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Development of Vertical Quadrant Auto-electrical Mock-up

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ABSTRACT

The project will focus on the development of an auto electrical mock –up that can save space and accommodate more trainees to perform/practice at the same time. Additionally, the proposed mock-up will have more functional features than the conventional auto electrical mock-up. It also has wheels/rollers for easier transfer from one place to another without carrying the prototype. The main objective of the project is to develop a prototype that would benefit the students involved in the field of Automotive Servicing specifically, the study shall seek to: design a prototype that could also be utilized as an automotive instructional trainer for charging, starting and ignition system; construct the prototype according to design and specification; test the performance of the prototype in accordance to its design parameters and operational limitations; and determine the acceptability of the prototype in terms of its functionality, aesthetic, workability, durability, safety and instructional applicability.

Keywords: *Development, Vertical Quadrant Auto-electrical Mock-up*

INTRODUCTION

Education achieved through learning and learning is easy with the help of instructional materials. With these mock-ups, students may get a better understanding on how the principles and applications of learning are being done. In relation to this, the researcher will introduce the vertical quadrant auto-electrical mock-up that is very useful in automotive servicing. One of the identified problems that led to the study of vertical quadrant auto-electrical mock-up Was the conventional auto electrical mock-up which can only accommodate one person to perform and/or practice.

Furthermore, the researcher also found out that moving to the front and rear part of the mock-up to check the wiring connection is also a hassle. However, the vertical quadrant auto-electrical mock-up is a lot more comfortable to work on, there is no need for a wide space, because the size is one square meter only.

Moreover, it is also equipped with rollers/wheels for easier mobility and it can accommodate four person at the same time to perform electrical wirings, it has with individual test lamp with test lamp polarity selector switch for a hassle-free connections, equipped with battery charging terminal without removing the battery from its tray to charge battery outside and more importantly, it has a battery source power switch to turn ON/OFF the electrical/electronic unit/assemblies at the same time and it could be emergency shutdown in case of electrical fault occur as per requirements for it safety use. The development of the project in some aspects runs parallel with studies conducted by various researchers in different fields of specialization.

Singueo (2017) developed the Automotive Ignition System Trainer for automotive instructional devices that helps automotive students enhance their learning experience. The Automotive Ignition System Trainer uses a battery as the source of current and ignition system components same as with the prototype using a battery for the auto-electrical system components. The Automotive Ignition System Trainer was driven by the hand to produce the spark-ignition while the prototype is operated by an automotive battery to activate the wiring/lighting system.

Andaya (2002), a chairman of the researcher at the Isabela State University-Ilagan City Campus, constructed an “AC Machine Circuit Trainer” for electrical instructional devices that helps the electrical students gain a deeper understanding on how electrical devices works. The AC Machine Circuit Trainer uses an electrical wiring diagram for the circuit components likewise with the Alternator Tester/Trainer using an electrical diagram for the electrical component. The AC Machine Circuit Trainer uses an Alternating Current (AC) wire for a rigid use for household as well as to the industrial purposes with high voltage needs while the prototype uses an automotive wire for Direct Current (DC) with low voltage usage powered by an automotive battery. It also determines the functionality of the auto-electrical/electronic unit/assemblies.

METHODOLOGY

The proposed plan and necessary procedure and steps needed in the construction, the evaluation method, tools and equipment to be used, the estimated time and cost to be consumed for the fabrication and testing of the project are included in this chapter. The Vertical Quadrant Auto-electrical Mock-up will be developed and fabricated out of locally available parts and materials. This instructional device will be used by the students and instructors to hasten the time and labor cost. The proposed project will compose of frame assembly, auto electrical system charging unit and lighting system. The safety and comfort of the user will be given emphasis.

Table 1
List of materials and cost

Line Budget Items				
G.I. sheet (gauge #16)	1	PC	₱800	₱800
Angular bar (3/16X1 in.)	4	PCS	₱450	₱1,800
Horn (12V)	4	SETS	₱350	₱1,400
Park light (12V)	4	SETS	₱550	₱2,200
Head light (12V)	4	SETS	₱600	₱2,400
Ammeter Gauge	4	PCS	₱350	₱1,400
Fuse box	4	PCS	₱250	₱1,000
Flasher relay (12V)	4	PCS	₱550	₱2,200
Stoplight Switch	4	PCS	₱300	₱1,200
Steering Wheel Assembly	4	PCS	₱1800	₱7,200
Bosch relay (12V)	32	PCS	₱350	₱11,200
Tail light	4	SETS	₱560	₱2,240

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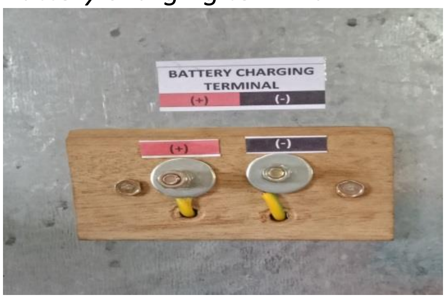
Line Budget Items				
Automotive wires (gauge #18)	2	ROLLS	₱580	₱1,160
Rollers	4	PCS	₱460	₱1,840
Paint	1	LITER	₱260	₱280
Electrical tape (big)	4	PCS	₱180	₱720
Automotive Battery (12V) 3 SMF	1	PC	₱5,600	₱5,600
Total				₱44,640

Figure 1

Prospective view of vertical quadrant auto-electrical mock-up

Figure 2

Battery charging terminal



The battery charging terminal serves as a charging port for the battery without removing it from the tray. It is easier to recharge the battery without carrying it out and sending it to the charging station. It also prolongs the life of the battery post from connecting and disconnecting the battery clamp.

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Figure 3

Battery source power switch

The battery source power switch is use to supply and disconnect current to the electrical system, at the same time it could also be used as emergency shutdown switch for any electrical failure that occurs to ensure the safeness of the prototype as well as the learners itself

Figure 4

Test lamp polarity selector switch

The test lamp polarity selector switch is a hassle –free switch in which the learners may choose the polarity connection of the test lamp at a glance without directing it to the battery terminal pole.

Figure 5

Test lamp

The test lamp is attached to the steering column for accessible use, each steering assembly is equipped with individual test lamp ready to use

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Figure 6
Rollers/wheels

The rollers/wheels are effective for the mobility of the prototype, it is easier to transport the prototype at any place with the help of these rollers/wheels without carrying a heavy load. It is also easy to steer at any direction with this pivot motion of the rollers/wheels.

The following are the proposed step-by-step procedures in the fabrication of the Vertical Quadrant Auto-electrical Mock-up.

Frame Assembly
1. Measure specified length of the angular bar.
2. Cut the angular bar into size.
3. Smooth cut areas using a flat file.
4. Weld the cut angular bar and plain G.I. sheets.
5. Smoothen weld areas with sanding paper or machine.
6. Apply paint to the frame assembly.

Electrical Assembly
1. Drill hole for the electrical components on the G.I Sheet board.
2. Smoothen holes to prevent any damage to the parts to be installed.
3. Install electrical/electronic parts to the G.I. sheet board. Be sure that all parts should be properly tightened.

Steering Assembly
1. Weld the steering column assembly to the frame assembly
2. Weld the brake pedal assembly at the bottom of the steering assembly.
3. Install the stoplight switch to the brake pedal assembly.

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Rollers

1. Weld the rollers at the foundation of frame assembly.

Testing Procedure

After constructing all the major components on their respective places, the project will be subjected to a rigid test to determine its functionality. The tests will be conducted to prove whether the prototype will function its intended purpose and be able to withstand major stress during operation.

Evaluation Procedure

The evaluation shall be conducted through survey, using the qualitative analysis method of determining the acceptability of the device. In the process, a survey on the functionality, economy, workability, durability, safety and instructional applicability of the machine will be solicited based on the format of the evaluation criteria for the alternator tester/trainer adopted by College of Industrial Technology, TUP, Manila. However, the study will not make use of all the criteria, instead only the ones that are related to the prototype will be used so as to keep a more concrete and definite outcome of evaluation. Each criterion is determined by a set of three indicators rated in a scale of 1 to 5, where 1 is the lowest and 5 is the highest.

The population who will panel the evaluation shall be composed of ten (10) faculty members; ten (10) auto shop service mechanics and twenty (20) students, ten Automotive NCI, and ten Automotive Servicing NCII, TESDA-ISAT, City of Ilagan, Isabela. These people will be tapped because of their level of expertise and experience in the field of Automotive Servicing.

Results of the testing conducted shall also be shown to the evaluators to serve as evidence of its viability and reliability as a new economical and effective tool in art and craft creation.

Demonstration on how the tool is operated will be presented to all the members of the panel, after which, all will be given an evaluation instrument for them to judge and evaluate the alternator tester/trainer.

Treatment of Data

After the evaluation, the results shall be tabulated and interpreted. The weighted mean (**x**) will be used to determine the level of acceptability of the project. The formula is given below:

$$x = \frac{\text{©} f w}{n}$$

where: x = weighted mean

©fw = summation of the product of frequency and weight

n = Total number of respondents

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The Likert scale will also be employed to determine the equivalent descriptive rating of the weighted mean listed below:

Weighted Mean	Descriptive equivalent
4.51 – 5.00	Outstanding
3.51 – 4.50	Very Satisfactory
2.51 – 3.50	Satisfactory
1.51 – 2.50	Fair
1.00 – 1.50	Poor

RESULTS AND DISCUSSION

Performance Evaluation

Table 2 presents performance evaluation with regards to the battery charge drain use per hour is how many trainees perform on the mock-up. The battery charge will drain within 8 hours if a single trainee will perform and 4 trainees will perform at the same time the charge will last up to 2 hours.

Table 2

Performance evaluation regarding to battery charge drain per hour

Number of trainee to perform	Battery discharge per hour
1	8 hrs.
2	6 hrs.
3	4 hrs.
4	2 hrs.

Evaluation of the Project

The project was evaluated in terms of its functionality and efficiency as an emergency power source by the residents who availed of the free services. The instrument used is a questionnaire checklist developed by the researcher. The questionnaire checklist was used to rate the functionality and efficiency of the project and its effectiveness as an emergency power source using a five-point Likert Scale. (4-Very Good, 3-Good, 2-Fair, 1-Poor)

The design aspect of the project as shown in Table 3 indicates an affirmative acceptance on the part of the respondents. All the criteria were rated Strongly Agree which indicate that the trainer has an exceptional design suited for automotive students in their laboratory activities, it further reveals that the use of the trainer, students can learn by themselves, replaceable components were considered to its design and the capacity of wires used in terminals were appropriate for its purpose as instructional mock-up for auto-electrical system.

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Table 3

Evaluation result on the design aspect of the instructional mock-up

Criteria	Average Mean	Description
1. Colour appeal	4.77	Strongly Agree
2. Attractiveness of design	4.87	Strongly Agree
3. Appropriateness of size	4.83	Strongly Agree
Weighted Average Mean	4.82	**Strongly Agree**

On the durability aspect, it could be noted that the respondents strongly agree as to its construction. This was evidenced by high ratings of 4.7 as shown in table 4. This could mean that the trainer was well constructed and organized and that set-up, installation of accessories, splices and portability were given consideration during the construction.

Further, the attachment of the component was neatly done, purposeful and functional.

Table 4

Evaluation result on the durability aspect of the instructional mock-up

Criteria	Average Mean	Description
1. Resistance to heat	4.80	Strongly Agree
2. Resistance to stress	4.70	Strongly Agree
3. Resistance to deformation	4.60	Strongly Agree
Weighted Average Mean	**4.7**	**Strongly Agree**

Table 5. Shows a Weighted Average Mean of 4.88 strongly agree). This supports that the trainer was functional, purposeful, effective for instructional use and can represent the required actual auto-electrical system circuit for demonstration and wiring purposes. Further, the respondents strongly agree that the trainer was easy to operate or manipulate and can be used in performing several activities or operations in automotive technology subjects.

Table 5

Evaluation result on the functionality aspect of the instructional mock-up

Criteria	Average Mean	Description
1. Resistance to heat	4.83	Strongly Agree
2. Resistance to stress	4.83	Strongly Agree
3. Resistance to deformation	4.87	Strongly Agree
Weighted Average Mean	**4.88**	**Strongly Agree**

The safety requirement of the trainer , which is considered as the most critical among the four evaluative criteria, has a Weighted Average Mean of 4.76 as shown in

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table below, which means that the performers/trainee were not vulnerable for any electrical or mechanical related injuries during wiring and laboratory activities.

Table 6
Evaluation result on the safety aspect of the instructional mock-up

Criteria	Average Mean	Description
1. Absence of toxic	4.73	Strongly Agree
2. User friendliness and convenience	4.80	Strongly Agree
3.Resistance to deformation	4.77	Strongly Agree
Weighted Average Mean	**4.76**	**Strongly Agree**

The overall result from the table below shows that the respondents Strongly Agree that the develop trainer has been designed and constructed well, that in terms of functionality, the trainer was proven operational and purposeful, safe to use and it can represent the actual circuits for the auto-electrical system.

CONCLUSIONS

The trainer has an exceptional design suited for automotive students in their laboratory activities, it further reveals that the use of the trainer, students can learn by themselves, replaceable components were considered to its design and the capacity of wires used in terminals were appropriate for its purpose as instructional mock. The trainer was easy to operate or manipulate and can be used in performing several activities or operations in automotive technology subjects. The trainer was proven operational and purposeful, safe to use and it can represent the actual circuits for the auto-electrical system.

RECOMMENDATIONS

Based on the findings and conclusion, it is recommended that the instructional mock-up should be inspected first for any defective parts before use to avoid any electrical failure occurring during operations and safety of the learners. The battery needs to charge first before its use to sustain power to all parts to avoid power shortage of the mock-up.

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