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Fabricating a Semiautomatic Screen-printing Table for the Department of Home Economics Education, Cross River State College of Education, Akamkpa

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ABSTRACT
The Department of Home Economics Education, Cross River State College of Education, Akamkpa, does not have a screen printing table for teaching home economics students arts and craft. Whereas a screen printing table is inalienable for teaching screen printing, there have not been funds to procure one for the department because of the huge costs. Imported semiautomatic screen printing tables, including freight and customs duty costs about twelve thousand dollars ($12,200.00) or about nine million naira (N9,000,000) at the present exchange rate of ₦750 per US Dollar. This clearly provides the incentive to fabricate, since it has been suggested that good equipment can be built for a fraction of the imported cost (Pitelka 2007). With a budget less than a sixth of the cost of an imported one (₦1,944,000.00), this study sought to employ standard industrial materials available locally to design and fabricate a semiautomatic screen printing table for the Department of Home Economics Education, Cross River State College of Education. The specific objectives were to use materials available locally in Nigeria to fabricate the semi-automated screen printing table, and ensure that it is powered by 24v DC electricity, to make it compatible with renewable energy. In the end, a semiautomatic screen printing table of 4feet by 8feet was designed, fabricated and tested to be functioning.

KEYWORDS: Screen printing table, semiautomatic, DC 24v, fabrication

Introduction

One major disadvantage of operating a tertiary educational institution in the present socioeconomic milieu in Nigeria is the lack of adequate funding for the purpose of acquisition and maintenance of vital teaching facilities and equipment. The evident result of this is that, in most academic departments in Nigerian tertiary education institutions, lectures, practical and tutorials are carried-out without students actually seeing or using the required equipment. In effect, students are graduating from programmes with only a glimpse of necessary equipment on the pages of textbooks and the Internet. This scenario is far more profound in departments where practicals, raw materials processing and demonstrations are primary, such as home economics departments.

At the Department of Home Economics Education, Cross River State College of Education, Akamkpa, textile design is taught as part of the curriculum, which ideally should include screen printing. These prints are made on paper, fabric, t-shirts and many other surfaces. Students ought to be doing screen printing on various surfaces. For printing, however, the most vital equipment required for the processes is the screen printing table. This is a special table with semi automation, padded and calibrated for the prepared screens to sit rigidly, to allow the printing of designs on to surfaces. Sadly, the lack of adequate funding has meant that the department has not had a screen printing table and teaching and learning has been grossly inadequate in our laboratories. Beyond pictures in textbooks, our students graduate without having seen or used the screen printing table. This is clearly a negative development that should be stopped by providing vital equipment for students to use in training. Without the screen printing table, hundreds of man hours are wast-

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ed in the department, and students are unable to achieve the quality of production needed. The unavailability of a screen printing table has therefore hindered the ability of the Department of Home Economics Education, Cross River State College of Education, Akamkpa, to execute an important aspect of its curriculum. The semi-automated screen printing table is therefore an urgent need in the department.

Statement of the Problem

Whereas the curriculum needs it, there is no semi-automated screen printing table in the Department of Home Economics Education, Cross River State College of Education, Akamkpa, for the processing of screen-printed designs and materials in the laboratory. Owing to this, lecturers and students have not been able to process screen printing works efficiently and effectively, which severely hinders teaching and learning. This study is justified because it will produce a functional semi-automated screen printing table for use in lectures, practical and tutorials in the Department of Home Economics Education, Cross River State College of Education, Akamkpa.

Furthermore, while automated screen printing tables are inextricable equipment for teaching and learning home economics, arts and craft, they are very expensive facilities when imported. Imported semiautomatic screen printing tables, including freight and customs duty costs about twelve thousand dollars ($12,200.00) or about nine million naira (N9,000,000) at the present exchange rate of ₦750 per US Dollar. This clearly provides the incentive to fabricate, since it has been suggested that good equipment can be built for a fraction of the imported cost (Pitelka 2007). With a budget less than a sixth of the cost of an imported one (₦1,980,000.00), this study sought to employ standard industrial materials available locally to design and fabricate a semiautomatic screen printing table for the Department of Home Economics Education, Cross River State College of Education. As Pitelka (2007) notes, improvisation and self-sufficiency are often a matter of economic survival for mainstream studio artists, which provides the incentive to fabricate. Pitelka insists that one can build studio equipment at much lower costs of imported versions. In the sense in which Pitelka makes clear, it is a sufficient justification for undertaking this study, if we can have such a vital but imported and expensive equipment for use, at a sixth of the cost of importing it.

Objectives

This research sought to employ standard industrial materials available locally to fabricate a semi-automated screen printing table for the Department of Home Economics Education, Cross River State College of Education. The specific objectives were to:

1) Design a semi-automated screen printing table powered by 24v DC electricity.
2) Use materials available locally in Nigeria to fabricate the semi-automated screen printing table.

Literature Review

A screen printing table is a machine in the basic shape of a table, which is used to produce various forms of art works that utilize screen printing techniques to transfer design onto surfaces (*Instructables Workshop* 2021). A screen printing table is a structure that resembles a normal table, but with soft layers of felt covered by thick, good quality canvas and other facilities that enable good screen printing (Hackshaw 2003). As with all studio equipment, the screen printing table's design and action can be matched to the right application (Philips 2015). Besides this, all screen printing tables can be automated in design or semi-automated. These tables are very expensive and it is not expedient for tertiary education institutions in Nigeria to import them. The Automatic Flat Screen Printing Machine with Vacuum Table for Ruler shown in Figure 1 is good, but very expensive at about $16,200 (about N12,000,000) with shipping and Customs charges. Owing to its expensive nature, the Department of Home Economics Education, Cross River State College of Education, Akamkpa, has not been able to buy one for its arts laboratory. This has meant that a good part of the practical curriculum has not been fulfilled. This is the gap that this research seeks to fill, by designing and producing a semi-automatic screen printing table for use in the department.

In the online resource, titled *How to Build a DIY Single-Color Silk-Screen Printing Station*, MITCHYBOY (2018) provides a clear modality for understanding the 3 basic types of screen printing tables. According to the

Fig. 1: Automatic Flat Screen Printing Machine with Vacuum Table for Ruler.

author, there are three basic types of printing tables that can easily be fabricated: wall-mounted press, simple board with hinge clamps, and workbench-mounted press

1. Wall-Mounted Press

According to MITCHYBOY (2018), the wall-mounted press is very easy to build and requires only a few building materials. It also functions easier for some jobs than the other two types of printing stations. The practical thing about this type of screen printing table is that the board on which the t-shirt is placed is adjustable, which means one can use different sized screens on the same table. The disadvantage of this design is that it needs to be mountd on the wall, making it unsuitable in a studio where more than 800 students will be using the equipment. That means that the screen printing table that will be produced in this research cannot be wall-mounted.

2. Screen Printing Board With Hinge Clamps

The 2nd design of the screen printing table is the most simple as it is just a flat wooden board with hinge clamps. This very basic design just needs screwing some hinge clamps into the wooden board and making sure they are lined up correctly. However, this design is too basic and is not adjustable. The hinge clamps are screwed into the board where the t-shirt is placed, so one cannot adjust the distance between the screen and where the t-shirt lies MITCHYBOY (2018).

Another issue is that it is difficult to slide the t-shirt over the board because it is sitting on the table. This means that one just has to lay both layers of the t-shirt on top of the board, which is not always easy to print, without some stains. Now, because of the challenges with this type of design, the screen printing table that this research will produce cannot be this, because it needs to be adjustable and wide enough for a broad range of printing jobs to be done with it. The Department of Home Economics has a lot of students, and it is important to have the best available for their uses in printmaking.

3. Workbench Screen Printing Press

The 3rd design of printing table is similar to the first, in that it has an adjustble board. However, the difference is that this press is designed to sit on top of a workbench. If one wishes to produce this type of screen printing table, one needs to ensure that the board protrudes from the desk so that one can slide the t-shirt onto the board. To design this press, one can use regular hinges attached to a piece of metal, to which the screens would be clamped. The disadvantage of this design is that it is very difficult to get it lined up nice and straight (MITCHYBOY 2018).

Again, because of this serious disadvantage of not being easily lined up, this research will not produce a workbench type screen printing table. It is important that students are able to easily line up their print jobs on the printing table, without mistakes that will end up being costly, because of the waste of materials and time. When line up is not straight, the print turns out very badly.

Determination of Appropriate Design from Literature Review

After reviewing literature on the three basic print table designs, it is clear that all the types – wall-mounted press, simple board with hinge clamps and workbench-mounted press – have disadvantages that prevent the researchers from adopting them wholesale. Scientifically, it is therefore not feasible to use any of these as template. What is scientifically appropriate to do is combine all the positive elements in the three types of work stations, and then use the combined elements to design an appropriate screen printing table for the Department of Home Economics Education, Cross River State College of Education, Akamkpa. In that context this research will produce a semi-automated screen printing table that will not be wall-mounted, will not have a bench, but will have a large surface area that can be used for large prints. Additionally, the guide rails will be structurall fixed to a very sooth moving linear bearing system, to ensure that the screen clamped to it are easy to align, move, adjust and printed. Also, the automation will be achieved with the use of multiple linear actuators, to achieve tight contacts between the screen and print surface. In terms of control, the controls will be user-friendly for ease of use by the students of the department. Furthermore, for safety reasons and to avoid accidents related to electric shock, the whole design automation will not be based on 220 volt Alternate Current (AC), but on 24 volt Direct Current (DC), which is harmless, because it will not produce dangerous electric shocks. It is also cheaper to use because it will consume less power. Furthermore, because of the negative power situation in Nigeria, the semiautomatic printing table will be fitted with an inverter and battery system to ensure that work can still continue when there is power outage.

According to Finck and Heumannskaemper (2013) of *Morgan Advanced Materials*, choosing materials that will provide maximum performance for one's operation is an individualized and complex task. The authors insist that any material selected to produce objects like studio equipment must be able to withstand the maximum pressures that may be applied to the equipment. Also, in terms of equipment fabrication, Ighodalo (2011) recommends the incorporation of control systems in equipment design and the determination of best practices in professional operations. Thus, the study shall include simple to use control systems to make it safe and user friendly. According to Graham (2003), in order to fabricate equipment, one can use

mild steel, cast aluminium and stainless steel. While mild steel has serious rust problems, cast aluminium may also corrode in no time. Thus, to avoid rust and corrosion, the steel used to produce the semiautomatic screen printing table will be coated with hard industrial protective paint. In the context of the assertions of Finck and Heumannskaemper (2013), Ighodalo (2011) and Graham (2003), this study shall employ materials that will ensure that the equipment will be durable, easy to use and safe in the studios, for the staff and students of the Department of Home Economics who will be using it to print.

Also, scholars have established the importance of using the right equipment in the teaching of technical courses in tertiary education (Ogundu 2011, Ugwua and Ogbonnaya 2013, and Ogundu and Wordu 2014). Ogundu (2011), for instance, sought to determine the effect of teacher constructed equipment on students' performance in metal work technology in technical colleges in Rivers state. The study adopted a quasi-experimental design that involved the use of a control group, pre-test - post-test design, using a population of 194 students from four technical colleges in Rivers state. The results indicate that the use of the constructed equipment had positive effects on students' performance in the course. The study established a difference in performance between those taught using the constructed equipment and those taught without the equipment. In the light of the findings, Ogundu (2011) and Ogundu and Wordu (2014) recommend that governments, institutions and relevant agencies should provide funds to procure materials and components for designing and constructing equipment for teaching. On this basis, the researchers are convinced that the semiautomatic screen printing table to be produced in the research will significantly enhance the teaching and learning in the department. This present study is therefore in line with scientific recommendations by seeking to fabricate the semiautomatic screen printing table for practical instructions in textiles design and production. The semiautomatic screen printing table is a primary equipment for all forms of printmaking and printing in courses taken by NCE students in Cross River State College of Education, Akamkpa, to produce several types of utilitarian, aesthetic and industrial print designs.

Materials and Methods

A bulk of materials were bought for the project (see Table 1). The 2"x1" 2mm square pipe was used to construct the table's mainframe with four legs (Figs. 2 and 3). An inner table frame of 4 feet by 8 feet was also welded, to mount the full sheet of MDF. Sheets of 1" inch foam was gummed to one side of the MDF, and the thick canvas cotton fabric was used to wrap it, to be used as the printing surface (Fig. 4). One piece each of the HGH2 linear bearings were screwed to the legs of the inner table frame. Short 25cm lengths of HGR25

Table 1: Materials used in Fabricating the Printing Table.

1	3mm sheets of steel
2	3mm 2" x 1" square pipe
3	3mm 1" x 1" square pipe
4	2" angle iron (4mm)
5	8mm square rods
6	HGH2 Linear bearings
7	HGR25 Linear rail
8	Welding electrodes
9	2 pieces 20mm stroke, 2000N 12VDC Linear actuators
10	Wired controller
11	1 sheet of Medium Density Fibreboard (MDF)
12	1 KVA inverter (12v)
13	12v 50ah deep circle battery
14	Sheets of 1" foam.
15	Zinc plated hinge clamps
16	Screws
17	Heavy duty 15 Ampère plug
18	4 Core industrial flex cables
19	3 yards of thick canvas fabric
20	1 yard of open mesh
21	Industrial squeegees

Fig. 2: The welded structure, showing the inner table, carriage, rail guard. Finishing is being applied to the structure.

Fig. 3: The welded structure, near completion, is being filed in preparation for spray-painting.

Fig. 4: One-inch foam gummed to the MDF and the thick blue canvas fabric being used to wrap the table's printing top.

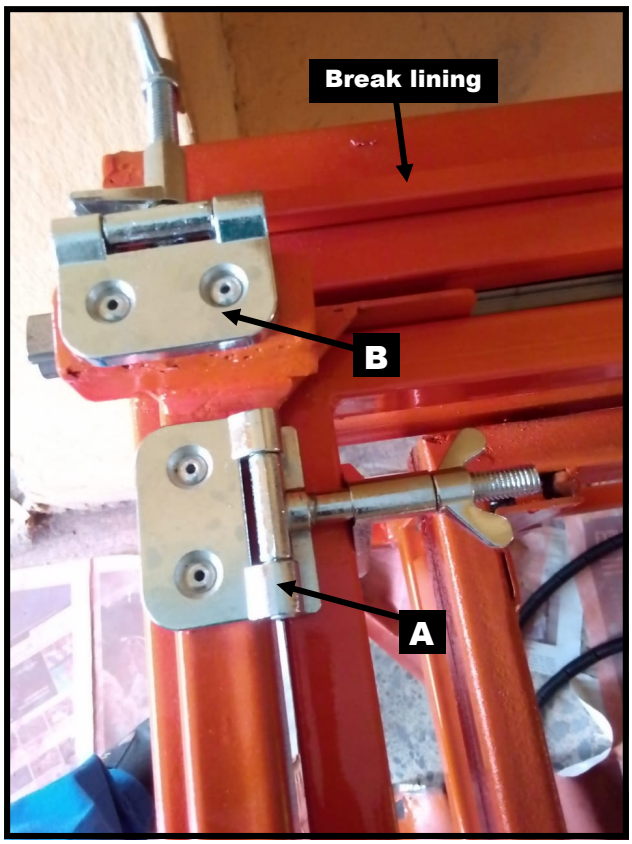

Fig. 5: Hinge clamps used as screen holder in the printing carriage (A) and as a "break" when clamped on the break lining (B).

Fig. 6: The table, undercoated and awaiting spray-painting.

linear rails were screwed to the legs of the printing table's main frame, to align with the linear bearings of the inner table frame. The inner table frame was then socketed to the mainframe of the table, and tested to ensure that the table top can move freely up and down the main frame.

Flaps of 2"x1" metal pips were welded to both long sides of the table and the HGR25 Linear rails were screwed on both sides. The researchers made sure to plum the two rails parallel to each other, so that the printing screen can move smoothly. Two printing carriages were welded from the 2" angle iron, and hinge clamps were screwed on them, so that they are able to firmly hold the screen (Se Fig. 5 "A"). The 1" x 1"

Fig. 7: The 2000N linear actuator screwed into position, under the table's printing top.

Fig. 8: The wired controller, showing the buttons that control the two linear actuators.

square pipe was welded to extend both ends of each printing carriage, to meet the linear rail. Two pieces each of the HGH2 Linear bearings were screwed on to both ends of each carriage, to ensure that both carriages can move smoothly across the printing table.

The 2" angle iron was also used to create protective covers for the linear rails, to prevent dust, particles and liquids. The 8mm square rods were welded on to the top of the rail protectors, to act as break lining for the printing carriage. Hinge clamps were then screwed on both sides of each carriage, such that they can clamp the carriage firmly to the break lining (See Fig. 5 "B"). 1" x 1" square pipe was also used to create the frame for the screen.

The table's legs were braced by welding, and a stow box of size 30cm x 30cm x 60cm was welded on one side, under the table. Ventilation holes were made on the box, and a lid was attached to this box, using smooth door hinges. Since the box was stowing away the electronic components, controls and small tools, a key was also installed. The whole table was first sprayed with a grey undercoat (Fig. 6), and then spray-painted with orange auto base paint and left to dry for one day.

The upholstered MDF was then screwed to the inner table frame, to complete the printing surface. The 2 pieces 20mm stroke, 2000N 12VDC linear actuators were mounted centrally, at the two long ends of the table, so that they can move the table's printing surface 2cm up to meet the screen, and down away from the screen (Fig. 7). The 12v 1 KVA inverter, 12v 50ah deep circle battery and 2-way power DC switch were mounted inside the stow box. The linear actuators were then wired to connect with the terminals of the 12v battery already mounted inside the stow box. Flex cable was used for the power cable, with a plug at one end. The wired controller was then connected to the system (Fig. 8). The entire table system was then tested, to ensure that it performed as expected.

Results

At the end of the fabrication, installation of various components and spray-painting, the semiautomatic printing table was tested. The printing carriage held the screen very firmly, and the screen moved very freely and easily across the table. Also the break lining and hinge clamp system worked perfectly to hold the entire printing carriage in position while the impression was being made during printing. Also, the electrical and electronic part of the system worked very well too. At the pressing of the "Extend" button on the wired controller, the linear actuators actuate and raise the printing table up to meet the screen, and firmly provide the contact and pressure required for a good print. After the printing, the entire table top also moves down when the "Retract" button on the wired controller is pressed to actuate the linear actuators. Owing to

Fig. 9: The finished semiautomatic screen-printing table. Notice the stow-box underneath, where the battery and electronics are located.

the inverter and battery bank in the system, the semiautomatic printing table can work long hours when power outage occurs. This happens because of the power stored in the battery.

Conclusion

The study has been able to design and fabricate a semiautomatic screen printing table that is functional, durable and easy to use (Fig. 9). Standard screen printing tables usually use vacuum pumps to raise the printing surface to meet the screen. In this study, however, the researchers used linear actuators to perform the function and it worked perfectly. The linear actuator system is also cheaper and easier to install than the vacuum system. In an economy like Nigeria, where outages occur regularly and power may be gone for hours and even days, the system fabricated by the researchers is of immense benefit, because there will be power to print for several hours and even days, depending on the volume of printing. Another good thing about this semiautomatic printing table s that it can be used with renewables sources such as solar or wind, since it is based on 12VDC.

References

Adventures in DIY Screen Printing (2010). Building Your Own Vacuum Table Poster Press. Online. <http://diysilkscreenprinting.blogspot.com/2010/12/building-your-own-vacuum-table-poster.html> Accessed 29.12.20.

Finck, D. and Heumannskaemper, D. (2013). Matching Your Crucible to Your Application. Morgan Advanced Materials. <http://www.morganmms.com/content/matching-your-crucible-your-application>. Accessed 18/06/2016.

Graham, Rogers (2003). Building a Pug mill. Online. <http://www.potteryatoldtoolijooaschool.com/building_a_pugmill.pdf>. Accessed January 29, 2017.

Hackshaw, Ashley (2013).The Making of a Printing Table. Online. <https://www.lilblueboo.com/2013/02/the-making-of-a-printing-table.html>. Accessed 06.02.2021.

Ighodalo, O. A. (2011). "Current Trend in Furnace Technology in the Melting Industries". Research Journal of Applied Sciences, Engineering and Technology 3 (3): 540-545.

Instructables Workshop (2021). Build a Professional Style Screen Printing Table. Online. <https://www.instructables.com/Build-a-proffesional-style-screen-printing-table/> Accessed, 02.3.21.

MITCHYBOY (2018). How to Build a DIY Single-Color Silk -Screen Printing Station. <https://feltmagnet.com/crafts/How-To-Build-A-DIY-Single-Color-Silk-Screen-Printing-Station> Accessed 20.10.2018.

Ogundu, I. and H. Wordu (2014). "Effect of an Improvised Furnace on Students Performance in Foundry Technology in Technical Colleges in Rivers State, Nigeria". Mediterranean Journal of Social Sciences 5 (1): 649-655.

Ogundu, Isaac. (2011). Effect of Teacher Constructed Furnace on Students' Performance in Metal Work Technology in Technical Colleges in Rivers State. Unpublished PhD Thesis, University of Nigeria Nsukka. <http://hdl.handle.net/123456789/1694>.

Philips, David (2015). "Pug Mill Mixer Selection Guide". Bulk Solids Handling 35(1): 28–29.

Pitelka, Vince (2007). Building the Harry Davies Single Shaft Vacuum Deairing Pugmill. Online. <https://www.scribd.com/document/131941430/Building-the-Harry-Davis-Single-Shaft-Vacuum-DeAiring-Pugmill> Accessed 04.09.2019.

Ugwua, H.U. E. A. Ogbonnaya (2013). "Design and Testing of a Cupola Furnace for Michael Okpara University of Agriculture, Umudike". Nigerian Journal of Technology 32(1): 22-29.