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Cutaway Single-Cylinder Marine Diesel Engine

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Abstract

This study was conceptualized and conducted to improve and expand the learning materials, principles, and applications of Bachelor of Industrial Technology Management (BITM) students during theoretical and laboratory classes. It aimed to enhance the instructional materials available to the Engineering and Technology Department and contribute to the improvement of the BITM laboratory. Specifically, the study focused on the design, fabrication, and utilization of a cut-away single-cylinder marine diesel engine as an instructional device. The project aimed to identify the essential components of the engine and establish appropriate procedures for designing, constructing, testing, and revising the finished product. The cut-away single-cylinder marine diesel engine was developed as a concrete instructional material to supplement the existing laboratory equipment of the institution. The air-cooled diesel engine is a four-stroke engine with a direct fuel-injection system that provides efficient mechanical power and is commonly used in industrial, agricultural, and machinery applications. The instructional device was designed to help students visualize and recognize the essential engine components while developing practical skills in tool usage, machine operation, servicing, and maintenance. The fabricated project consisted of a cylinder block, cylinder head, and various gears. Its construction followed sequential fabrication procedures based on the proposed design and sound engineering principles. The completed device was evaluated by students and instructors in terms of functionality, aesthetics, design, and cost-effectiveness. The results showed a mean rating of 4.95, indicating very high functionality, aesthetics, and cost-effectiveness. With a total fabrication cost of only Php 7,584.00, the cut-away engine proved to be a useful and economical instructional material for enhancing laboratory-based learning.

Keywords: Cylinder block, Cylinder head, Diesel, Engine, Industrial

INTRODUCTION

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort to achieve some value. In this usage, technology refers to tools and machines that may be used to solve real-world problems. The word "technology" can also be used to refer to a collection of techniques. In this context, it is the current state of humanity's knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants; it includes technical methods, skills, processes, techniques, tools, and raw materials. (Asker's 2009). The Air-cooled diesel engine is a type of technology that is widely used as a power source for industrial machinery, light-type transport vehicles, and also used as an engine for boats. At Northwest Technical College (NWTC), they invented a small road vehicle whose engine is a 10 hp air-cooled diesel engine with an electric start.

In the Philippines, teaching automotive technology may not be a simple task and may pose some difficulties if there is an enormous shortage of books and other instructional devices that can facilitate the acquisition of knowledge and skills development of the learner. Presently, students are handicapped in communicative competence, which is very important in the educational process. Many teachers/instructors would have the same sentiments, which cause a lot of frustration as far as teaching objectives are concerned. However, with the pressure of giving quality instruction to the learner, the teacher/instructor should make the necessary innovations to become effective. He should learn to devise his own instructional materials to become effective and efficient in delivering both simple and complicated concepts. It is also related because this study is a material intended for use in the classroom as a teaching device, a Trainer capable of being mass-produced. Likewise, this study is intended for classroom instruction and can be reproduced for educational purposes (Fernandez 2010).

Learning with technology implies that students acquire knowledge when they are actively engaged in designing and creating technology-based products. Students become product developers when they produce real-world applications, engaging in authentic learning processes, such as research, design, analysis, composition, and communication (Jonassen, Howland, Morre, &Marra, 2003; Kiili, 2005; Stratford & Brown, 2002).

The Davao Oriental State College of Science and Technology offers a Bachelor of Industrial Technology Management, which is in demand in some countries is equipped with both in theory and in practice. It is imperative to produce an innovative project cutaway single-cylinder marine diesel engine using locally available resources to improve the training equipment of our institutions. Through the use of this instructional gadget, students would be able to visualize the parts of an engine and how it is operated. It reinforced the students' grasp of the concepts behind the theories discussed and also supported the knowledge obtained during lectures.

The study is entitled "Cut-Away Single Cylinder Marine Diesel Engine", which would be useful to the Davao Oriental State College of Science and Technology Department, especially the BITM shop. This is an aid in improving the instructional delivery system, aside from visualizing and recognizing the essential components of a cut-away single-cylinder marine diesel engine. The students could also manipulate it not only in theory but also hands-on during laboratory activities.

This study aimed to produce a cutaway single-cylinder marine diesel engine. Specifically, it sought to determine the essential components of a cutaway single-cylinder marine diesel engine; identify the procedures employed in the design, construction, try-out, and revision of the project; determine the production cost of the project in terms of construction time and material expenses; evaluate the functions and limitations of the cutaway single-cylinder marine

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diesel engine in terms of its capability, limitations, and longevity; and describe the project in terms of its functionality, cost-effectiveness, and aesthetics.

This project study was designed to create new instructional equipment in the Bachelor Industrial Technology Management laboratory shop. This was for the students to visualize and easily recognize the essential parts of the cut-away single-cylinder marine diesel engine trainer. This study focused only on the design, construction, and function of the cut-away single-cylinder marine diesel engine. It showed the internal parts by labeling or by color coding. The conceptual model served as a guide for the researcher in developing the project and is illustrated in the paradigm below, following the input, throughput, and output model. This was based on the system theory of Zwanepoel (1980). The Input- is composed of the gathered data from various sources, such as ideas from related literature and studies, journals, magazines, the internet, and advice from experts. This also included other significant elements so as methods, materials, tools and equipment being used. Throughput, or the process, is the main process that combined all methods, tools, and materials, which mainly came under designing, constructing, testing, and revising, and the second part was the assessment by the evaluators.

The Output- referred to the project that came out after the whole process, in which the result was the completed Single Cylinder Marine Diesel Engine Trainer. To come up with the finished project, the study followed the input, throughput, and output approach. Input c omprised the ideas from related literature and studies, supplies and materials, and tools and equipment used, while output contained the finished project automotive system trainer

METHODOLOGY

The project "cutaway marine diesel engine was made of local materials, including a stand. Parts of the marine diesel engine were cut to view the inside and its parts. This learning tool could really help us to determine and easily identify the important parts of the engine.

Bills of supplies and materials

The following table includes the quantity, units, and description of supplies and materials used in fabricating the project.

Table 1. Bill of supplies and materials.

Qty	Units	Description and specification of materials	Unit cost	Total cost (PHP)
5	Feet	Pipe (1.5-inch diameter)	65	325.00
1	Pcs	Sandpaper (1000)	20	20.00
5	Pcs	Bolt and nut	20	100.00
1	Unit	Air-cooled Diesel Engine (Second-Hand)	3,000	3,000.00
1 ½	Kg	Welding rod	100	250.00
4	Pcs	Steel Caster	100	400.00
8	Pcs	Lotus Enamel	18	144.00
4	Pcs	Pipe (1.0-inch diameter)	65	260.00
1	Length	Length Angle Bar (1 5 x 1.5 x¼)	400	400.00
1	Pcs	Pylox	85	85.00
		Total Cost		**4,984.00**

Tools and Equipment

The following are the included tools and equipment used in constructing and assembling the project.

Table 2. Tools and equipment and their functions.

Tools and equipment	Functions
A. Tools	
1. Hacksaw blade	Used to cut metal.
2. Steel tape	Used to measure the stand.
3. Grinder	Used to grind and smoothening the rough surfaces
4. Open wrench	Used to loosen and tighten bolts and nuts.
5. Welding machine	Used to connect the metals for mock-up.
6. Chipping hammer	Used to remove the flux on the welded part.
7. Electric drill	Used to drill holes in the metal.
8. Steel Brush	Used to remove the rust from the metal.

Construction procedure

Steps: Construction procedure of a trainer stand

1. Sketch the design/plan for the engine stand
2. Cut the pipe and angle bar to its measurements.

A. Cut 2 pieces of B.1 pipe, 46 cm, with a size of (1 5inch diameter) for the base as shown in Figure1.

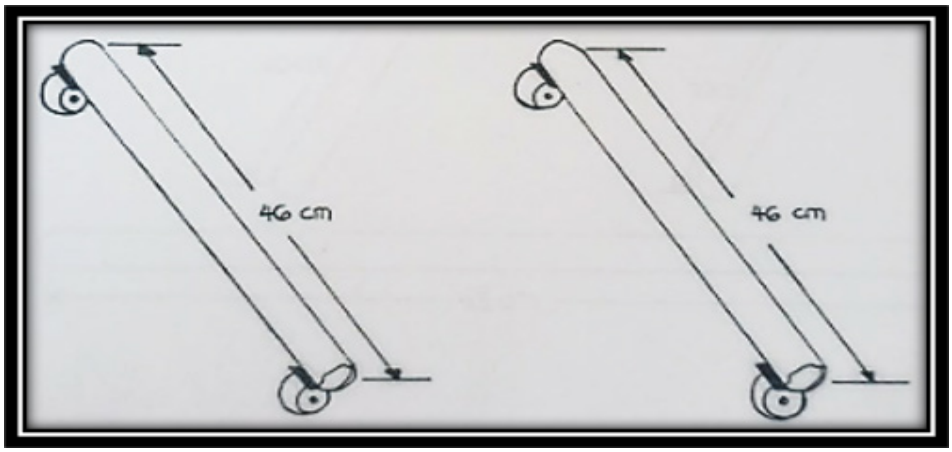


Figure 1. Base.

B. Cut 2 pieces of B.2 pipe, 43 cm, with a diameter of 1.0 inch for the brace of the base, and cut2 pieces of10cm pipe for another brace, as shown in Figure 2.

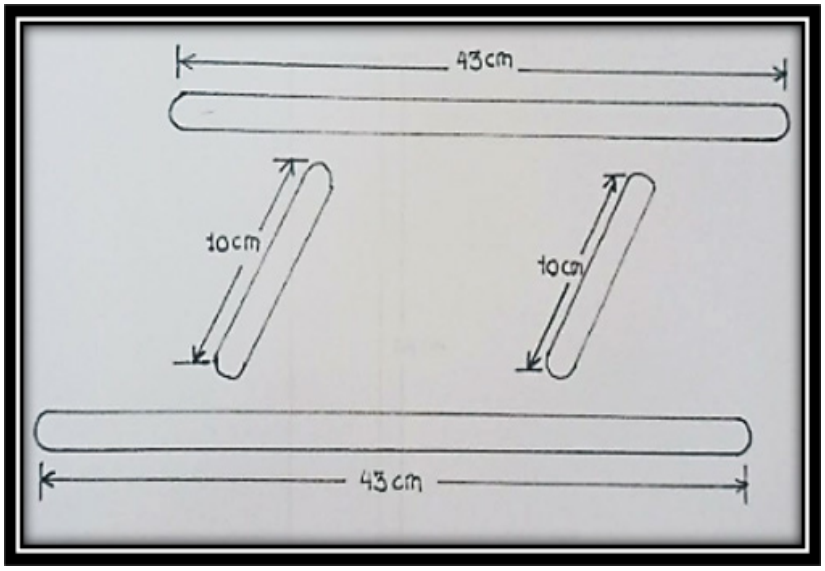


Figure 2. Base support.

C. Cut 1 piece of B.3 pipe 54 cm with a diameter of 1.5 inches for the post, and cut the flat bar in a form similar to letter H with a length of 11 centimeters for the base of the post. Cut another flat bar for the brace of the angular platform as shown in Figure 3.

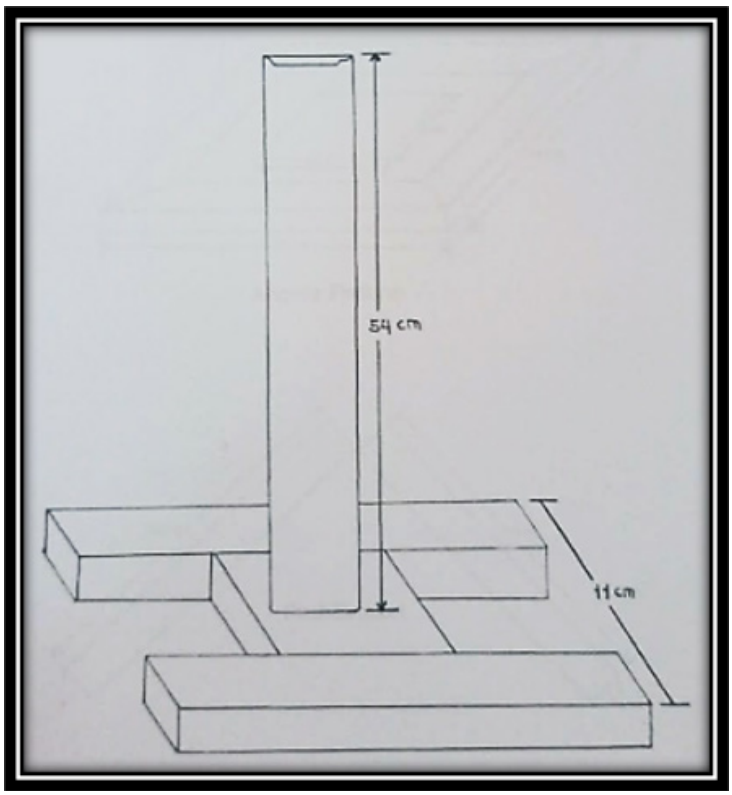
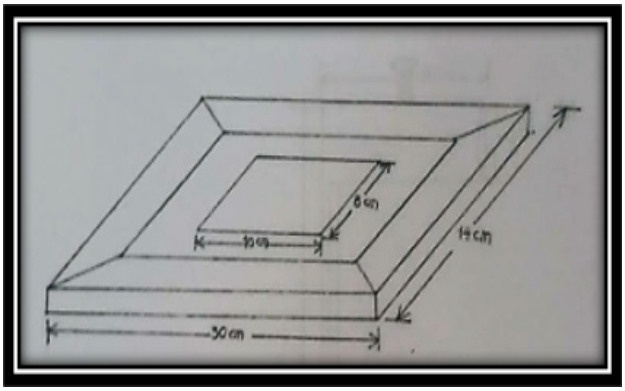


Figure 3. Center post assembly.

D. Cut 2 pieces of angle bar with a length of 30 cm for the post support, and bend the angle bar at 90 degrees with a length of 30 cm on both parallel sides, with a 14 cm length at the opposite sides as shown in Figure 4.



Angular Flatform

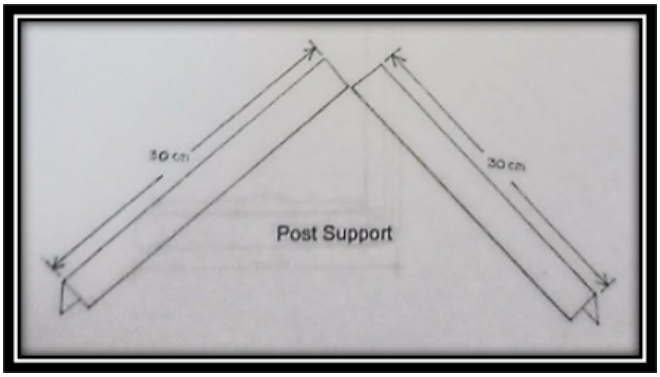


Figure 4. Angular flat form/ Post support.

E. Cut the pipe to 8 cm, with a diameter of 1.0 inch, and cut the round bar to a length of 18 cm. Connect a round bar with a length of 13 cm for the handle of the engine as shown in Figure 5.

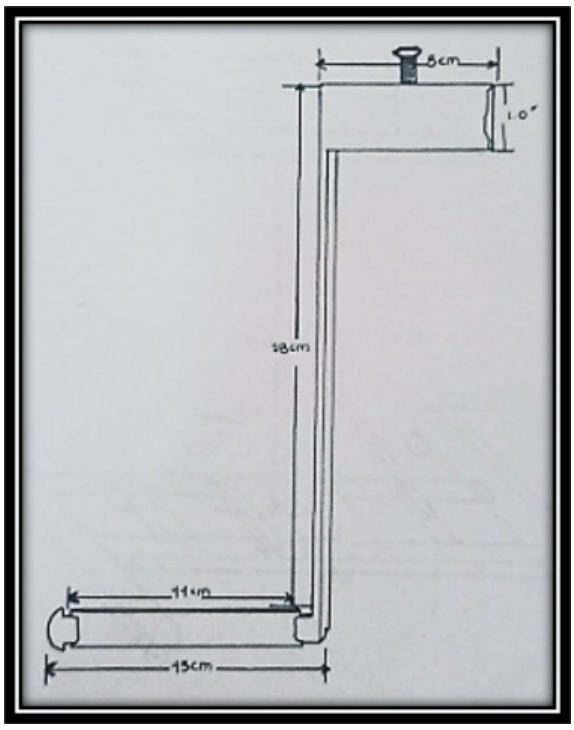


Figure 5. Handle.

F. Trainer Stand Perspective view as shown in Figure 6.

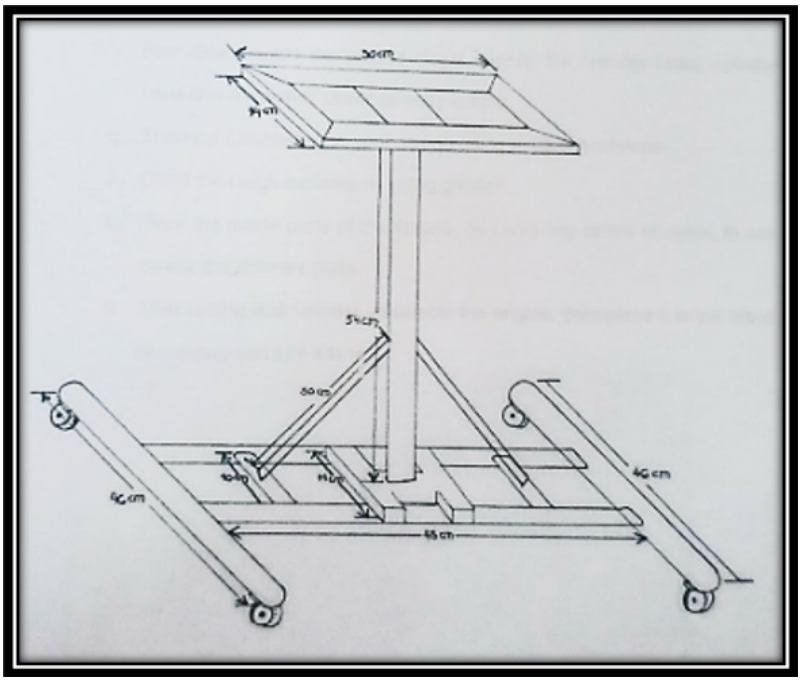


Figure 6. Trainer stand perspective.

3. Using the welding machine, connect each metal according to the desired features.
4. Grind the rough surfaces of the metal.

Constructing procedure for cutting the cylinder head, cylinder bore, and crankshaft cover.

5. First, disassemble the marine diesel engine: the cylinder head, cylinder bore, and crankshaft cover for easy cutting.
6. Then cut it according to your design using oxygen-acetylene.
7. Grind the rough surfaces using a grinder
8. Paint the inside parts of the engine using any color of Pylox to see the different parts clearly.
9. After cutting and painting, assemble the engine, then place it on the stand or mockup and bolt it to fit.

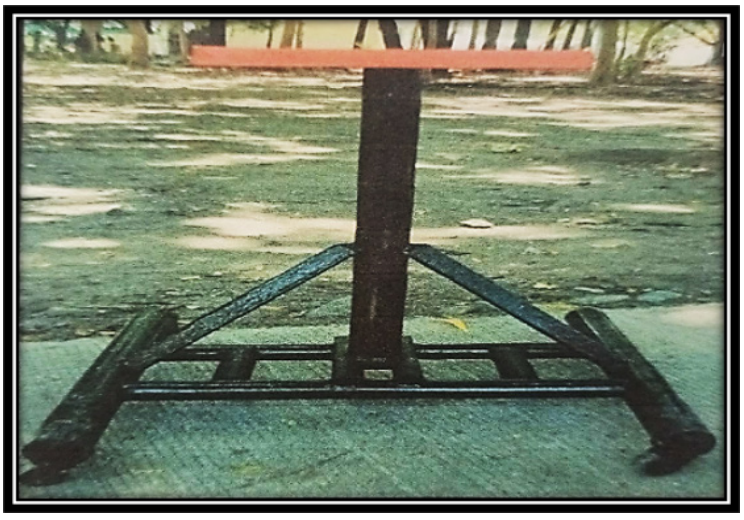


Plate 1. Trainer stands and Base mounting side view.

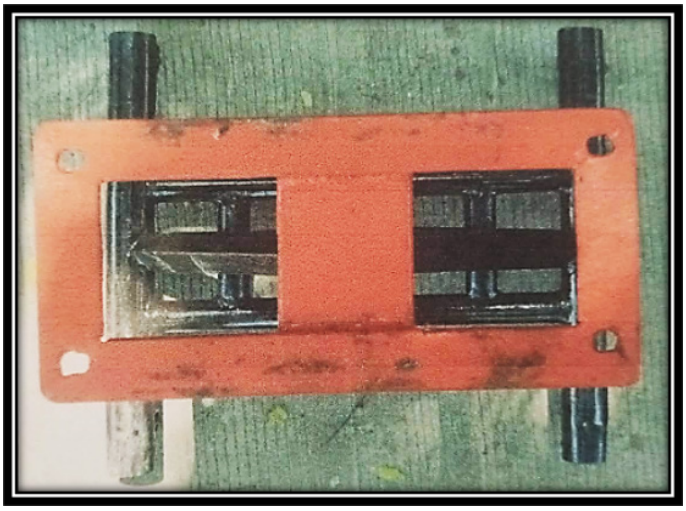


Plate 2. Trainer stands and Base mounting top view.

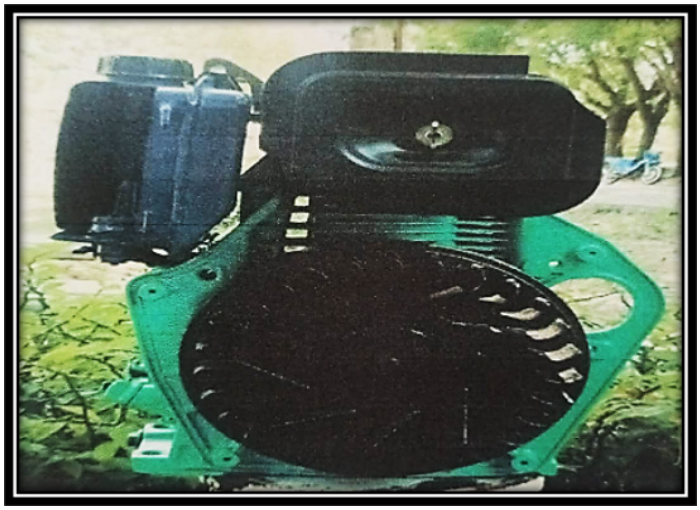


Plate 3. Cut-away Marine diesel Engine front view.

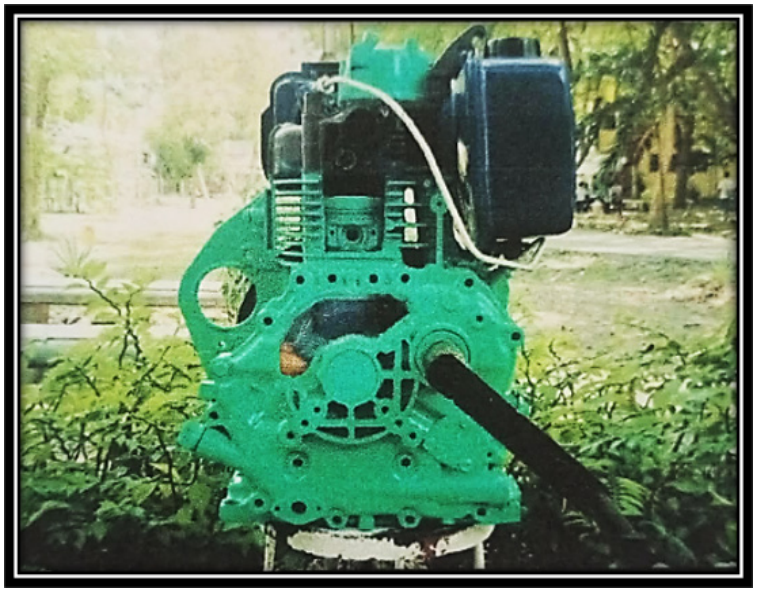


Plate 4. Cut-away Marine diesel Engine back view.

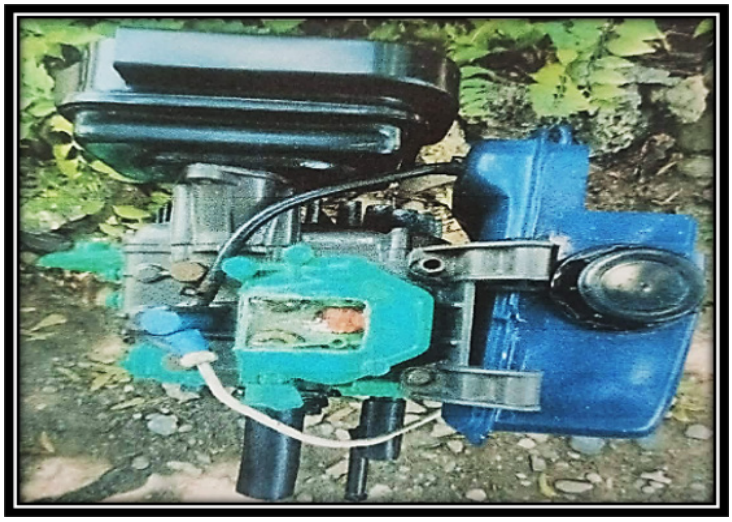


Plate 5. Cut-away Marine diesel Engine top view.



Plate 6. Cut-away Marine diesel Engine right-side view.



Plate 7. Front view of the project.

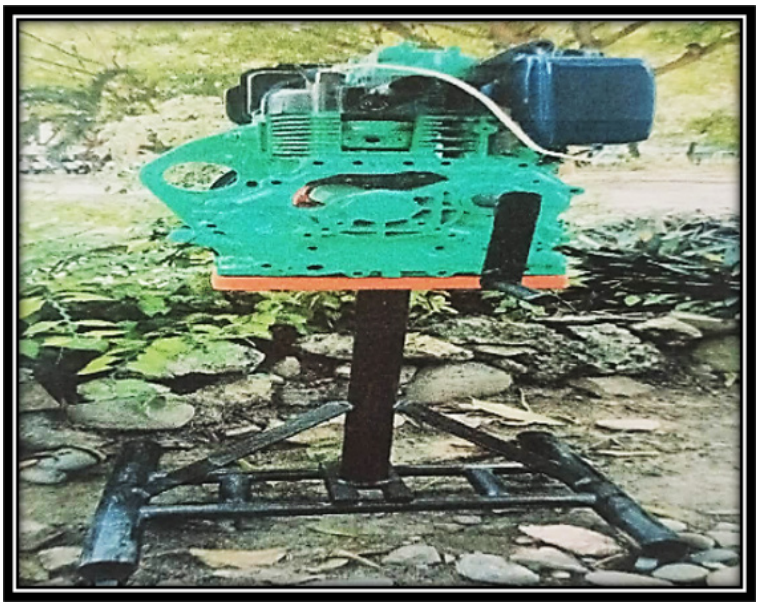


Plate 8. Back view of the project.

Production Cost

In this section, Table 3 manifests the production cost of one unit of Cutaway Single Cylinder Marine Diesel Engine Trainer.

Table 3. Production Cost

Source	Cost
1. Supplies and materials	Php 4,984.00
2. Labor of constructing	Php 2,600.00
Total Cost	**Php. 7,584.00**

The table 3 shows that the total cost of the project is Php 8004. This total cost of the project covers the supplies and material cost Php 5.404.00. The labor for cutting the marine engine is Php 2,600.00.

Constructing time frame

Tables 4 manifest the time allotment and duration in assembly of the project from Conceptualization of the design, Cutting, Stand Construction, Painting the engine and stand, Installation of Parts of marine diesel engine.

Table 4. Work activities and time allotment.

A. Nature of work	B. Time
1 Planning of the Project	10 hours
2. Cutting	15hours
3. Stand Construction	20 hours
4. Painting the Stand Trainer	8 hours
5. Installation of Parts of Marine Diesel Engine	10 hours
Total hours	**63 hours**

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Try- out and Revision

Throughout the development of the project, its functionality was tested were noted as follows:

1. The cutting bore has no mirror
2. The base of the stand has not been applied with sander
3. The pipe that we use is improper alignment.
4. The color coding of our project is not totally improper

Assessment of evaluators of the functionality, aesthetics and design and the cost-effectiveness

Formulating questionnaires or the evaluation sheet was done by the help of the thesis adviser and statistician which was formed for the assessment of the study. The said evaluation sheet was created to validate the functionality, aesthetics and design as well as the cost-effectiveness of the project. The evaluation sheets were distributed to different respondents, the instructors and students in Davao Oriental State College of Science and Technology. To assess the completed project, instructors and automotive students used the validated questionnaire. It was intended to congregate the data in terms of functionality, aesthetics and design and the cost-effectiveness of the study. The evaluation sheet has five variables and responses with corresponding equivalent.

Legend for evaluation rating per criteria

Score/Rating	**Response**
1.00-1.49	Strongly Disagree
1.50-2.49	Disagree
2.50-3.49	Undecided
3.50-4.49	Agree
4.50-5.00	Strongly Agree

The scores of each of the variables had their corresponding description to wit:

Functionality

Score/Rating	**Description**
1.00-1.49	Very Unfunctional
1.50-2.49	Unfunctional
2.50-3.49	Moderately Functional
3.50-4.49	Functional
4.50-5.00	Very Functional

Aesthetics and Design

Score/Rating	**Description**
1.00-1.49	Not Presentable
1.50-2.49	Fairly Presentable
2.50-3.49	Moderately Presentable
3.50-4.49	Presentable
4.50-5.00	Very Presentable

Cost-Effectiveness

Score/Rating	**Description**
1.00-1.49	Not Affordable
1.50-2.49	Fairly Affordable
2.50-3.49	Moderately Affordable
3.50-4.49	Affordable
4.50-5.00	Very Affordable

Sampling procedure

The respondents of the study evaluated the completed project through the questionnaires or evaluation sheets in terms of functionality, aesthetics, and design, as well as cost-effectiveness. During the sampling, the respondents were composed of 5 instructors and 145 students from Davao Oriental State College of Science and Technology, particularly in the Bachelor of Industrial Technology Management, with a total of 150 respondents. Data from the responses of the different respondents were consolidated. With the aid of a statistician, the data collected were interpreted through purposive and descriptive type of statistics. Afterward, the interpreted data revealed that the completed project is very functional, very attractive, and very affordable.

Statistical Treatment

The statistical treatment used in the study was only Means (Descriptive Statistics).

RESULTS AND DISCUSSION

This chapter clearly illustrates the internal and mechanical parts of the finished gadget. The structure includes the standard parts of the project and their functions and the interrelationship of parts, capabilities, and limitations. The process includes the operational procedure, maintenance, safety, and control measures.

Structure

Features

1. Economical-there is no fuel injection consumption in this project. Also, this will be manually operated.
2. Cutaway Single Cylinder Marine Diesel Engine Trainer-this study aims to enhance the learning facilities.
3. Accessibility of Resources-all components of the project are locally available and affordable.

Parts and functions

1. Cylinder head-this part covers the piston of the valves.
2. Cylinder block-this part covers all the gears inside the engine.
3. Bore- this is where the burning and the stroke cycle.
4. Crankshaft-to crank the engine.
5. Flywheel-the starting point.
6. Handle-serves as an instrument to perform the manual operation
7. Air-cooled diesel engine-manually operates the 4-stroke cycle of the engine.
8. Base Mounting-the base is used to attach the air-cooled diesel engine and hold in place.
9. Trainer Stand-the stand used to serve as the foundation of the assembly to carry the trainer

Interrelation of parts

All parts of the gadget have their respective functions to support efficiently and effectively. This section shows the primary relationship of each part of the Cutaway Single Cylinder Marine Diesel Engine Trainer.

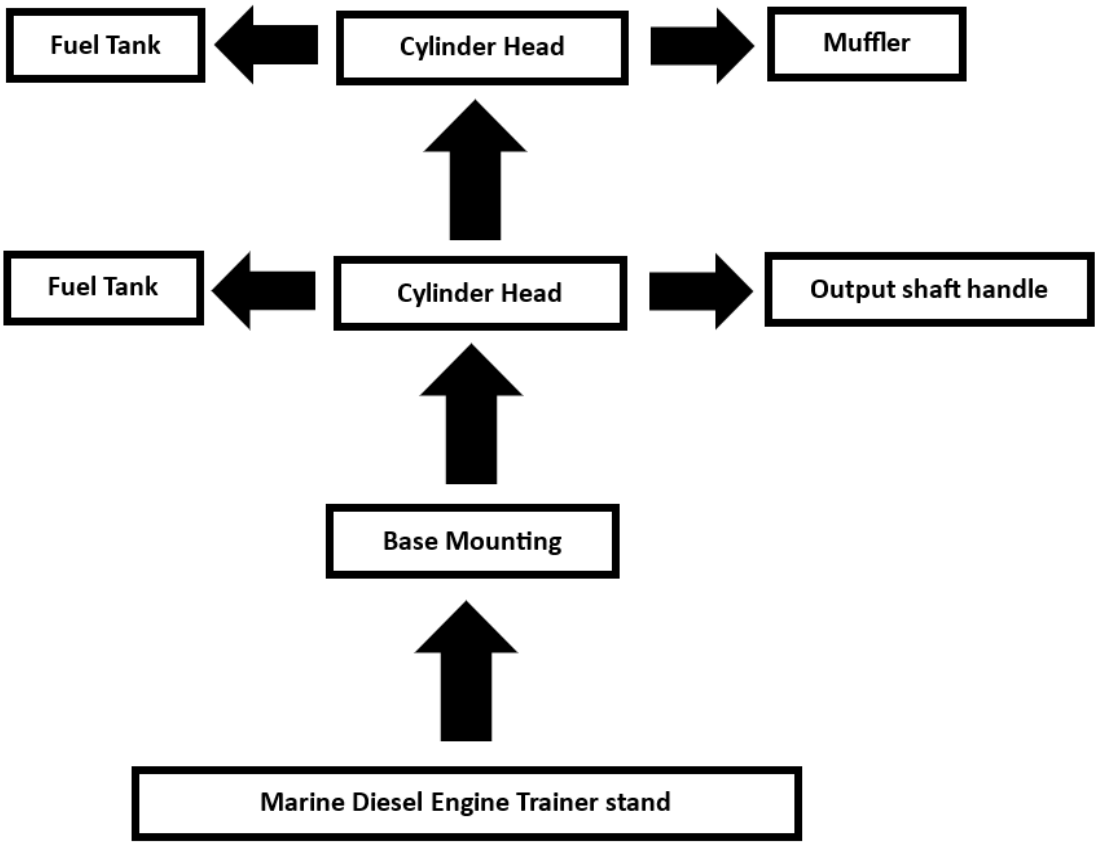


Figure 7. Interrelationship of parts.

The following is a model of the interrelationship of parts: the Cutaway Single Cylinder Marine Diesel Engine Trainer. The engine stand connects to the base mounting; from the base mounting, the engine attaches. When the handle rotates manually, the internal parts will move and perform the four-stroke cycle of the engine, which are the intake, compression, power, and exhaust, rapidly.

Capabilities

The Cutaway Single Cylinder Marine Diesel Engine Trainer will be used as a reinforcement material in the learning practice of the BITM students. It also demonstrates the operation of a four-stroke cycle engine also they exhibit the essential parts of the engine.

Limitations

The Cutaway Single Cylinder Marine Diesel Engine Trainer can only be used for instructional materials and for demonstration of the four-stroke cycle of the engine, except that the fuel injection system is not functional.

Longevity

The durability of the completed project depends on the users' ability to manage and apply the steps of maintenance of the project.

Process

The process portrays the series of operations and development of the project. It includes the operating procedures and maintenance.

1. Operating procedures
   A. To easily visualize the parts of the trainer, position it in front of the class.
   B. Rotate the output shaft handle in a counterclockwise motion to view the actual operation of the four-stroke cycle engine
   C. After which, the students can observe how the Air-cooled diesel Engine performs the four-stroke cycle of the engine.
2. Maintenance

The following are the steps to maintain the Cutaway Single Cylinder Marine Diesel Engine Trainer

   A. Avoid spilling any amount of substance on the parts of the gadget to prevent damage to the design and color of the project.
   B. Lubricate the bore section and the flatform bearing.
   C. Protect the Cutaway Single Cylinder Marine Diesel Engine Trainer in a safe area if it is not used.

Validation of performance and reliability

One hundred forty-five (145) respondents consisting of both students and faculty of the Davao State College of Science and Technology, particularly in (BITM) Bachelor of Industrial Technology Management, evaluated the performance and reliability of the completed project in terms of functionality, aesthetics, and design as well as cost-effectiveness.

Functionality

Faculty

Faculty's evaluation of the functionality of the Cut Away Single Cylinder Marine Diesel Engine Trainer was very significant. This was because they were the ones who would be using the trainer as instructional materials. Table 9 illustrates the Functionality Responses of Faculty members of the Engineering and Technology Department, particularly Bachelor of Industrial Technology Management instructors. The results manifested that faculty agreed that the trainer was functional. Faculty agreed on the majority of the statements but the highest mean and having very functional on the interpretation column belonged to statement item number 1 and 2 which states that the cut away single cylinder marine diesel engine trainer would demonstrate the operating principle of the four strokes cycle and that the trainer helped the students to understand the actual operation of the engine fundamental principle respectively with both had an average mean of 4.8000.

Table 5. Functionality Responses of Faculty on Cutaway Single Cylinder Marine Diesel Engine Trainer.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The cutaway single-cylinder marine diesel engine trainer will demonstrate the operating principle of the four-stroke cycle.	4	1	0	0	0	4.80	Very functional
2. The trainer helps the students to	4	1	0	0	0	4.80	Very functional

3. The trainer is simple and easy to manipulate.	1	3	1	0	0	4.00	Functional
4. The instructional gadget can be transferred from one place to another conveniently.	2	2	1	0	0	4.20	Functional
5. The instructional gadget can be transferred from one place to another conveniently.	1	4	0	0	0	4.20	Functional
6. The trainer helps improve the facilities in the laboratory.	2	2	1	0	0	4.20	Functional
Overall	**14**	**13**	**3**	**0**	**0**	**4.34**	**Functional**

Functionality

Students

Table 5 shows the Functionality Responses of Students on the Cut Away Single Cylinder Marine Diesel Engine Trainer. The results manifested that students rated the trainer as very functional. The interpretation column noticeably contains " strongly agree which means that students evaluated each of the statements about the trainer's functionality positively. While all the statements show a very functional assessment, the highest mean belonged to statement item number 5, which stated that the instructional gadget could be transferred from one place to another conveniently, with a weighted mean of 4.97.

Table 6. Functionality responses of students on cutaway single cylinder marine diesel engine trainer.

Criteria	**Frequency of responses**					**Mean**	**Interpretation**
	5	**4**	**3**	**2**	**1**		
1. The cutaway single-cylinder marine diesel engine trainer will demonstrate the operating principle of the four-stroke cycle	52	5	0	0	0	4.91	Very functional
2. The trainer helps the students to understand the actual operation of the engine's fundamental principle.	55	2	0	0	0	4.96	Very functional
3. The trainer is simple and easy to manipulate.	54	3	1	0	0	4.95	Very functional
4. The instructional gadget can be transferred from one place to another conveniently.	55	2	1	0	0	4.96	Very functional
5. The instructional gadget can be transferred from one place to another conveniently.	54	3	0	0	0	4.97	Very functional
6. The trainer helps improve the facilities in the laboratory.	55	2	0	0	0	4.96	Very functional
Overall	**325**	**17**	**0**	**0**	**0**	**4.95**	**Functional**

Functionality

Faculty and students

Table 13 shows the Functionality Responses of Faculty and Students on the Cut Away Single Cylinder Marine Diesel Engine Trainer, and the results manifested that they both strongly agreed that the trainer was very functional. The interpretation column noticeably contains " strongly agree which means that faculty and students evaluated each of the statements about the trainer's functionality positively. While all the statements show a very functional assessment, the highest mean belonged to statement item number 2, which stated that the trainer helped the students to understand the actual operation of the engine's fundamental principle, with a weighted mean of 4.95.

Table 7. Functionality responses of faculty and students on cutaway single-cylinder marine diesel engine trainer.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The cutaway single-cylinder marine diesel engine trainer will demonstrate the operating principle of the four-stroke cycle	56	6	0	0	0	4.90	Very functional
2. The trainer helps the students to understand the actual operation of the engine's fundamental principle.	59	3	0	0	0	4.95	Very functional
3. The trainer is simple and easy to manipulate.	55	6	1	0	0	4.87	Very functional
4. The instructional gadget can be transferred from one place to another conveniently.	57	4	1	0	0	4.90	Very functional
5. The instructional gadget can be transferred from one place to another conveniently.	55	7	0	0	0	4.90	Very functional
6. The trainer helps improve the facilities in the laboratory.	57	4	1	0	0	4.90	Very functional
Overall	**339**	**30**	**3**	**0**	**0**	**4.90**	**Very functional**

Aesthetics and Design

Faculty

Table 11 shows the Aesthetic and Design Responses of Faculty on the Cutaway Single Cylinder Marine Diesel Engine Trainer, with generally agree results presented in the interpretation column. This meant that the trainer's aesthetics and design met the expectations of the faculty. It was evident that all the statements were rated as attractive, but the highest mean belonged to statement item number 5, stating that the trainer structure was attractive due to its positioned structure, with an average mean of 4.60 and attractive as the interpretation.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The cutting of the outside casing of the engine shows the actual position and operation of the gear system.	1	4	0	0	0	4.20	Attractive
2. The trainer components are properly assembled and have a pleasing appearance.	2	3	0	0	0	4.40	Attractive
3. The trainer has a presentable color.	2	3	0	0	0	4.00	Attractive
4. The materials used are precise and easy to handle.	0	5	0	0	0	4.00	Attractive
5. The trainer structure is attractive due to its positioning.	3	2	0	0	0	4.50	Very attractive
6. The trainer has an adequate height for effortless manipulation of students.	2	3	0	0	0	4.40	Attractive
7. The design of the trainer is coherent, following the principle of good architecture.	2	3	0	0	0	4.40	Attractive
8. The gadget trainer is very useful	2	2	1	0	0	4.20	Attractive
Overall	**14**	**25**	**1**	**0**	**0**	**4.33**	**Attractive**

Aesthetics and Design

Students

The Aesthetics and Design Responses of Students on the Cut Away Single Cylinder Marine Diesel Engine Trainer, as revealed in Table 7, were generally very attractive, as presented in the interpretation column. This meant that the trainer's aesthetics and design met the expectations of the students. It was evident that all the statements were rated as very attractive, but the highest mean belonged to statement items 7 and 8, stating that the design of the trainer was coherent following the principle of good architecture and that the gadget trainer was very useful, with similar weighted means of 4.98, respectively.

Table 9. Aesthetics and design responses of students on cutaway single-cylinder marine diesel engine trainer.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The cutting of the outside casing of the engine shows the actual position and operation of the gear system.	54	3	0	0	0	4.95	Very Attractive
2. The trainer components are properly assembled and have a pleasing appearance.	53	4	0	0	0	4.93	Very attractive

3. The trainer has a presentable. color	51	6	0	0	0	4.90	Very attractive
4. The materials used are precise and easy to handle.	53	4	0	0	0	4.93	Very attractive
5. The trainer structure is attractive due to its positioning.	53	4	0	0	0	4.93	Very attractive
6. The trainer has an adequate height for effortless manipulation of students.	52	5	0	0	0	4.91	Very attractive
7. The design of the trainer is coherent, following the principle of good architecture.	56	1	0	0	0	4.98	Very attractive
8. The gadget trainer is very useful	56	1	0	0	0	4.98	Very attractive
Overall	**428**	**28**	**0**	**0**	**0**	**4.94**	**Very attractive**

Aesthetics and Design
Faculty and students

The Aesthetics and Design Responses of Faculty and Students on the Cut Away Single Cylinder Marine Diesel Engine Trainer are revealed in Table 14, with generally attractive results presented in the interpretation column. This meant that the trainer's aesthetics and design met the expectations of the faculty and students. It was evident that generally the statements were rated as agree, but the highest mean belonged to statement item number 5, stating that the trainer structure was attractive due to its positioned structure, with the average mean of 4.60.

Table 10. Aesthetics and design responses of faculty and students on cutaway single-cylinder marine diesel engine trainer.

Criteria	**Frequency of responses**					**Mean**	**Interpretation**
	5	**4**	**3**	**2**	**1**		
1. The cutting of the outside casing of the engine shows the actual position and operation of the gear system.	55	7	0	0	0	4.20	Attractive
2. The trainer components are properly assembled and have a pleasing appearance.	55	7	0	0	0	4.40	Attractive
3. The trainer has a presentable color.	53	9	0	0	0	4.40	Attractive
4. The materials used are precise and easy to handle.	53	9	0	0	0	4.00	Attractive
5. The trainer structure is attractive due to its positioning.	56	6	0	0	0	4.60	Very attractive
6. The trainer has an adequate height for effortless manipulation of students.	54	8	0	0	0	4.40	Attractive
7. The design of the trainer is coherent, following the principle	58	4	0	0	0	4.40	Attractive

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of good architecture.							
8. The gadget trainer is very useful	58	3	1	0	0	4.20	Attractive
Overall							**Very attractive**

COST-EFFECTIVENESS

Faculty

The Cutaway Single Cylinder Marine Diesel Engine Trainer was also evaluated with its Cost and effectiveness, as presented by the responses of faculty in Table 10. The following table manifested that faculty strongly agree that the trainer was very affordable and they could benefit from it as well as the students. Furthermore, the said trainer could be used as an instructional material as reinforcement of concepts obtained by the students during lectures. As a result of the evaluation, the cost of the project was reasonable. As presented in the interpretation column, faculty agreed with the majority of the statements, but the highest mean belonged to statement item number 2, which was that automotive instructors and students could both benefit from the trainer for effective learning due to its affordability, with the interpretation of strongly agree and an average mean of 5.00.

Table 11. Cost-Effectiveness responses of faculty on cutaway single cylinder marine diesel engine trainer.

Criteria	**Frequency of responses**					**Mean**	**Interpretation**
	5	**4**	**3**	**2**	**1**		
1. The materials used are economical.	3	2	0	0	0	4.60	Very affordable
2. Automotive instructors and	5	0	0	0	0	5.00	Very affordable
3. The total cost of the project is reasonably priced.	2	3	0	0	0	4.40	Affordable
4. The school could provide a second-hand single-cylinder marine diesel engine trainer for instructional purposes.	4	1	0	0	0	4.80	Affordable
5. The gadget is affordable to the general public.	3	2	0	0	0	4.60	Very affordable
6. The technician can afford to make this gadget.	3	2	0	0	0	4.60	Very affordable
Overall	**20**	**10**	**0**	**0**	**0**	**4.67**	**Very affordable**

COST-EFFECTIVENESS

Students

Cut Away Single Cylinder Marine Diesel Engine Trainer was also evaluated with its Cost and effectiveness, as presented by the responses of students in Table 6. The following table shows that students strongly agreed that it was effective as reinforcement of their learning during lectures, and the cost of the project was very affordable. As presented in the interpretation column. It is very affordable because it was supported by those statements, but the highest mean belonged to statement item numbers 1, 3, and 4. Statement Item 1 stated that the materials used were economical; Statement Item 3 stated that the total cost of the project was reasonably priced; and Statement Item 4 stated that the school could provide a second-hand single-cylinder

marine diesel engine trainer for instructional purposes, with an individual mean of 4.97.

Table 12. Cost-Effectiveness responses of students on cutaway single cylinder marine diesel engine trainer.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The materials used are economical.	55	2	0	0	0	4.96	Very affordable
2. Automotive instructors and students can both benefit from the trainer for effective learning due to its affordability.	54	3	0	0	0	4.95	Very affordable
3. The total cost of the project is reasonably priced.	55	2	0	0	0	4.97	Very affordable
4. The school could provide a second-hand single-cylinder marine diesel engine trainer for instructional purposes.	55	2	0	0	0	4.97	Very affordable
5. The gadget is affordable to the general public.	53	4	0	0	0	4.93	Very affordable
6. The technician can afford to make this gadget.	54	3	0	0	0	4.95	Very affordable
Overall	**326**	**16**	**0**	**0**	**0**	**4.95**	**Very affordable**

COST-EFFECTIVENESS

Faculty and students

Evaluation of the Faculty and students of the Cutaway Single Cylinder Marine Diesel Engine Trainer, was also with its Cost and effectiveness, is presented in Table 15. The following table shows that faculty and students strongly agree that the trainer was effective and that both could benefit from it. As a result, the cost of the project was reasonable and very affordable. As presented by the interpretation column, faculty and students rate that trainer was very affordable with all of the statements but the highest mean belonged to statement item numbers 2 and 4 which was Automotive instructors and students can both benefit from the trainer for effective learning due to its affordability, and the school could provide a second hand single cylinder marine diesel engine trainer for instructional purposes respectively both with the interpretation of Very affordable and average mean of 4.95.

Table 13. Cost-effectiveness responses of faculty and students on cutaway single-cylinder marine diesel engine trainer.

Criteria	Frequency of responses					Mean	Interpretation
	5	4	3	2	1		
1. The materials used are economical.	58	4	0	0	0	4.93	Very affordable
2. Automotive instructors and	59	3	0	0	0	4.95	Very affordable

students can both benefit from the trainer for effective learning due to its affordability.							
3. The total cost of the project is reasonably priced.	57	5	0	0	0	4.97	Very affordable
4. The school could provide a second-hand single-cylinder marine diesel engine trainer for instructional purposes.	59	3	0	0	0	4.97	Very affordable
5. The gadget is affordable to the general public.	56	6	0	0	0	4.93	Very affordable
6. The technician can afford to make this gadget.	57	5	0	0	0	4.95	Very affordable
Overall	**346**	**25**	**0**	**0**	**0**	**4.95**	**Very affordable**

General statement
Faculty

Table 12 shows the general assessment of Responses of Faculty on the Cut Away Single Cylinder Marine Diesel Engine Trainer according to its Functionality, Aesthetics and design, and cost-effectiveness. The interpretation column noticeably included functional, very affordable, and attractive as students' evaluation of the trainer. Indeed, based on the ratings provided, the trainer was functional, very affordable, and attractive. Functionality gained an average mean of 4.34, cost-effectiveness gained 4.67 mean and aesthetics and design were 4.33, with an overall mean of 4.95.

Table 14. General assessment of faculty for the cutaway single-cylinder marine diesel engine trainer.

Variables	Mean	Interpretation
Functionality	4.34	Functional
Cost Effectiveness	4.67	Very affordable
Aesthetics and Design	4.33	Attractive
Overall	**4. 95**	**Strongly agree**

General statement
Students

General Assessment Responses of Students on Cut Away Single Cylinder Marine Diesel Engine Trainer according to its Functionality, Aesthetics and Design and Cost-Effectiveness are summarized and presented in Table 8. It was evident in the interpretation column that students strongly agreed that the trainer was very functional, very affordable, and very attractive, with average means of 4.95, 4.95, and 4.94, respectively. The overall results showed an average mean of 4.946, with a strongly agree interpretation.

Table 15. General assessment of students of the cutaway single-cylinder marine diesel engine trainer.

Variables	Mean	Interpretation
Functionality	4.96	Very functional

Functionality	4.96	Very functional
Cost effectiveness	4.96	Very affordable
Aesthetics and design	4.94	Very attractive
Overall	**4.946**	**Strongly agree**

Conclusion

Based on the findings and results of this study, it can be concluded that the trainer assisted and reinforced the learning of BITM students during laboratory activities. The development and fabrication of the project were also technically feasible, as the required materials were readily available locally. Furthermore, the data gathered from the different respondents indicated that the completed project demonstrated very high functionality, was highly attractive, and was highly cost-effective. Finally, the trainer effectively demonstrated the complete operation of the air-cooled marine diesel engine, with corresponding colors and labels provided to facilitate better identification of its components.

References

Books

Acero, Victoria O. et al. (1964). Principles and strategies of teaching. Philippines: Rex Printing Company Inc.

Garo, Candelaria D. (2008). Theories and principles of educational technology. Philippines: National Book Store, Inc.

Dr Williams, H. Michael D. (2010) Integrating Technology into Learning. Singapore: Prentace Hall.

Published Materials

Angie, Adecain A. (2000) Hydraulic kingpin remover and installer.Published Master's Thesis, University of Southeastern Philippines.

Unpublished Materials

Andoyoet, al. (2009) Engine Drive Train and Underchassis Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology.

Ausa and Labus. (2011) Power Window Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Bandigan and Garcia. (2009) Car Air-Conditioning Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Bernal and Donato. (2007) Cutaway View Differential Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Desales and Dicayan. (2010) Cut-Away View Manual Transmission Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Francisco and Gavino. (2010) Cutaway View Turbocharger Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Lim and Lubiano. (2010) Cut-Away View Gasoline Marine Engine Trainer. Unpublished Project Study: Davao Oriental State College of Science and Technology

Sarita and Sicabalo. (2010) Cut-Away View Torque Converter Trainer Unpublished Project Study: Davao Oriental State College of Science and Technology

Tipudan and Visandy (2010) Cut-away View Transfer Case Trainer Unpublished Project Study: Davao Oriental State College of Science and Technology

Internet

Eastern Tools & Equipment, Inc. From http://easterntools.com/news.html2008

Diesel Generator. From http://johnmeister.com/DIESELS/Diesel_Generator/Diesel-ETQ-Gen-178F.pdf

Sivertson, Jennifer From http://ezinearticles.com/?expert-JenniferSivertson 2011

Hako-Lehrmittel.Advancement in Technical Developments From http://www.hako-didactic.com/2011

Mockup. Mockup Definition From http://en.wikipedia.org/wiki/Mockup2011

Eder; Erich (Vombach/Inn, DE).Air-cooled Internal Combustion Engine 2002

Justin Ziehsldorf and Alex Baierl. Mini Baja, a Vehicle Prototyped for a Northeast Technical College. From http://www.preblemotorsports.com/minibaja.html
Ask.com from http://in.answers.yahoo.com/question/index?qid=20090723051150AAWSpqii

Mr. Jose S. Fernandez (2010) from http://iveta2010.cpsctech.org/downloads/materials/full%20papers/25.%20Individualized%20Trainer-Fernandez.pdf