).

In line with this, this notes that the Hydraulic Coil Spring Compressor was developed and manufactured to assist automotive technology students in servicing and repairing faulty coil springs, shock absorbers, and spring seats on all light vehicles equipped with the Mc-person suspension system (Cabrera, 2010). Additionally, similar equipment was conceptualized in Javier's (2012) analysis. The Hydraulic Tie-rod Remover would be extremely beneficial to Automotive Instructors and Students alike. The simple machine will expedite the removal of a damaged tie-rod from the car. As with the hydraulic tie-rod remover, this proposed Multi-Purpose Hydraulic Puller for Underchassis Servicing would be extremely beneficial to Automotive Instructors and Students, as well as to students enrolled in Automotive Servicing NC II, and finally, to automotive technicians in the community, in terms of wheel alignment correction and avoiding the forcing and damage of the u-joint. Lake Area Technical College is a member of Skills USA, a national association that serves students studying trade, manufacturing, technical, and health professions in high school and post-secondary technical institutes. Skills USA's goal is to enhance the quality of America's qualified workforce by implementing a comprehensive curriculum of citizenship, leadership, employability, and

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technical and professional skills training. Each year, Automotive Technology students will compete at the program and state levels. The curriculum builds on students' skills in a class by encouraging participation in program related clubs and funded activities. This engagement benefits both the students' learning experience and their community service experience by allowing them to network with peers at local, state, and national skills competitions, share their expertise within our community at program-sponsored events such as the car care inspection event and car show, volunteer valuable community service hours to local causes in need, and contribute to local charities with monetary contributions.

The Multipurpose Hydraulic Puller for Under-Chassis Servicing is an instructional device and an efficient tool for the community's backyard automotive shop. This is beneficial for them, making it easier to remove parts, especially when servicing under-chassis defective components. The Automotive Technology Instructor imparts their abilities, experience, and expertise on the under-chassis system and its components to the learners. They conducted practices conducive to removing damaged parts using a hydraulic puller, as they are practitioners in automotive technology. When an automobile mechanic is on duty, the Multi-Purpose Hydraulic Puller is a useful tool. Assume they are assigned to perform underchassis servicing and are instructed to pulldown, remove the parts immediately, and avoid making errors that might damage other components. The Multi-Purpose Hydraulic Puller also addresses the proposal for an extension service to establish a campus-based Automotive Service Center that promotes various automotive services, especially in the under-chassis. It provides an alternative revenue stream for the university and enables the group and students to exchange work as auto mechanics. The primary service provided is Underchassis Servicing, which involves using the unit. This will assist alumni and in-plant trainees in pursuing opportunities to work, improve their skills, and represent their school simultaneously. On the other side, the under-chassis puller may assist the community by extension services such as Basic Automotive Services Training offered at the Bustos Campus. They intended to establish their own company and pursue an auto mechanic career locally or abroad as a means to a successful life after the course. The under-chassis device's other extended assistance is to agree with local automotive shops to use the developed device in their under-chassis services to assist in the assembly and disassembly of system component pieces. The technological use of the hydraulic system is to drive the device. Compared to conventional type steering and suspension puller, it uses a mechanical puller that tightens and loosens the tools. The manipulation of the hydraulic system may result in more convenient use and a minimized wear and tear components.

Objectives of the Study General Objectives:

The general objective of the study is to design and develop Multi-purpose Hydraulic Puller for Underchassis Servicing. It’s an instructional tool to be used by the faculty and students of the Automotive Technology department of the Bulacan State University of Bustos Campus. Hence, it also serves the students taking the Assessment in Automotive Servicing NC II and the Automotive Technician near the community.

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Specific Objectives:

Specifically, the researcher:

1. Design and develop an innovative Multi-Purpose Hydraulic Puller for Underchassis Servicing.
2. Test the performance of the Instructional device.
3. Evaluate the performance of the device in terms of functionality, workability, durability, safety, and instructional applicability.

CONCEPTUAL FRAMEWORK

Based on the foregoing concepts, ideas, theories, and findings of related literature, studies presented, and insights taken from them, a conceptual model was made, which is shown in Fig. 1.

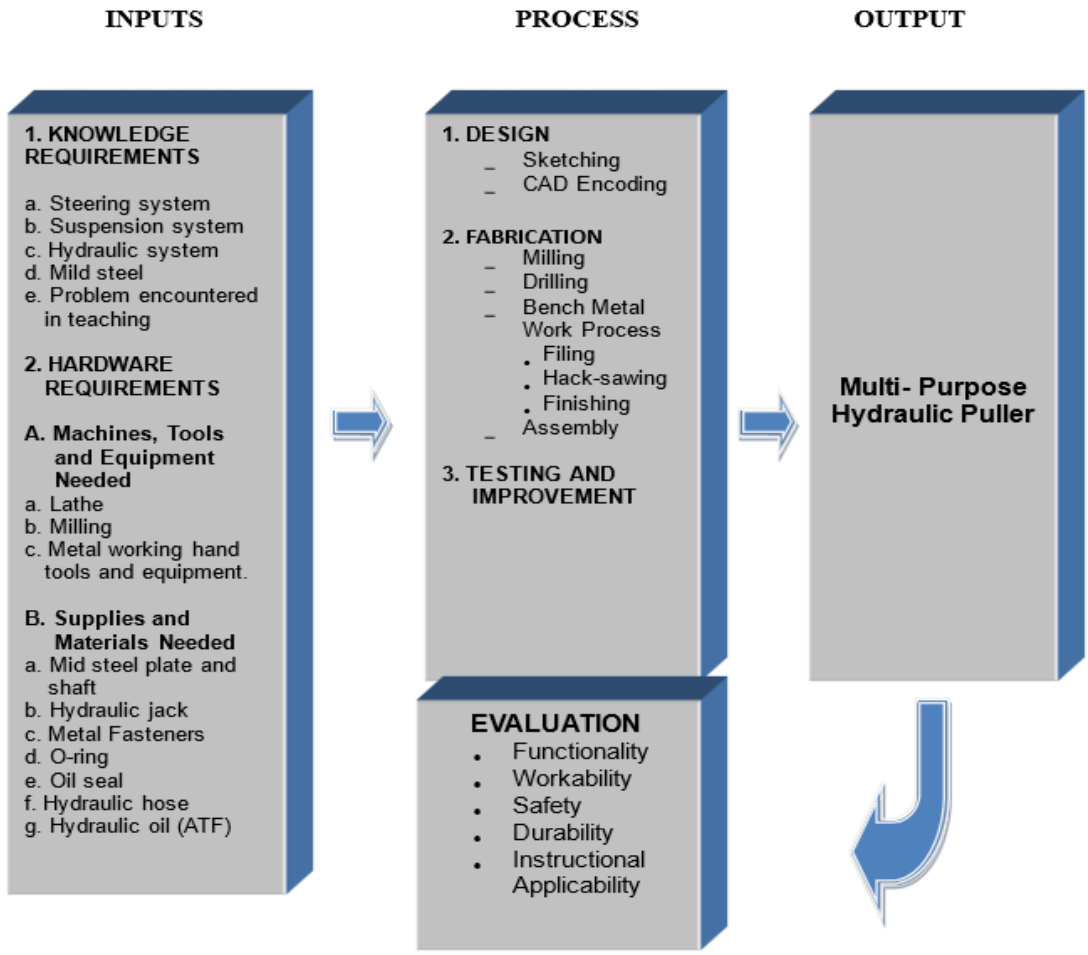

Fig 1: Conceptual Framework

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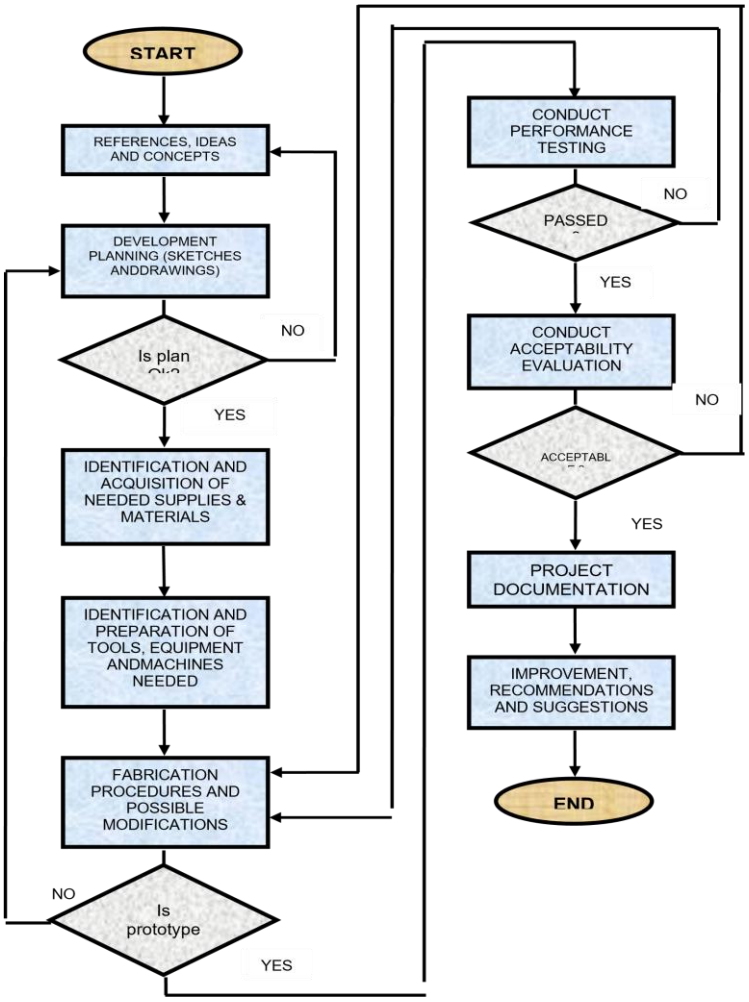
In all the sequences, testing and evaluation were given attention, especially the output relationship to the hydraulic project's basic principles and theories. Furthermore, the evaluation process was conducted utilizing the standard format for prototype evaluation adapted by the Bulacan State University Bustos Campus, College of Industrial Technology.

RESEARCH METHODOLOGY

The Multi-Purpose Hydraulic Puller for Underchassis Servicing is a solution tool to ease the students' hardness to pull down the steering wheel, tie rod, and ball joint when they perform wheel alignment. In the Under chassis Steering and Suspension System, they will learn the actual scene of a problem and the proper way to pull down the underchasssis parts and correct the toe-in and toe-out, camber, and caster correction in the tires and wheel. The study is applied research innovating the conventional type steering wheel and suspension puller in convenience and a friendly tool for the users.

Project Development Flowchart



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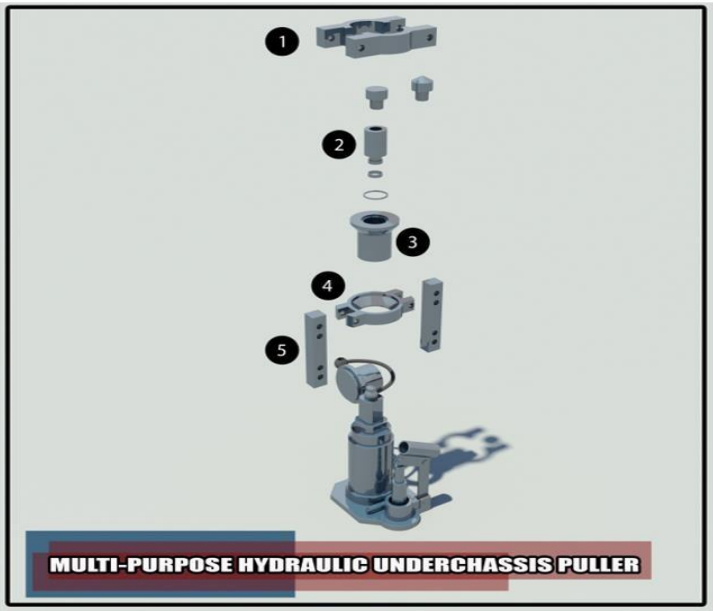

Fig 2: Multi-Purpose Hydraulic Puller for Underchassis Hydraulic Steering Wheel Puller Parts

Where:

1) Puller Block
2) Revolving Screw
3) Piston Assembly
4) Wheel Cup
5) O-ring
6) Cylinder
7) Cylinder Base Holder
8) Arms
9) Flexible Hose
10) Pressure gauge
11) Hydraulic Pump

Reserved Parts for Tie – Rod Puller

1) Lock Guide
2) Arm Claws
3) Revolving Screw

Reserved Parts for Ball Joint Puller

1) Cup Holder Assembly
2) Arm Flat design
3) Revolving Cup

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Fig 3: Multi-Purpose Hydraulic Underchassis Puller

Multi-Purpose Hydraulic Underchassis Puller Parts

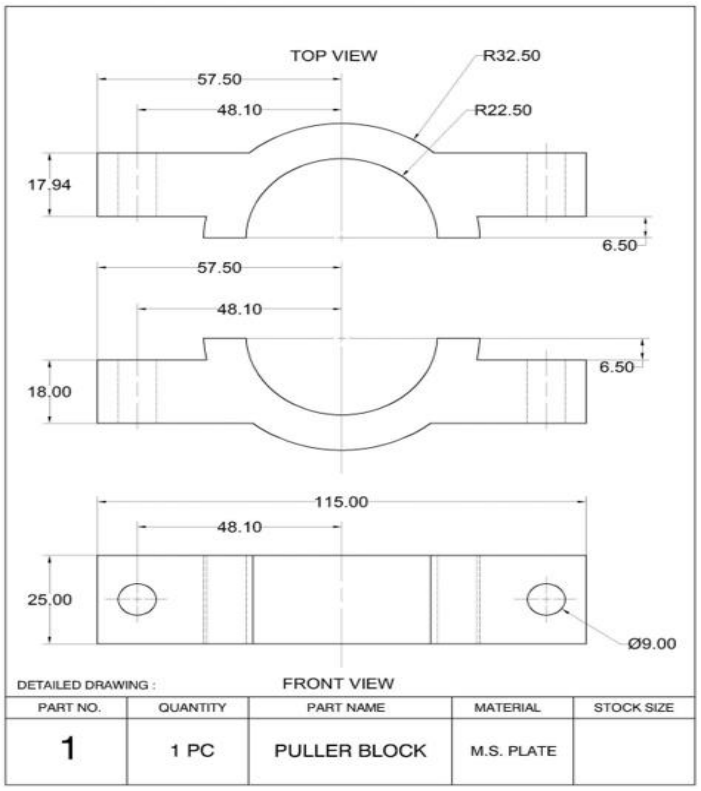

Fig 4: Puller Block

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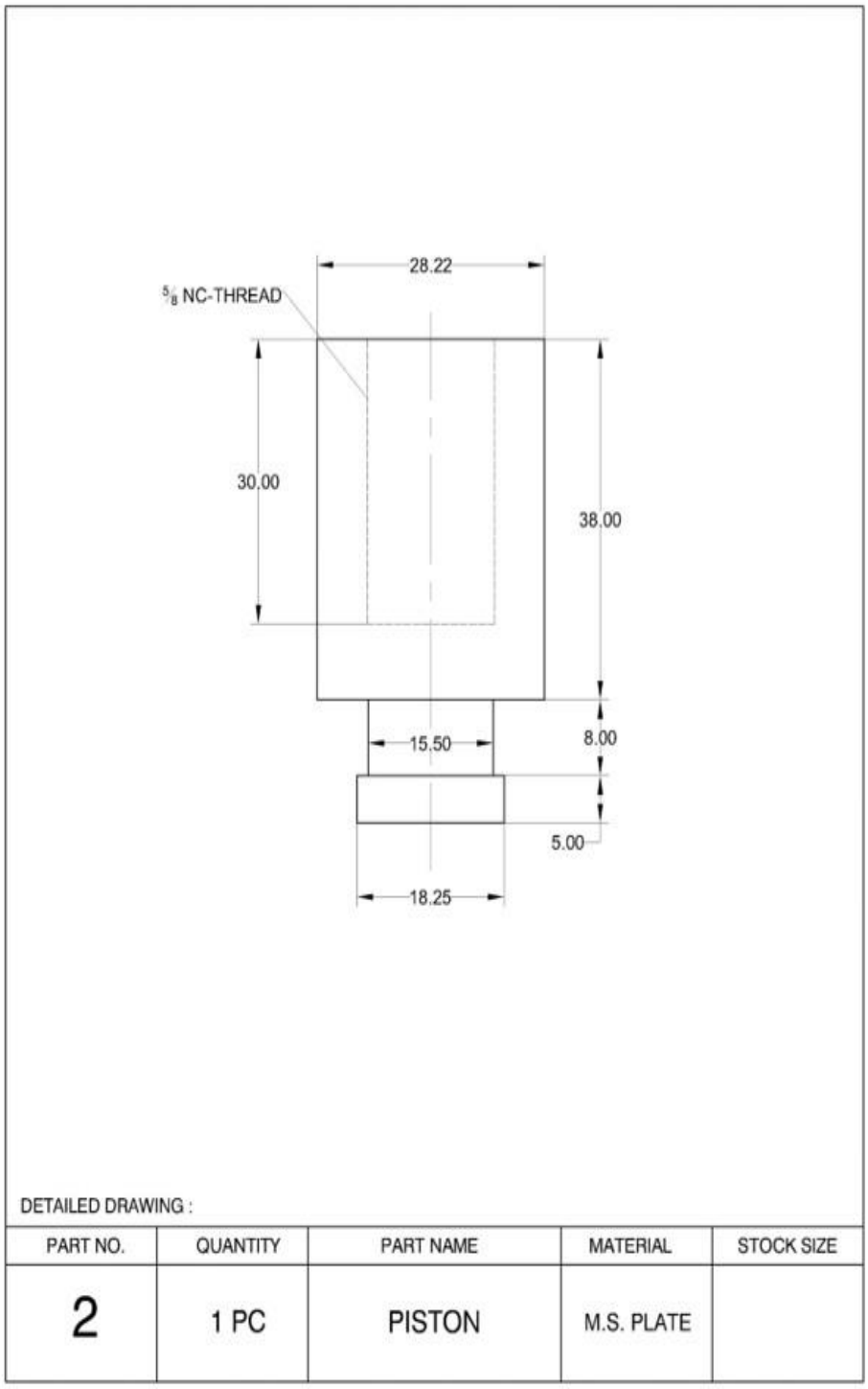

PART NO.	QUANTITY	PART NAME	MATERIAL	STOCK SIZE
2	1 PC	PISTON	M.S. PLATE	

Fig 5: Piston Assembly

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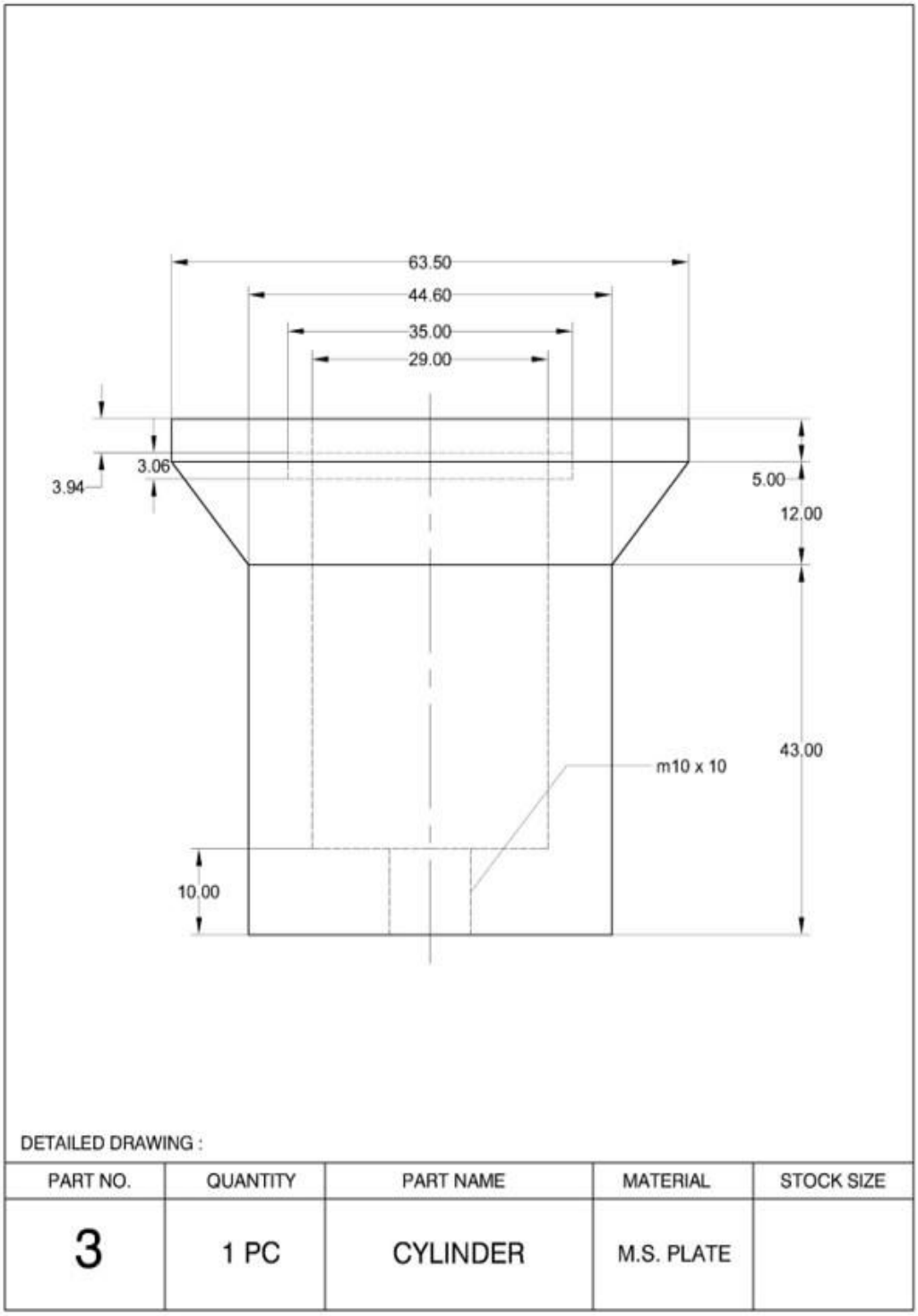

Fig 6: Cylinder Assembly

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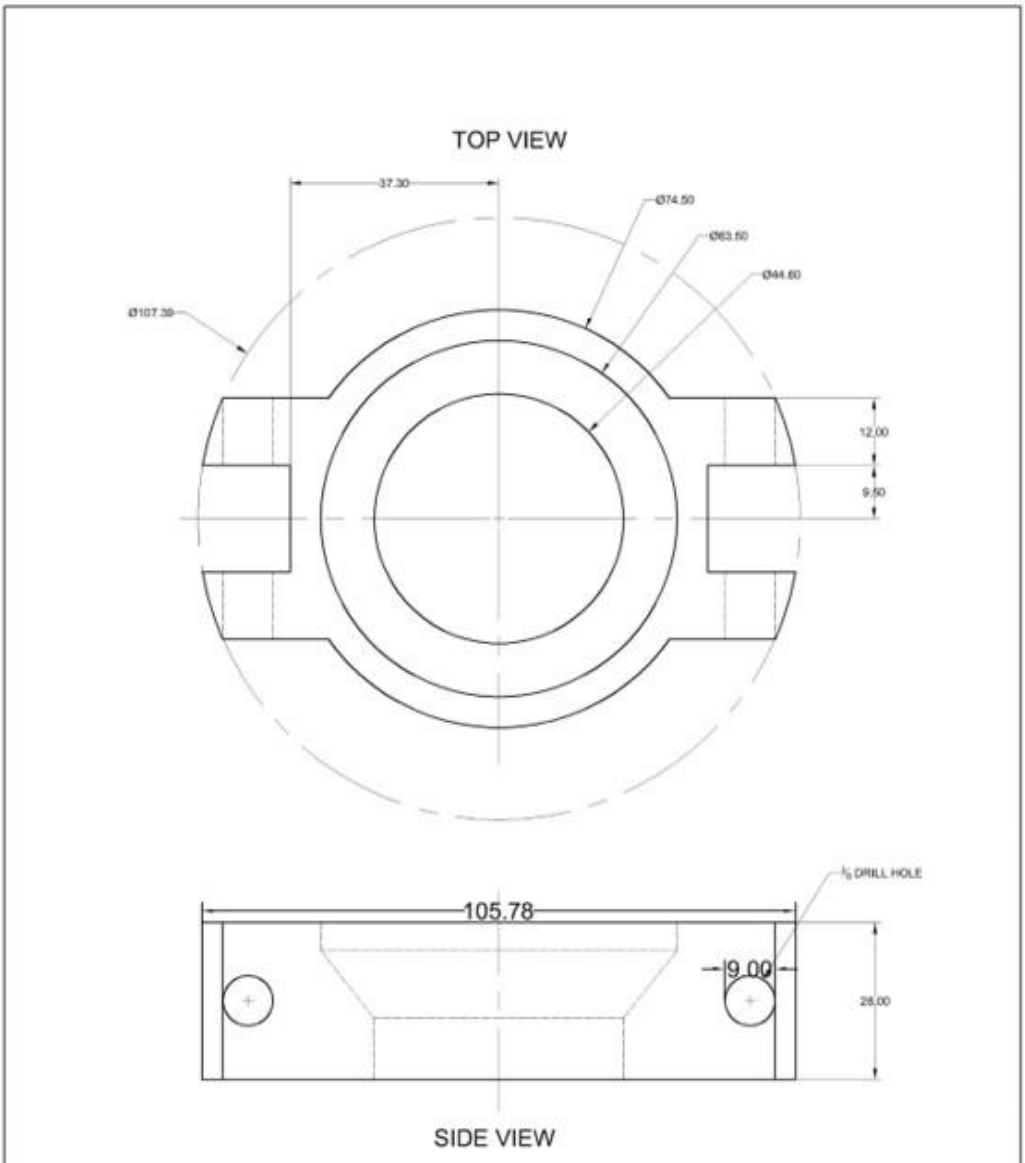

PART NO.	QUANTITY	PART NAME	MATERIAL	STOCK SIZE
4	1 PC	CYLINDER HOLDER	M.S. PLATE	

Fig 7: Cylinder Holder

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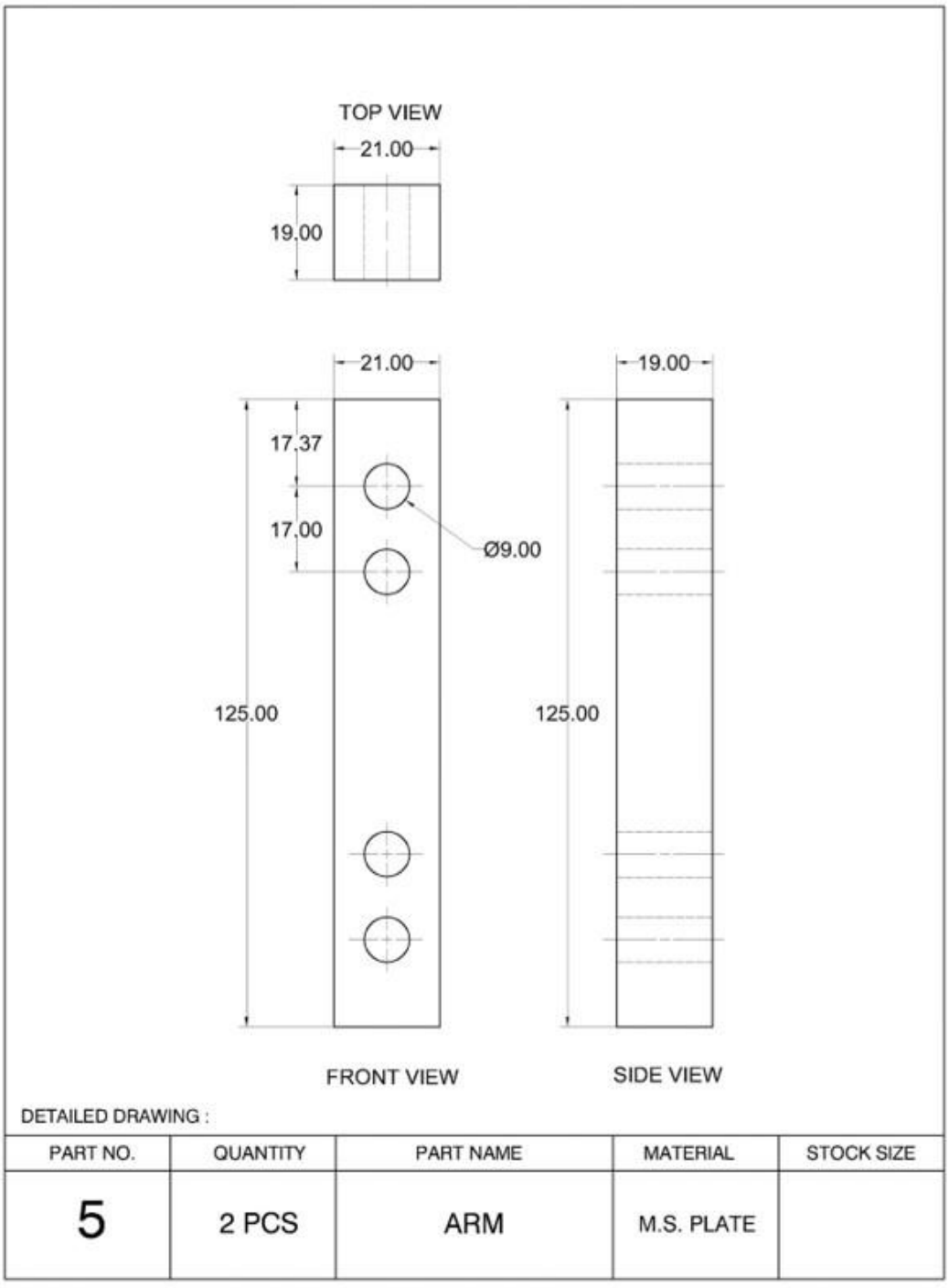

Fig 8: Arm

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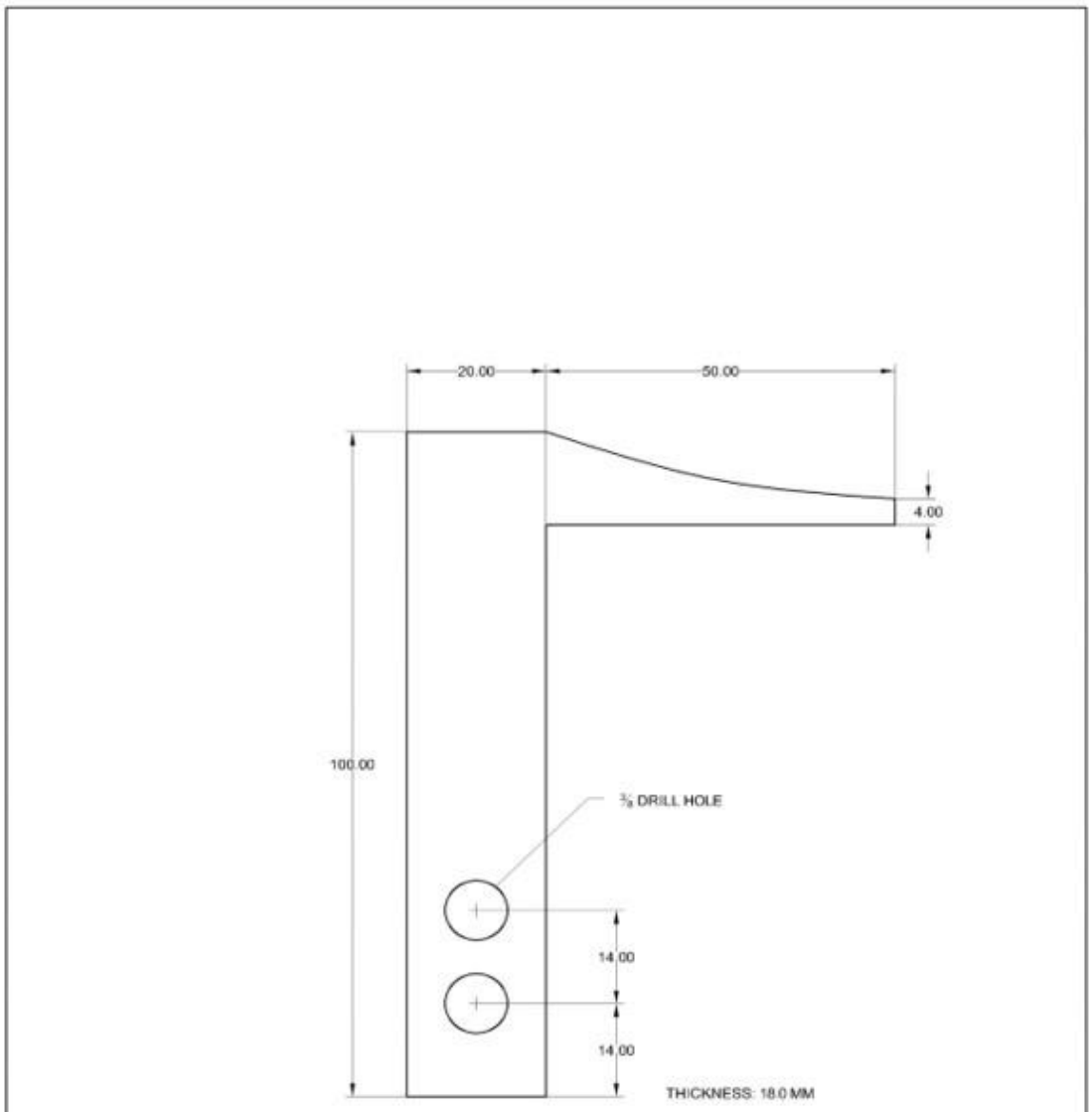

Fig 9: Arm Claw

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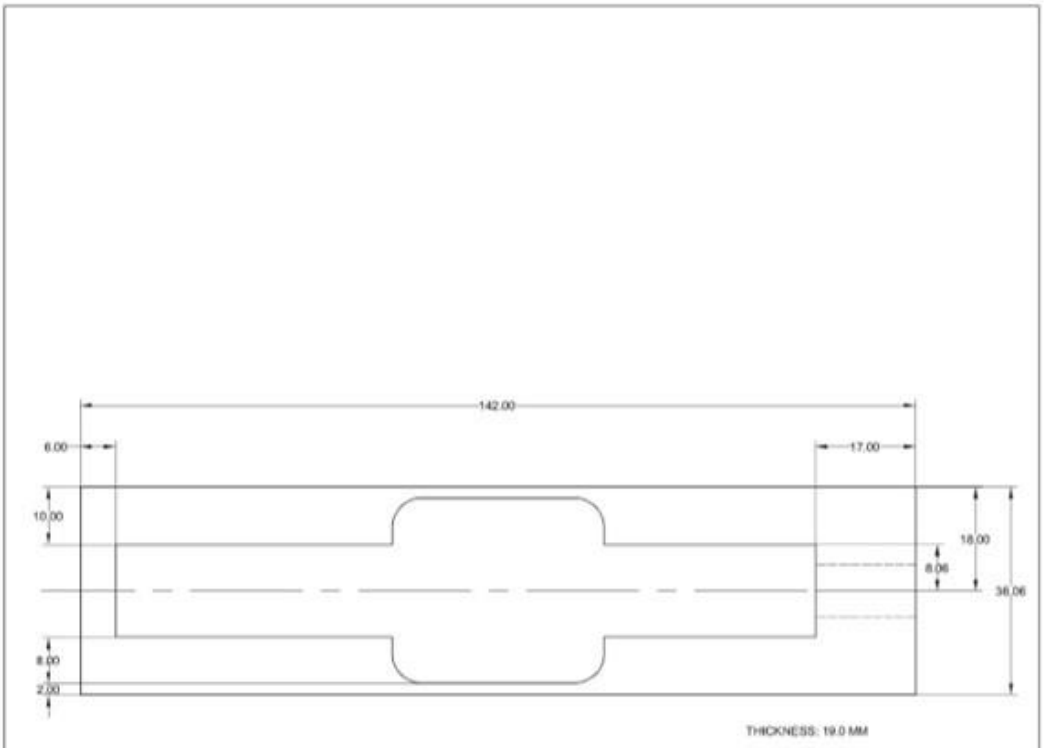

DETAILED DRAWING :

PART NO.	QUANTITY	PART NAME	MATERIAL	STOCK SIZE
7	1 PC	LOCK GUIDE HOLDER	M.S. PLATE	

Fig 10: Lock Guide Holder

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PROJECT DEVELOPMENT

Fabrication Procedure of Multi-Purpose Hydraulic Puller for Underchassis Servicing:

The foreseen step by step accounts in the fabrication of the Multi-Purpose Hydraulic Puller for Underchassis Servicing is presented as follows:

1) Planning and designing must be the first step to achieve the goal of the study.
2) Preparation of the tools in making an instructional device.
3) The project has three major parts, the puller block, the Revolving Screw, and the Piston and Cylinder.
4) The Multi-purpose Hydraulic Puller has a hydraulic pump using 2 tons hydraulic jack that converts and makes it a puller's hydraulic pump.
5) In assembling the major parts of the project, the following procedures are as follows:
   - 5.1 Cut one piece of plate steel (25 mm) thick by using oxy acetylene
   - 5.2 Layout the arms of the hook arm (25 mm x 150 mm) on metal plates and cut them by using oxy-acetylene.
   - 5.3 Place the plates vertically on the hooks by using nuts and bolts.
   - 5.4 Prepare the cylinder (25 mm x 50 mm) of the improvised hydraulic steering wheel puller by drilling 3 mm diameter inside the shafting using boring tools such as the drill bit where the piston will be placed inside later on.
   - 5.5 Prepare the piston (25 mm x 50 mm) that will be placed inside the cylinder. Using the lathe machine will rephrase the shafting.
   - 5.6 In between the hydraulic pump and the cylinder assembly line that delivered the hydraulic oil from the pump to the cylinder, the hydraulic hose has 8 feet and 225 bar or 2000 psi. This hydraulic hose is tightened between the hydraulic pump and the cylinder assembly.
   - 5.7 In the cylinder, on top of the piston, place the puller block (150 mm x 150 mm), rebored using boring tools. One hole of the plate will be fastened on the puller block, and the other hole will be fastened on the arms by using nuts and bolts.
   - 5.8 With the lathe machine, bore the cylinder with a 5/8” drill bit or 5/16” drill bit.
   - 5.9 In installing a hydraulic gauge, buy or make an adaptor that is fitted on the instructional device. This is place in between the pump and the hydraulic hose.

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Fabrication Procedure of the Tie Rod Puller upper parts:

1) The upper parts have three major parts, the Hook or claws, the revolving screw, the piston, and cylinder.
2) In assembling the parts of the project, the following procedures are as follows:
   2.1 Cut one piece of plate 25mm thick by using oxy-acetylene.
   2.2 Layout the hook arm's arms (25mm x150mm) on metal plates cut them by using oxyacetylene.
   2.3 Place the plates vertically on the hooks by using nuts and bolts.
3) In the cylinder, on top of the piston, place the revolving holder (25mm x 50mm), rebored using boring tools. One hole of the plate will be fastened on the revolving holder, and the other hole will be fastened on the arms of the claws by using nuts and bolts.
4) The use of lathe machine bore the piston inside so that an adjusting screw with the size of 3/16" in diameter would fit inside it. This will serve as an adjuster.
5) The adjustment screw will be covered with a screw protector with a size of 9/16" diameter. Inside the screw, the protector is the engineering plastic that will secure the tie rod's thread from damage or losing its contour.

Fabrication Procedures of Ball Joint Puller the Upper Parts

1) In making the arm, cut 2 pcs of flat bar (304mm x 21mm) using Oxy-acetylene.
2) Using a drill press, drill 18 holes on a flat bar (5/16" diameter).
3) Layout the cup and the cylinder holder with the arm holder.
4) Using a drill press, drill eight holes on the arm holder (5/16" diameter).
5) Place the cup holder and cylinder holder on both ends of the arm by using bolts and nuts.
6) For the receiver cup, cut the black iron pipe with the size of (105.8m long) x (49.5 mm in Di, 57.2mm Do) and for installer cup, cut with the size of (76.7mm long) x 40.6mm Di, 48.3mm Do.) by using machine saw.
7) Using a grinder, grind the sharp, excess, or unwanted parts of the project to have the desired shape and smoothen the surface.

Cost of Development

The costs incurred in the development and fabrication of the multi-purpose hydraulic puller for underchassis servicing are based on the availability of materials. The cost of the materials is based on its current price in the local market. The itemized cost of materials, labor, and other miscellaneous is hereby presented:

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Table 1: Materials and labor cost in the development of the prototype

Item No.	QTY.	Unit	Specifications	Unit Price	Total Price
1	1	Assy	Hydraulic jack 2 tons	100	100
1	1	Pc	Flexible Hose 8 ft 2000 psi	850	850
4	4	Pcs	3/8" x 2 ½" high tensile bolts and nuts	32	32
1	1	Pc	Shafting Mild Steel 1 ¼ "	73	73
1	1	Pc	Shafting Mild Steel 2 ½"	340	340
2	2	Pcs	Fitted nut	90	90
4	4	Pc	Plate 1" Thick	220	880
1	1	Pc	O – ring	10	10
4	4	Pcs	Copper washer	40	40
3	3	Pcs	Black iron pipe	400	400
1	1	Pc	Carbon Round Steel	100	100
			Total Bill of Materials		3369
			Total Labor Cost		4,000.00
			Total Project Cost		8,029.00 Php

Time Element Involved in Development

The time spent in the conceptualization, fabrication, and evaluation of the project was done ten weeks. It includes the revisions and modifications of the project as it was subjected

Table 2: Time Consumed in the Development of the Study

Conceptualization and Planning	2 weeks
Acquisition of Materials	2 weeks
Preparation of Materials	1week
Machining and Cutting	2 weeks
Finishing Touches	1 week
Assembly	1 week
Demonstration (chapters 1-3)	1 week
Total No. of Weeks	10 weeks

Evaluators

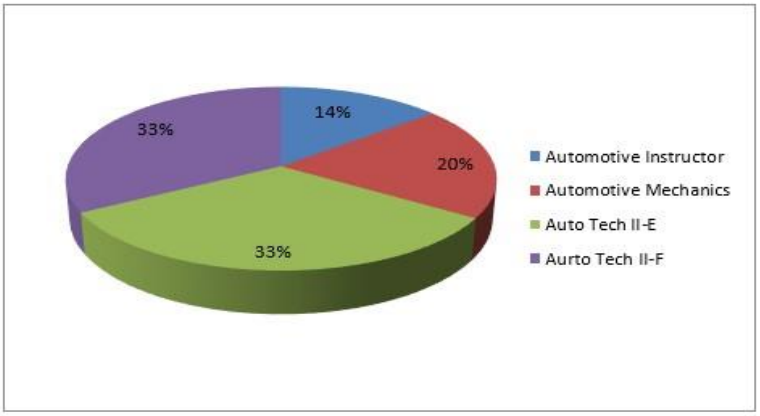

Fig 11: Respondents of the Study

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Fig. 11 illustrates the frequency and percentage distribution of respondents' profiles in terms of specialization. It reveals that most of the respondents are from Automotive Technology II-E, with ten (10) or 33% of the total respondents. The Automotive Technology II-F has ten (10) or 33% of total respondents, and the Automotive Mechanics has six (6) or 20%. The last respondents, automotive instructors, have four (4) or 14% of total respondents.

Research Instrument

The evaluation shall be conducted through a survey, using the qualitative analysis method of determining the project's acceptability. In the process, a survey on the functionality, workability, durability, safety, and instructional applicability of the device was solicited based on the format of the evaluation criteria for the prototype adapted by the College of Industrial Technology. Only the ones related to the prototype were used to keep a more concrete and definite evaluation outcome. Each criterion is determined by a set of three indicators rated on a Likert-scale of 1 to 5, where 1 is the lowest and 5 is the highest.

Data Processing and Statistical Treatment

After the evaluation, the results shall be tabulated and interpreted. The mean was used to determine the level of acceptability of the project. The interpretation of the mean score is listed below.

Weighted Mean	Descriptive equivalent
4.21 – 5.00	Excellent
3.41 – 4.20	Very Good
2.61 – 3.40	Good
1.81 – 2.60	Fair
1.00 – 1.80	Needs Improvement

RESULTS AND DISCUSSION

Table 3: The Respondent's Computed Mean in the Quality of the Multi-Purpose Hydraulic Puller for Underchassis Servicing in Tie Rod

Indicators	Faculty	Auto Mechanic	Students	Mean	Interpretation
A. Functionality					
1) Ease of Use	5.00	5.00	4.55	**4.85**	Excellent
2) Speed of hydraulic device operation	4.50	5.00	4.80	**4.76**	Excellent
3) Efficiency of power consumption	5.00	4.83	4.75	**4.86**	Excellent
4) Sub Mean	4.83	4.94	4.7	**4.82**	Excellent
B. Workability					
1) Availability of Materials	4.75	5.00	4.75	**4.83**	Excellent
2) Availability of technical expertise	5.00	5.00	4.90	**4.96**	Excellent
3) Availability of tools and machine for the fabrication works	4.75	5.00	4.90	**4.88**	Excellent
Sub Mean	4.83	5	4.85	**4.89**	Excellent
C. Durability					
1) Quality of materials	4.75	4.66	4.70	**4.70**	Excellent

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2) Appropriateness of size and design	4.75	4.83	4.70	**4.76**	Excellent
3) Resistance to stress and deformation	4.75	4.83	4.75	**4.77**	Excellent
Sub Mean	4.75	4.77	4.71	**4.74**	Excellent
D. Safety					
1) Absence of toxic/hazardous materials	4.75	4.83	4.80	**4.79**	Excellent
2) Provision of protection devices	5.00	4.50	4.85	**4.78**	Excellent
3) Absence of sharp edges	5.00	4.66	4.75	**4.80**	Excellent
Sub Mean	4.91	4.66	4.8	**4.79**	Excellent
E. Instructional Applicability					
1) Improvement and skills in servicing automotive underchassis steering and suspension system (psychomotor)	4.75	4.83	4.75	**4.77**	Excellent
2) Enhancement of knowledge and information transfer in the automotive underchassis steering and suspension system (cognitive)	5.00	4.66	4.90	**4.85**	Excellent
3) Reinforcement of student enthusiasm and interest in automotive underchassis steering and suspension system (affective)	4.75	5.00	4.85	**4.86**	Excellent
Sub Mean	4.83	4.83	4.83	**4.83**	Excellent
GRAND MEAN	**4.83**	**4.84**	**4.78**	**4.81**	**Excellent**

Table 3 shows the respondent's computed mean in the quality of the Multi-Purpose Hydraulic Puller for Underchassis Servicing in Tie Rod. The respondents' opinion of the tie rod's computed grand mean regarding functionality, workability, durability, safety, and instructional applicability was 4.81, which were verbally interpreted as *"excellent*."

In the study of Javier (2004), similar equipment was conceptualized. Hydraulic Tie-rod Remover was of great help to the Automotive Instructors, and the Students as well for reasons like the simple machine hasten the removal of a broken tie-rod from the vehicle.

Table 4: The Respondent's Computed Mean in the Quality of the Multi-Purpose Hydraulic Puller for Underchassis Servicing in Ball Joint

Indicators	Faculty	Auto Mechanic	Students	Mean	Interpretation
A. Functionality					
1) Ease of Use	4.75	4.50	4.60	**4.61**	Excellent
2) Speed of hydraulic device operation	4.50	4.50	4.60	**4.53**	Excellent
3) Efficiency of power consumption	5.00	4.33	4.85	**4.72**	Excellent
Sub Mean	4.75	4.44	4.68	**4.62**	Excellent
B. Workability					
1) Availability of Materials	4.75	4.83	4.90	**4.82**	Excellent
2) Availability of technical expertise	5.00	4.83	4.85	**4.89**	Excellent
3) Availability of tools and machine for the fabrication works	4.75	4.83	4.95	**4.84**	Excellent

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Sub Mean	4.83	4.83	4.9	**4.85**	Excellent
C. Durability					
1) Quality of materials	4.75	4.66	4.90	**4.77**	Excellent
2) Appropriateness of size and design	4.50	4.66	4.80	**4.65**	Excellent
3) Resistance to stress and deformation	4.75	4.66	4.80	**4.73**	Excellent
Sub Mean	4.66	4.66	4.83	**4.72**	Excellent
D. Safety					
1) Absence of toxic/ hazardous materials	4.75	4.66	4.85	**4.75**	Excellent
2) Provision of protection devices	5.00	4.50	4.85	**4.78**	Excellent
3) Absence of sharp edges	5.00	4.66	4.70	**4.78**	Excellent
Sub Mean	4.91	4.60	4.8	**4.77**	Excellent
E. Instructional Applicability					
1) Improvement and skills in servicing automotive underchassis steering and suspension system (psychomotor)	4.75	4.50	4.85	**4.7**	Excellent
2) Enhancement of knowledge and information transfer in the automotive underchassis steering and suspension system (cognitive)	5.00	4.83	4.85	**4.89**	Excellent
3) Reinforcement of student enthusiasm and interest in automotive underchassis steering and suspension system (affective)	4.75	4.83	4.85	**4.81**	Excellent
Sub Mean	4.83	4.72	4.85	**4.80**	Excellent
Grand Mean	**4.8**	**4.65**	**4.81**	**4.75**	**Excellent**

Table 4 shows the respondent's computed mean in the quality of the Multi-Purpose Hydraulic Puller for Underchassis Servicing in Ball Joint. The opinion of the respondents to the computed grand mean of the ball joint with regards to functionality, workability, durability, safety, and instructional applicability was 4.75, which were verbally interpreted as *"excellent*."

As supported by the study of Samuel (2000), the proposed Multi-Purpose Hydraulic Puller for Underchassis Servicing ensures the underchassis component parts' safety, which is a very important part of the automobile unit in under chassis steering and suspension system. It leaves the steering wheel, tie rod, ball joint, and rubber bushing free from any form of damage resulting from hammering or forcing it out from the assembly by using the traditional method.

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Table 5: The Summary of the Respondent's Computed Mean of the Quality of the Multi-Purpose Hydraulic Puller for Underchassis Servicing

Indicators	Faculty	Auto mechanic	Students	Mean	Interpretation
Steering Wheel	4.38	4.26	4.68	4.44	Excellent
Tie Rod	4.83	4.84	4.78	4.81	Excellent
Ball Joint	4.80	4.65	4.81	4.75	Excellent
Over-all Mean	**4.67**	**4.58**	**4.75**	**4.66**	**Excellent**

Summary results of the evaluation conducted (Table 5) showed the respondent's computed overall mean of the Multi-Purpose Hydraulic Puller for Underchassis Servicing was 4.66, which were verbally interpreted as *"excellent*." The Multi-Purpose Hydraulic Puller for Underchassis Servicing has a high quality in functionality, workability, durability, safety, and instructional applicability. In Grandall's (2010) study, the Performance and Efficiency Pumps and Motors, hydraulic pumps and motors are almost exclusively positive displacement devices. They use a moving boundary to trap a fluid packet and then force the fluid into the outlet. Unfortunately, hydraulic pumps and motors have many leakage paths from high pressure to low pressure, so a significant amount of energy is lost to leakage. This loss is known as the volumetric loss. Hydraulic pumps and motors are also mechanical devices, with many moving parts operating at high loads. Consequently, friction develops between the many moving parts, despite hydrodynamic lubrication between many of those parts. This loss is known as mechanical or torque loss.

CONCLUSIONS

Considering the objectives of the study and the technical evaluation of the respondents, it is concluded that the Multi-Purpose Hydraulic Puller for Underchassis Servicing has a high quality in terms of functionality, workability, durability, safety, and instructional applicability. The Multi-Purpose Hydraulic Puller for Underchassis Servicing is excellent.

RECOMMENDATIONS

In light of the foregoing conclusion, the researcher recommends utilizing safety in the end-user, making it handy for travel purposes, improving the base of the project to large diameter for it to operate in a good performance, limiting only in lightweight automobile unit, assembling the pump into a more stable and in higher tons required to avoid a fluid leak and damaged its internal part, and producing different adaptors to pulldown other brands of automobile.

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