

DESIGN AND FABRICATION OF MULTIPURPOSE STATIONERY RACK

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ABSTRACT

The perception of product creation is thriving daily in the realm of modern technology to users. Products with several features have notably altered the modern world. This project shows the construction of a multipurpose stationery rack by gathering knowledge from college students. The prime objective of product development is to expand its market share considering all the college students' requirement. It is necessary for a product not only to fulfil college students need but also to cope up with target market specification. Various product development tools have been used to implement the desired concepts. 3D printer machine used to complete the fabrication of this project. The design is done by using SOLIDWORK.

Keywords: stationery rack, 3D printer, design

1.0 INTRODUCTION

Most college students need a stationery rack on a regular basis. Figure 1 shows existing stationery rack for used by most students. Stationery rack is one of the needs for students to store and organized their stationery. The common issues face by users for this product are lack of spaces and hard to pack especially by students. In college, most students need to pack their things at the end of semester. It is inconvenience for students to pack stationery rack as they are taking up space and unfold able. This issue has made students to just left and throw away this stationery rack. To avoid this wastefulness, it is necessary to design the products that can solve these issues. Nowadays, users students are more inclined to hold a device with several functionalities in one hand. They seek smart items that not only meet their many needs at a low cost, but also take up less space and have an appealing appearance. As a result, the designers' primary emphasis is to establish and develop the notion of multifunctional usage of a product to stay up with the current situation. The design and development process of a multifunctional stationery rack is interpreted in this study. Product design and development tools are used to undertake design simplification, concept formulation, assessment, and selection.



Figure 1: Common stationery rack

2.0 RESEARCH METHODOLOGY

The methodology of this study is divided into two parts. The first step is to design a multifunctional stationery rack. concept generation and evaluation which consists of morphological chart and Pugh chart are the first step of design [1-3]. In generating novel concepts, it is strategic to use CAD software where this type of software can represent a wide range of concepts which allows the unexpected matching of components to be considered [4]. In this project, CAD design using SolidWork is used before proceeding with product fabrication. This Computer-Aided Design (CAD) developed by SolidWorks is working as a device to envision the outcomes of the intended product. This process is done after selecting the best design using morphological and Pugh chart. In this project, the fabrication process for this product is using a 3D printer. This method was chosen because it is easier to custom each design part by printing according to the design. Since the design is small and doesn't need to withstand critical load, it is advantageous to use this method. The multi-purpose stationery rack will be created through a series of processes. PLA+ was chosen as the material used in this project since it doesn't jam the equipment during extrusion processes where this material melts properly. PLA+ filament is a type of 3D printing material that combines the best qualities of PLA and PETG. It is an enhanced version of PLA filament with special additives that improve its strength, heat resistance, and dimensional accuracy. The multi-purpose stationery rack will be created through a series of processes using 3D printer where it involves converting file, material selection, levelling, pre heat process, part removal and assembly of the parts. Each of the parts from SolidWork file needs to be converted first before parts are printed. Figure 2 shows the flowchart of design process while Figure 3 shows flowchart of fabrication process respectively.

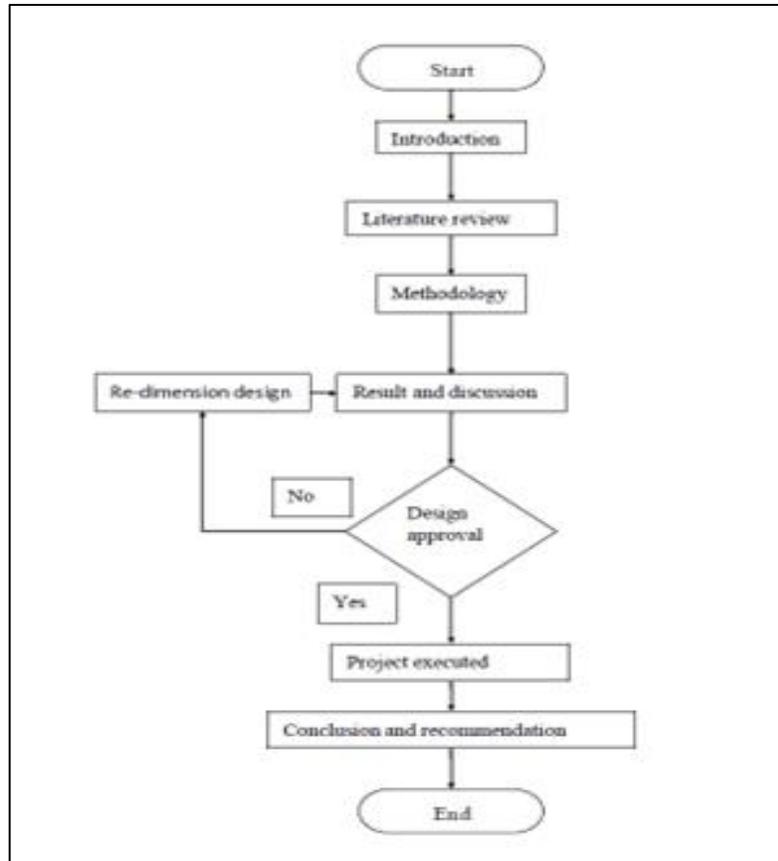


Figure 2: Design Process Flowchart

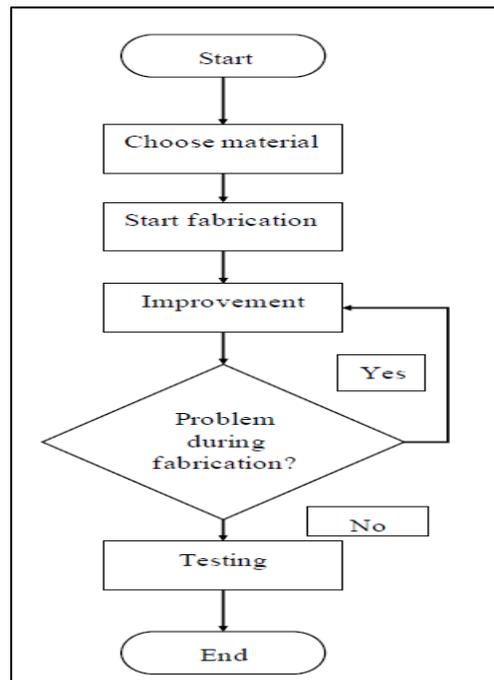


Figure 3: Fabrication Process Flowchart

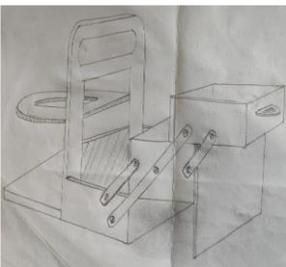
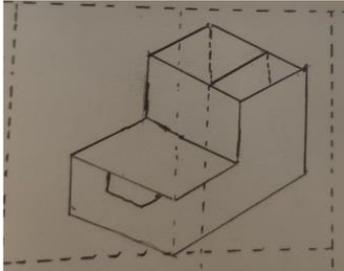
3.0 RESULT AND DISCUSSION

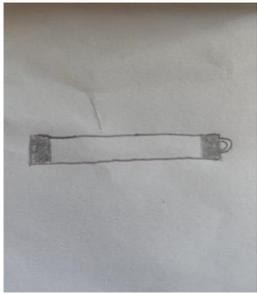
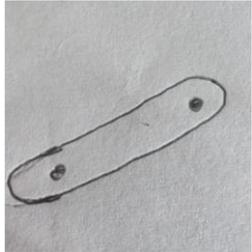
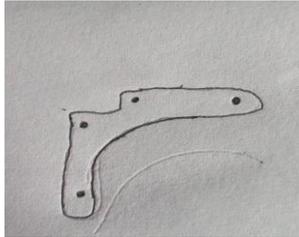
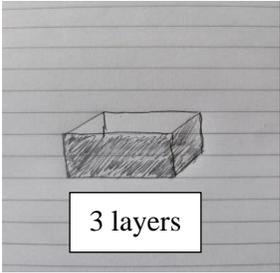
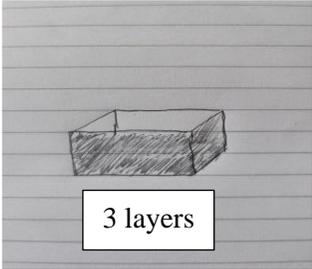
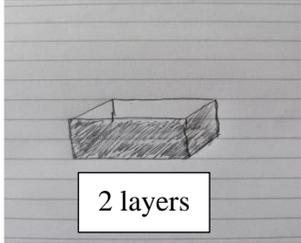
3.1 Design Process

The progress of concept of a product is started using morphological tables. The morphological table includes a complete list of drawing concepts applicable to each function. Three different designs are sketched on A4 paper. Then, from there the final design will be chosen using this process. The identification of design's weakness and strengths is described in detail in these sketches. Materials that will be used in each design are also stated in the sketches. The appropriate design will be chosen after the process of examining the concept's endurance and evaluation. All aspects must be considered when choosing the design. To probe various methods and combinations of obtaining a functionality, a morphological chart can be used to visually denote the functionality that a product must have. There may be several options for dealing with each component of a product's function. Table 1 shows the morphological chart of this project.

One of the methods to determine the most suitable concept is concept selection. Before proceeding to the design stage process, the specifications given should follow all the decision-making criteria. This design process stage allows a cost reduction and time implication [5-6]. Augustine et al. [7], state that to exclude the cost of redesigning the final product and escalate the productivity in the project development process the right selection of design concepts should be determined first. There are many possibilities of multicriteria decisions mentioned by these researchers such as Quality Function Deployment (QFD), Analytic Hierarchy Process (AHP), Pugh Matrix, multi-criteria optimization, and fuzzy logic methods to aid concept selection namely. Pugh Matrix or also recognized as Pugh Chart, is selected as a systematic approach in deciding the best design from the three proposed design concepts for this paper.

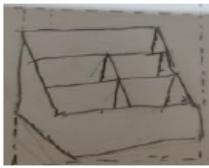
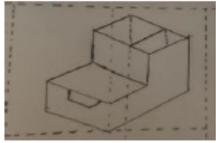
Table 1: Morphological Chart

Sub- function	Option Solution		
	1	2	3
Design			

Feature	Foldable	Spacious	Hidden drawer
Lamp Type			
Switch Type	Pushbutton switch	Toggle switch	Pushbutton switch
Folding Step		-	
Lamp Fastener Type	Magnet	Course (UNC) Screws	Rivet
Storage			
Material	Polylactic Acid (PLA)	Steel	Aluminum

Pugh chart is used to evaluate different concepts at the same time. Pugh chart is also used to encourage individuals to evaluate the advantages and disadvantages of each design with respect to the design criteria. The best option can be chosen by using a Pugh chart to compare various concepts. As a result of its assistance with decision-making, it is also known as a decision-making matrix or decision-matrix approach. Table 2 shows the Pugh Chart used for this project.

Table 2: Pugh Chart

Description	Design Concept			
				
Criteria	Weightage	Design 1	Design 2 (datum)	Design 3
Easy to use	3	+	0	0
Durable	3	+	0	0
Cost	1	-	0	+
Aesthetic	2	+	0	+
Efficiency	2	+	0	-
Materials	2	+	0	0
+		12	0	3
0		0	12	8
-		1	0	2
Net Score		11	0	1

Scale indicator:

[+] = greater than datum

[0] = as per datum

[-] = less than datum

Scores are assigned to each design based on a weighted average of all the criteria. Design with the highest score is the best design to choose.

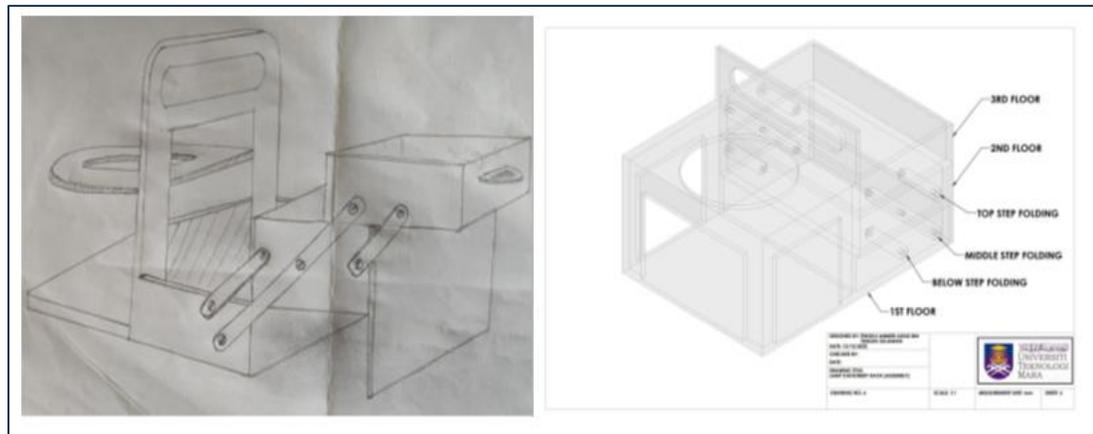


Figure 4: Final Design

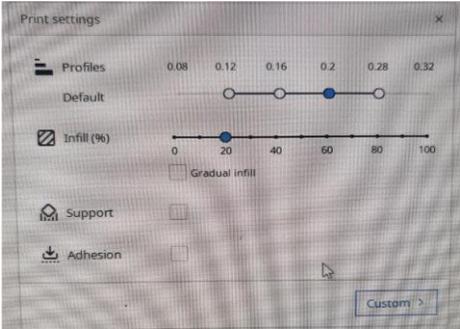
Figure 4 shows the final and best design chosen in this project. Design 1 was chosen because the net score is the highest according to Pugh chart. This design provides the best criteria where the design is easy to use, durable, more efficient and the material used is user-friendly and safe. Lastly, Solid Works application is used to draw the final design. Solid Works can be used to generate detail drawings for each component as well as assembling each component with dimensions. Each dimension of every drawing should be accurate and should be labeled as reference for the fabrication process. After the design’s drawing is finalized, the fabrication process can be executed.

3.2 Fabrication Process

The fabrication process is executed in the lab where machines needed is prepared. The multi-purpose stationery rack will be created through a series of process. After fabrication process is completed, product must be tested to ensure it is properly functioning. Modifications should be made if product does not function properly and achieve objectives.

For the fabrication process, two main parameters, which are material selection and fabrication execution, will be prioritized. The multi-purpose stationery rack will be created through a series of processes using 3D printer (converting file, material selection, levelling, pre heat process, part removal and assembly). Table 3 shows the fabrication process of multi-purpose stationery rack.

Table 3: Fabrication Process of Multipurpose Stationery Rack

Process	Description
	<p>Converting file the file of SOLIDWORK which is (.PRT) is converted to (STL) format. These files is converted for each part that need to be printed.</p>
	<p>Materials Selection PLA+ is a material chosen in this project. This material is chosen because of the ability of this materials to melt without jamming the 3D printer.</p>

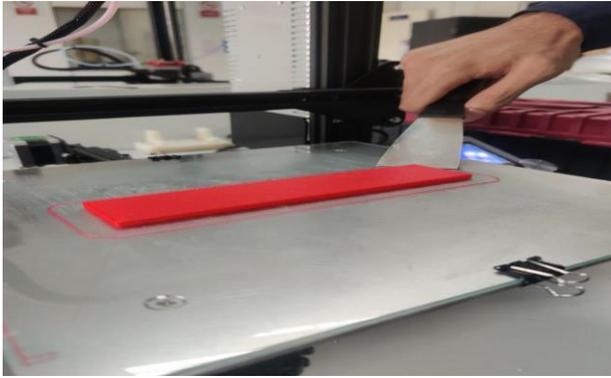
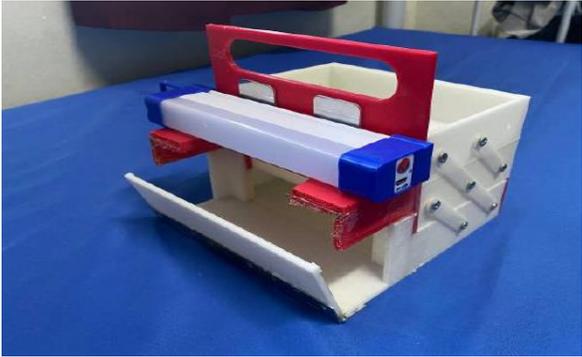
	<p>Levelling The 3D printer is set up first by levelling the build platform. By doing this, it can avoid a significant likelihood the filament doesn't first appear to be adhering to the print bed.</p>
	<p>Pre-heat process The materials should be pre heat first before being extruded.</p>
	<p>Part Removal After part is finish printed, flat chisel is used to take the part slowly from the base.</p>
	<p>Assembly of each part Each part is assembled according to the design.</p>

Figure 5 shows the view of multipurpose stationery rack when extended. Each part of the design should be simulated by the software Ultimaker CURA on finding the stability of the design before the printing process is started to make sure the design that printed finish faster and smooth effectively.

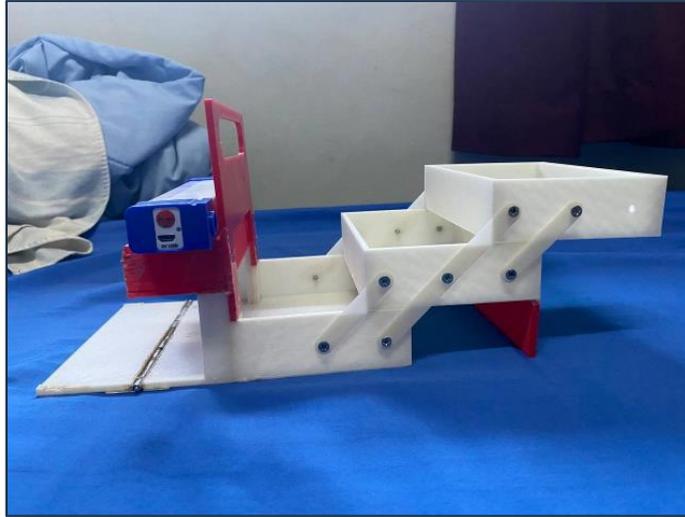


Figure 5: Side view of multipurpose stationery rack (extended)

4.0 CONCLUSION AND RECOMMENDATION

The design of the multi-purpose stationery rack was completed as per the planned design. Fabrication using 3D printer was carried out accordingly as per process. Then, the product has undergone testing to ensure all the safety aspects and the objectives of this project were achieved. The focus of this project is to fabricate a multipurpose stationery rack with foldable functions is achieved. The primary purpose of this stationery rack is to place stationery in a more organized way and to maximize space. This project provides an alternative for a common stationery rack that takes up more space and is harder to store and pack. It is a recommendation to use materials that are user-friendly.

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