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DESIGN AND PROTOTYPE DEVELOPMENT OF DIDACTIC HYDRAULIC PANEL TO BE USED IN RWANDA TVET SCHOOLS

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ABSTRACT

Didactic hydraulic panel is a fully equipped hydraulic training system with all necessary components and aids to conduct a comprehensive training course in the fundamentals of hydraulic controls. The didactic structure of the course is based on the long-established concept of training in hydraulic drive engineering. The central element of the unit is the large assembly panel. Here, two different circuits can be easily constructed using items from the kit of modern standard industrial components and connecting hoses. The moving frame within the didactic hydraulic panel system has a double sided assembly panel with tables sufficiently large for performing practical work at ease on either sides. It is assembled on four wheels, two of which have a brake, which enables moving and holding it in the classroom simply and comfortably. It includes a glass for volumetric measurements on each side of the panel. The lower section has a support shelf for holding the hydraulic power pack and storage drawers for components. A special quick-clamping system ensures all components are securely attached. The component connections face outward to allow easy interconnection by means of quick-couplers. An oil drip tray is positioned beneath the full width of the assembly panel. The sturdy mobile base unit houses the hydraulic unit and the electrical switch box. There is

generous space for all the system components to be accommodated in drawers and cabinets. The well-structured instructional material sets out the fundamentals and provides a step-by-step guide through the experiments.[HYDROTRAINER-200 Hydraulics - Electro-hydraulics by Igor J Karassik, 2010, 5th Edition] It will make them the spirit of creativity and innovation. And in this study we will have five chapters: chapter one is the introduction, the second chapter concerns literature review, the third chapter deals with design and data analysis, fourth research methodology, and the fifth is conclusion and recommendation, then reference.

KEYWORDS: Hydraulic, Prototype, Didactic, Panel, Polytechnic, TVET, TSS, Design and Development.

INTRODUCTION

The prototype design of didactic hydraulic panel is most used in Hydraulics Training System is part of a modular program in hydraulics and its applications and this prototype design of didactic hydraulic panel will help most of students from different TVET schools for realizing, analazing and simulating the main hydraulic circuits. The Hydraulics Training System answers the needs of students in Technical Institutes, vocational colleges, and university engineering departments, as well as in industry. The training system encourages hands-on learning and is a great addition to any hydraulics and pneumatics lab. The training program is divided into the following subsystems: Hydraulics Fundamentals, Electrical Control of Hydraulic Systems, Hydraulics Applications. PLC (Programmable Logic Controller), Troubleshooting Hydraulic Circuits, Servo Control of Hydraulic Systems, and Sensors. In Hydraulics Fundamentals, students are introduced to the basic principles and components of hydraulics. Electrical Control of Hydraulic Systems covers electrical control of hydraulic systems with ladder diagrams. Hydraulics Applications – PLC expands upon the others with hydraulics applications controlled by PLCs. In Servo Control of Hydraulic Systems, students are introduced to servo-controlled hydraulic systems and their associated circuitry. In Troubleshooting Hydraulic Circuits, students develop their skills in troubleshooting. [HYDROTRAINER-200 Hydraulics - Electro-hydraulics by Igor J Karassik, 2010, 5th Edition].

1.2. Background information

The research and didactic team in the field of hydraulics and pneumatics was established in 1964 under the leadership of Professor Stefan Stryczek. Since the year 1978, the head of the department was Associate Professor Wacław Kollek until his retirement in 2011, already as a

professor organized all forms of research and didactics in the field of hydraulic drives as well as vibroacoustics of machines, ranging from the design stage to the industrial implementations of new solutions about prototype of didactic hydraulic panel. [HYDROTRAINER-200 Hydraulics - Electro-hydraulics by Igor J Karassik, 2010, 5th Edition].

Design, planning, and equipping of complete labs' prototype of didactic hydraulic panel for technology and training a FESTO Didactic has set itself the goal of making learning even more effective, using its experience from 50 years of company history to develop learning solutions, as well as lab and workshop equipment for the training sector.[FESTO Pneumatic/Hydraulic Learning systems and services for basic and further training, by R.K. Bansal,2003, 2nd Edition].

1.3. Problem statement

As we all know the Rwanda technical and vocational education and training (TVET) schools and institutions have the big problem in teaching practical work of hydraulic and pneumatic sector, most of Technical Secondary Schools(TSS) and Integrated Polytechnic Regional Centers (IPRCs) which have the option of Motor Vehicle Mechanics(MVM) they only teach the theory of Hydraulic but no practice for it because of material lack that why I have decided to develop the topic entitled **"Design and Prototype Development of Didactic Hydraulic Panel"** which in turn will be the solution of this faced problem and I need to work on it as a subject of my final year project.

1.4. General objectives of project

The aim of this study is to do the prototype design of didactic hydraulic panel which will be useful and helpful for hydraulic practice in most of RWANDA TVET schools.

1.5. Specific objectives of project

The objectives of designing the prototype of didactic hydraulic panel is:

- To assess the knowledge and skills about hydraulic operating system before and after study;
- To develop a prototype design of didactic hydraulic panel.
- To construct a complete training system providing an experimental introduction to the fundamentals of hydraulics.

1.6. Research questions

- Can you facilitate the teachers to do assessment about hydraulic systems?
- Is it easy to design a proper prototype of didactic hydraulic panel.
- What will be the positive impact of this prototype design of didactic hydraulic panel for RWANDA TVET Schools?

1.7. Hypothesis

- The prototype design of didactic hydraulic panel has been the one way to facilitate the teachers for doing their assessment with the students.
- The proper prototype of didactic hydraulic panel has been easy in design.
- Most of Rwandan TVET schools has used this didactic hydraulic panel and this has helped learners to get enough hydraulic practical skills as solution of problem faced in previous pages.

1.8. Significance of the study

- This project has upgraded my knowledge and skills about hydraulic equipments.
- Rwandan TVET student had full access to practical work of hydraulic issues.
- For the country level, this has helped government to reduce budget invested in hydraulic tools and equipments requested by schools.

1.9. Delimitations of study

This project has been done in Kigali city especially at Integrated Polytechnic Regional Center (IPRC KIGALI), Site visits has been carried out at all Integrated Polytechnic Regional Center of Rwanda where I have got all of required information. And it has taken 2 months to do prototype design of didactic hydraulic panel from May up to June 2017.

CHAPTER II. LITERATURE REVIEW

2.1. Introduction

The Design and Prototype Development of Didactic Hydraulic Panel is part of a modular program in hydraulics and its applications. The Design and Prototype Development of Didactic Hydraulic Panel answers the needs of students in technical institutes, vocational colleges, and university engineering departments, as well as in industry. The Design and Prototype Development of Didactic Hydraulic Panel encourages hands-on learning and is a great addition to any hydraulics and pneumatics lab. The Design and Prototype Development of Didactic Hydraulic Panel is divided into the following subsystems: Hydraulics

Fundamentals, Electrical Control of Hydraulic Systems, Hydraulics Applications – PLC (programmable logic controller), Troubleshooting Hydraulic Circuits, Servo Control of Hydraulic Systems, and Sensors. In Hydraulics Fundamentals, students are introduced to the basic principles and components of hydraulics. Electrical Control of Hydraulic Systems covers electrical control of hydraulic systems with ladder diagrams. Hydraulics Applications – PLC expands upon the others with hydraulics applications controlled by PLCs. In Servo Control of Hydraulic Systems, students are introduced to servo-controlled hydraulic systems and their associated circuitry. In Troubleshooting Hydraulic Circuits, students develop their skills in troubleshooting. [FESTO Pneumatic/Hydraulic Learning systems and services for basic and further training, by R.K. Bansal, 2003, 2nd Edition].

2.2. Definition of keywords

Design: a plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is made.

Prototype: Is an original or first model of something from which other forms are copied or developed. : Someone or something that has the typical qualities of a particular group, kind, etc.

Development: Is the act or process of growing or causing something to grow or become larger or more advanced.

Hydraulic: Is a technology and applied science using engineering, chemistry, and other sciences involving the mechanical properties and use of liquids.

Panel: a comparatively thin, flat piece of wood or the like, as a large piece of plywood.

2.3. Parts of Prototype Development of Didactic Hydraulic Panel

2.3.1.Work surface

The Work Surface consists in a solid metal, universal drip-tray hinged to a perforated; til-table work surface on which components can be mounted. The Work Surface can be placed atop a regular work table or on an optional bench, which provides mobility and storage space.

Specifications

Dimensions (H x W x D): 80 x 900 x 700 mm (3 x 35.5 x 27.5 in) when the perforated work surface is lowered Net Weight: 16.8 kg (36.6 lb)

Figure 1: Work Surface.

2.3.2. Frame of work surface

The Work Surface (A-Frame) consists of two sloping work surfaces joined at the top and braced at their base by a universal drip tray. It allows two groups of students to connect separate circuits. It can be placed atop a regular work table or on an optional bench, which provides mobility and separate storage for the components. [Technical Transactions for Mechanics 4-M, by Ven Te Chow, 1981, 4th Edition]

Specifications

Dimensions (H x W x D): 540 x 900 x 820 mm (21.3 x 35.5 x 32.3 in)

Net Weight: 23.6 kg (52 lb)

2.3.3. Unassembled Bench

The Unassembled Bench consists of a mobile workstation on which the Work Surfaces can be mounted. Four heavy duty, swivelling, lockable casters allow the bench to be easily moved in the laboratory classroom. The bench has three pairs of side supports over which three Storage/Work Surfaces, can be slid to provide shelving for component storage. This bench variant requires assembly and does not comprise any dressing panel. [Technical Transactions for Mechanics 4-M, by Ven Te Chow, 1981, 4th Edition]

Figure 2: Unassembled Frame.

Specifications

Dimensions (H x W x D): 910 x 850 x 660 mm (35.8 x 33.5 x 26 in)

Net Weight: 37.3 kg (82.5 lb).

2.3.4. Bench (with Dressing Panels and Lockable Front Door, Assembled)

The Bench (with Dressing Panels and Lockable Front Door, Assembled) consists of a mobile workstation on which the Work Surfaces can be mounted. Four heavy-duty, swivelling, lockable casters allow the bench to be easily moved in the laboratory classroom. The bench has three pairs of side supports over which three Storage/ Work Surfaces can be slid to provide shelving for component storage.

This bench variant is provided already assembled and comprises dressing panels with a lockable front door. These dressing panels fully enclose the bench. The lockable front door consists of two hinged panels with a lock handle to secure the content of the bench. [HYDROMODEL-200 Transparent Hydraulics - Electro-hydraulics by K Subramanya, 2000, 5th Edition].

Figure 3: Bench (with Dressing Panels and Lockable Front Door, Assembled) Specifications.

[HYDROMODEL-200 Transparent Hydraulics - Electro-hydraulics by K Subramanya, 2000, 5th Edition]

Parameter	Value
Intended Location	On the floor (stands on casters)
Dimensions (H x W x D)	910 x 850 x 660 mm (35.8 x 33.5 x 26 in)
Net Weight	64 kg (141 lb)

2.3.5. Power Unit 6310-00 used on hydraulic panel

The Power used on hydraulic panel Unit consists of an electric drive motor coupled to a fixed displacement gear-type hydraulic pump, an oil reservoir, and an oil filter with pressure drop indicator. A built-in pressure relief valve limits the maximum pump outlet pressure to 6200 kPa (900 psi). The Power Unit is provided with a lifting frame that allows the Power Unit to be raised and lowered hydraulically, using either of the Cylinders, Models 6340 and 6341. [Electro hydraulics work book basic level by McGraw Hill, 1998 4th edition.]

Figure 4: Power Unit 6310-00 used on hydraulic panel.

Specifications

Parameters	Value
Dimensions (H x W x D)	920 x 485 x 500 mm (36 x 19 x 20 in)
Net Weight	69 kg (152 lb)
Current	8.8 A
Service Installation	Standard single-phase ac outlet
Flow	3.01 L/min (0.81 gal US/min)
Pressure	6200 kPa (900 psi) max., limited by built-in relief valve
Oil Tank	16.5 L (5 gal US), 10-micrometer filter with pressure loss indicator

[Electro hydraulics work book basic level by McGraw Hill, 1998 4th edition.]

2.3.5. Prototype development of hydraulic panel

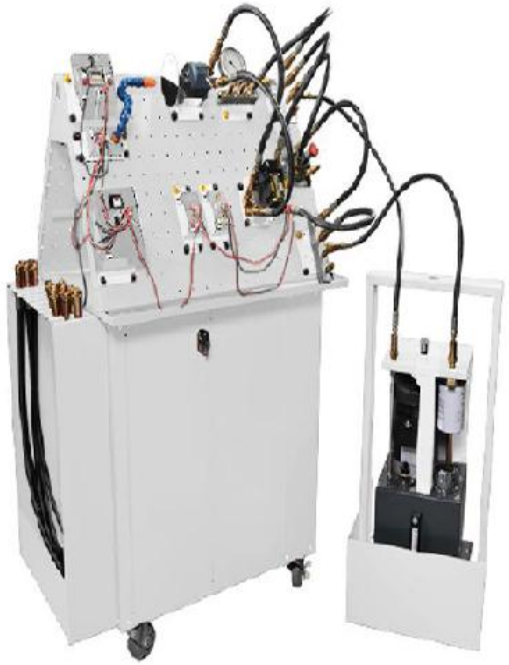

Figure 5: Prototype development of hydraulic panel.

[FESTO Pneumatic/Hydraulic Learning systems and services for basic and further training, by R.K. Bansal, 2003, 2nd Edition]

Presentation of Findings

Introduction

This chapter presents the results from all the respondents who took part in the study. The researcher employed the style of presentation of results where necessary using tables or figures to help readers summarize the findings from the field. This chapter therefore examines in detail the findings on availability and use of hydraulic teaching/learning resources in technical field and schools. This chapter begins by presenting the teachers and

pupils' profile in terms of gender and age and proceeds to present the general findings item by item and This section of my Research showed me how to discuss the results that I have to find in relation to both my research questions and existing knowledge about Design and Prototype Development of Didactic Hydraulic Panel. This has been my opportunity to highlight how my research about Design and Prototype Development of Didactic Hydraulic Panel reflects, differs from and extends current knowledge of the area in which I choose to carry out research. This section must be my chance to demonstrate exactly what I know about this topic by interpreting my findings and outlining what they mean.

General Findings

One of the items on the pupils' questionnaire was to know their gender and Table 1 below shows the details of how many males and female respondents took part in this study. In this research gender was very important because there was need to know the characteristics of the respondents who took part in this study and whether it had any influence in this study.

Table 1: Response of pupils by gender.

Response	Frequency	Percent
Male	73	56.2
Female	57	43.8
Total	130	100

In this study a structured interview schedule was administered to pupils the pupils were given objective questions where they had to answer yes or no. Table 1 indicates that there were 73 males (56.2%) as opposed to 57 females (43.8%).The results also mean that there were more male pupils taking hydraulic system who took part in the study than female pupils.

This study intended also to find out the ages of pupils who took part in t research as respondents. This was important in order to find out how age could influence the findings from the respondents. Table 2 below shows the ages of respondents who participated in this study.

Table 2: Age of high school pupils respondents.

Response	Frequency	Percent
19-22 Yrs	5	3.9
19-23 Yrs	118	90.8
24-30 Yrs	7	5.3
Total	130	100

Table 2 above shows that the majority of the pupil respondents were between 19-22 years old representing 90%. The ages between 19-23 contributed more responses to the questionnaires. The questions were all quantitative in nature as they demanded only 'yes' or 'no' responses. The table showed also that most of the pupils, 118 (90.0%) in high schools were in the range of 19-23 years old. This meant that the pupils had high levels of literacy and were able to read the questionnaires for themselves without difficulties.

In this study, the researcher also intended to find out the type from the schools under study whether they were government, mission or private This was important to the researcher in order to find out which type of schools had better facilities in terms of the provision of geography teaching/learning resources The details of the findings are presented in Table 3 below.

Table 3: Number of interviewed by types of schools.

Response	frequency	Percentage
Mission	51	39.3
Government	67	51.5
Private	12	9.2
Total	130	100.0

Figure 1 below showed that the majority of the) schools were GRZ (51%) followed by mission schools representing (39.2%) and the last being private schools representing (9.2%). There were more government schools due to government policy of building more schools to increase enrollment and accommodate more pupils. There were few schools being built by missionaries now. However, the beer of schools had no bearing on the type of responses obtained as the respondents were carefully selected Using the random sampling procedure.

As we have mentioned lines before the relationship between learning and teaching process is not causal, however when we refer to learning process, we have to do it in its own space as well as in relationship with teaching. Learning keeps up permanent relationships with practice, but the most important thing of its production takes root in the variety of perception relationships with environment. Learning is a topic of wide dedication in the current psycho-pedagogical field. To learn is the most universal occupation and a mean to make progress in any life stage, it is also important to point to the school period where autonomous and directed activity is organized and integrated in a curriculum. The study of learning process has been a concern of psychologists fundamentally, and from that results have come up

several theories. Some of them show learning which takes place in any subject and others have researched about school learning. Particularly, school learning is a very complex process, because of the variety of aspects on which we have to decide such as: planning, curricular development, evaluation, institutional participation matters, etc. "Therefore, the training of teachers as true pedagogues is an important work if we want to get an effective educational system"1 Curriculum components When we refer to the curriculum, we are talking about teaching-learning process organized into the educative phenomenon and the wide system of activities which are proposed in the Educational Centre in order to reach an integral formation of the student; that is to say the school learning. The teaching-learning process includes three intimately linked aspects:

- The techniques knowledge required by learners according to the respective level.
- The formation of their consciousness on the base of that knowledge and,
- The achievement of a behavior eminently practices in the first two mentioned aspects.

There are different ways of organizing and fulfill the teaching-learning process: the common class, seminaries, individual work, work group and so on. The elements which intervene in school curriculum can be summarized as to its Objectives and skills In their most general meaning objectives are related to the purpose or intention of a human action. All human activities are guided toward the acquisition of objectives, goals and purposes. Educational objectives are explicit formulations about abilities, attitudes and skills which the formation process attempt to reach in the subject of an educational situation. Learning objectives are defined as technical statements consider the arrival point of all teachers' action, and in this way they guide actions that allow achievements. Over them Functions of the instructional materials are Materials carrying out different functions in the classroom practice; neatly we will list some main functions of them as follow.

CONCLUSION

This project accomplished all the goals outlined in the project proposal.

Specifically the project designed, built and demonstrated a lower cost Prototype Development of Didactic Hydraulic Panel for hydraulic system that is efficient, and directly compatible with Rwanda TVET Schools. Because of the limitations of this demonstration, a small hydraulic power system was used. There is no reason to believe that this project could not be scaled up and used to produce deeper and/or higher hydraulic production rates. The most

economical means of hydraulic production using electrical energy utilizes the most efficient downhole pump available, reducing the size and cost of the power system for driving its pump. The use of flexible hydraulic lines over steel coil tubing also creates significant cost reductions.

REFERENCES

1. HYDROTRAINER-200 Hydraulics - Electro-hydraulics by Igor J Karassik, 5th Edition, 2010.
2. Hydraulics Training System, Lab Volt 6080 series by Less Hamil, 1996, 4th Edition.
3. Electro hydraulics work book basic level by McGraw Hill, 1998 4th edition.
4. HYDROMODEL-200 Transparent Hydraulics - Electro-hydraulics by K Subramanya, 5th Edition, 2000.
5. Technical Transactions for Mechanics 4-M, by Ven Te Chow, 4th Edition, 1981.
6. FESTO Pneumatic/Hydraulic Learning systems and services for basic and further training, by R.K. Bansal, 2nd Edition, 2003.
7. www.google.com.
8. https://sciencing.com/slovins-formula-sampling-techniques-5475547.html.