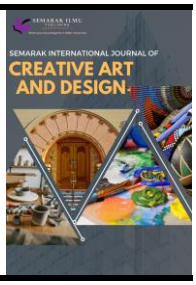
SEMARAK ILMU PUBLISHING

Semarak International Journal of Creative Art and Design

Journal homepage:
https://semarakilmu.digital/index.php/sijcad/index
ISSN: 3083-8584



The Beehive Design

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ARTICLE INFO

Article history:
Received 1 June 2024
Received in revised form 10 July2024
Accepted 15 August 2024
Available online 30 September 2024

Keywords:
Beehive; functional sculpture; art design

ABSTRACT

A functional sculpture can be described as a sculpture that merges artistry with practicality. To design a concept of functional sculpture that symbolizes the School of Design (SDe) specifically for Product Design at Universiti Teknologi Brunei (UTB) requires extensive background research on the subject itself, as well as conducting several surveys to gain information based on the public view and how well received is the concepts shown. Two methods of choosing are also done which is the House of Quality and Pugh method to pick the most favorable concept. One of the concepts chosen which was related to the school of design is a beehive where bees create honeycombs to provide shelter and food for the young bees to grow. A similar thing could be said for the School of Design towards its students.

1. Introduction

Product design is the process of conceptualizing, generating, and refining ideas into workable inventions and products. It can combine user needs with business objectives to assist brands in producing consistently successful products. It also involves imagining, creating, and iterating products that solve problems for users or address needs in each market. According to the Interaction Design Foundation, Product designers go beyond just functionality, they aim to make their products not only user-friendly but also sustainable for the company's future. The core of good product design is understanding the people who will use it. Designers put themselves in the user's shoes to grasp their habits, needs, and frustrations. This empathy allows them to solve real problems for real people [1]. The product designer's role has become a synergy of artistic vision, scientific analysis, and technological proficiency. This fosters the creation of user-centric products that are both aesthetically pleasing and functionally sound. The emergence of powerful digital tools has significantly streamlined this process, empowering designers with improved communication, visualization, analysis, and 3D modelling capabilities.

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https://doi.org/10.37934/sijcad.1.1.113a

A sculpture is defined as a three-dimensional art that is physically displayed in terms of height, width, and depth. However, a sculpture's meaning extends beyond its apparent spatial qualities. As written in the study on the problem of meaning in the art of sculpture [2]. The relationship between sculpture and location, as well as the act of creation, are identified as the two main levels of meaning in this study, it is concluded that the process of creating a sculpture dictates its final product thus why it is considered as a self-referring entity.

As a matter of fact, sculpture making has existed for a long time. Because stone was widely available and required little processing, it was one of the first naturally occurring materials to be employed to produce artifacts as written by Richard Newman on A Scientific Research on Stone Sculpture [3].

Functional sculpture, also known as sculptural furniture, merges artistry with practicality [4]. It serves a function while possessing aesthetic value and potentially hidden meaning. This concept aligns with the broader category of functional art, which bridges the gap between fine art (focused on emotions, intellect, and beauty) and everyday objects [5].

Contemporary sculpture embraces this blurring of lines, encouraging experimentation and innovation beyond traditional forms [6]. Grays, beiges, and white hues are emphasized in minimalistic components that define contemporary style. Carefully chosen details that are subtle and hidden accentuate a well-curated style. Designs emphasizing usefulness and simplicity above collections and fuss define the 'everything in its place' atmosphere with current style. Whether it is diverse design, interactive virtual reality design, green ecological design, or "people-oriented" customized design, design is proactive and predictive. Future development trends will center on the creation of the Emerging Technologies Alliance (ERA), which will fuse cutting-edge science and technology with the arts and sciences to create more avenues for development. The people and artists have never had such influence over design as concluded by Yan Lu in “Research on the Future Development trend of Contemporary Design” [7].

School of Design is a faculty under Universiti Teknologi Brunei (UTB) that houses undergraduates and postgraduate students throughout their course. It consists of three courses: Product Design, Architecture, and Fashion Design. The faculty itself has several rooms for the students to attend their classes, as well as a lobby. However, there are times when a room is shared between the students of different classes which then requires the next class students to wait outside by standing or going to farther places to sit and/or wait. This is where the idea of having a resting place or a lounge area for the students was born, it will be a great bonding place for the students as well as a resting spot before and after classes.

2. Methodology

2.1 Survey Analysis

Before a survey is conducted to receive public responses, a sample size is first required to know the specific number of responses needed for validation. Because it merely represents a portion of the target population or group of individuals, it is referred to as a sample. The survey is required as it’s important to gather others’ insights and opinions. The sample size required is 50 from the School of Design population and the total respondent received is 51.

Based on the 51 respondents, a rough idea can be generated during the concept idea generation process as the survey will serve as a guide for us to create well welcomed ideas. The performance and functionality of the product are then compared to those of rivals through benchmarking and product dissection, which enables the strategic development of the product roadmap and identifies opportunities for improvement.

The first product dissection is the sky machine, a blog explains all about The Shy Machine [8]. A dynamic, sound-responsive, environmentally friendly, motion-activated light sculpture. The sculpture exhibits shyness. Depending on the surrounding noise levels, it opens and shuts. The two parts close in on themselves and a fast, tense throbbing of multi-coloured light appears when the space becomes too boisterous. The machine opens halfway and shows a calmer pulse of green, blue, and purple light as the room becomes quieter. The Shy Machine fully opens and presents a gradual pulse of wavy rainbow colours when the room is at its quietest.

The next dissection is the Hold the Line sculpture. A sculpture-like design with obvious as well as hidden qualities. The seating furniture resembles a "waiting loop" [9]. The idea of a typical bench is entirely altered by the sitting configuration. It is not like the other public chairs; it is contemporary and distinctive. Several of the seats have geometric designs that make them both fashionable and cozy to sit on. The complete loop is powered by a network supply and network wires. [10].

The final dissection was on Vaask Hand Sanitizer. According to the official Vaask website [11], The Vaask is a long-lasting, integrated hand sanitizing device that enhances the aesthetics of any area and makes hand hygiene appealing. The PalmPilot® sensor in the fixture precisely measures the distance and motion of hands, preventing erroneous dispenses and removing mess. Vaask has earned numerous awards, including TIME's Best Inventions, and the Healthcare Facilities Symposium & Expo honoured Vaask with both its Architect's Choice and Most Sustainable Product awards.

2.2 Concept Generation and Sketch

Before the concept generation and sketching starts, anthropometric data is required to create a functional sculpture that will be compatible with most users. Since there is no research found regarding the anthropometric data for Brunei's population. The measurements of the sculptures would be based on the data from two studies which are the Anthropometric measurements among four Asian countries in sitting and standing [12], as well as the Anthropometry of Malaysian Young Adults [13].

The first concept done is "Light Bulb" as shown in Figure 1. The light bulb symbolises innovation, enlightenment, and holds rich symbolic meanings, as well as representing ideas, creativity, hope, and the illumination of truths [14]. Product design is all about the process of creating an idea into something tangible, and what represents an idea better than a light bulb.

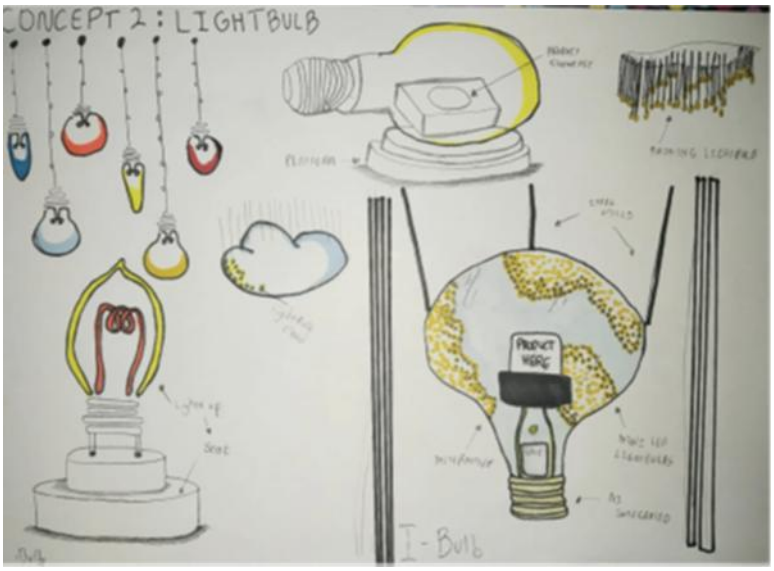


Fig. 1. A light bulb-inspired sculpture

The second concept is based on a “Duck” as shown in Figure 2. For a variety of waterfowl in the Anatidae family, duck is their typical name. Compared to geese and swans, who belong to the same family, ducks are typically smaller and have shorter necks. Personally, Cohort 5 has always referred to us as “duckies”. This is a play on words with Pro-’Duck’ Design. So, this could be an opportunity to make ducks a part of the product design identity. Moreover, ducks are generally viewed as a metaphor of new beginnings, reflecting the concept of fresh begins and good transitions. This could be a value that product designs can stand by, focusing on creating innovation for the world.

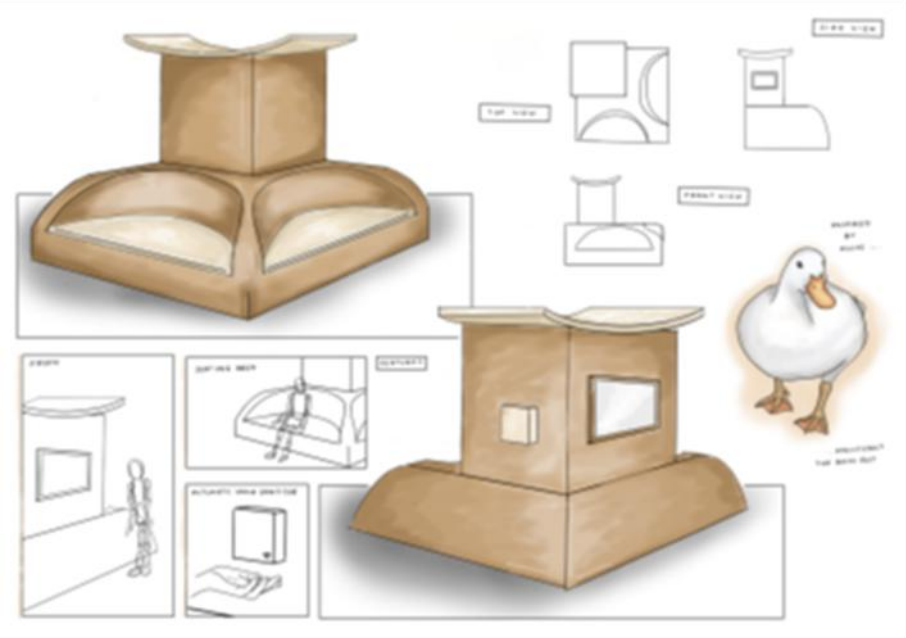


Fig. 2. Sketch of a duck inspired sculpture

Figure 3 shows the final concept is “Nature”. The main inspiration for this is “Bees”. They create honeycombs in hives, not only to store their honey but also to provide a place for young bees to grow. This structure, created by the bees, benefits the entire hive by providing food and shelter. As mentioned before in the problem definition, it is found that most user when thinking about product design, they think about products made first. Following this, the concept is more focused on the products made in this case, which are honeycombs instead of focusing on the bees. Honeycomb structures were also proven useful in a lot of areas as proven in an article about using nature to inspire human innovation [15].

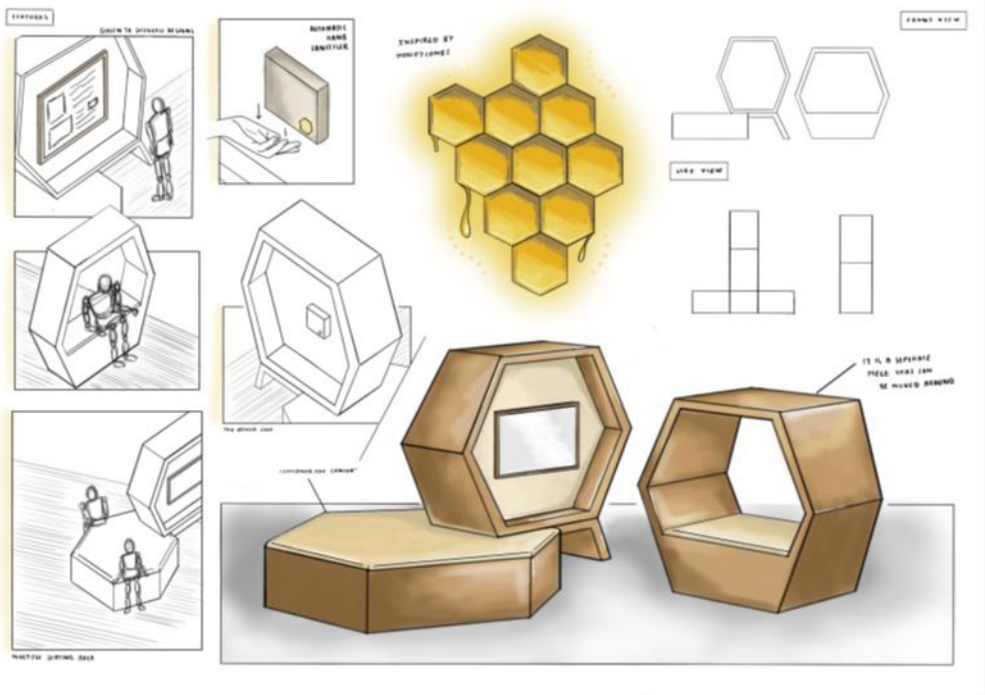


Fig. 3. Final concept sketch that is inspired by nature, specifically honeycombs

2.3 Concept Selection

To choose between the 3 concepts, the House of Quality (HOQ) and Pugh method as shown in Figure 4, 5, and 6 are used to choose between the concepts. The House of Quality is to identify the importance of the technical requirement, as well as scoring each concept according to the user's requirement to help for the final concept selection.

			Ergonomic	Smart System	Multi Material	Functionality	Contemporary Design	Indoor Sculpture	CONCEPTS: Honey-comb	CONCEPTS: I-Bulb
Size	1	4.54%	⊙		△	△		○	5	5
Interactivity	5	22.73%	⊙	⊙		△			4	3
Quality	2	9.09%	○		⊙		⊙		3	3
Reliability	4	18.18%	⊙	⊙	○	⊙		△	5	3
Resting Place	4	18.18%	⊙		○	⊙			5	2
Cleaning Place	3	13.64%	⊙	⊙		⊙			3	0
Product Showcase	3	13.64%	⊙	⊙		⊙		⊙	2	4
IMPORTANCE			8.45	6.14	1.95	4.77	0.82	1.55	TOTAL = 23.68	
PERCENTS OF IMPORTANCE			35.7%	25.9%	8.2%	20.1%	3.5%	6.6%		

Fig. 4. The HOQ table

USER REQUIREMENT	WEIGHTAGE/ %
SIZE	4.54
INTERACTIVITY	22.73
QUALITY	9.09
RELIABILITY	18.18
RESTING PLACE	18.18
CLEANING PLACE	13.64
PRODUCT SHOWCASE	13.64

HONEY COMB		I-BULB	
RATE/5	PERCENTAGE	RATE/5	PERCENTAGE
5	4.54	5	4.54
4	18.184	3	13.638
3	5.454	3	5.454
5	18.18	3	10.908
5	18.18	2	7.27
3	8.184	0	0
2	8.184	4	10.912
TOTAL	80.9%	TOTAL	52.7%

Fig. 5. The score table

From the score table, it is shown that The Hive has a score of 80.9% as compared to I-Bulb which has a score of 52.7% only. So, The Hive is a better design that fits the user's criteria better. To ensure that The Hive is a better design, we decided to evaluate it using Pugh's method. This method would allow us to provide an evaluation with relation to the user's requirement as well as the sculptures used as benchmarks. The benchmarked products would be set as the datum, a comparison.

		CHOSEN DESIGNS		DATUM	
Design Specification	Weighting	Concept 2 Bulb (I-Bulb)	Concept 3 Nature (Honeycomb)	The Shy Machine	Hold The Line
Has an Ergonomic Design	5	-	S	-	S
Smart System implementations	5	S	S	S	-
Consists of 3 functions (or more)	5	S	+	S	-
Has a Contemporary Design	4	-	-	-	S
Made from Multi-materials	1	S	S	S	-
Appropriate size dimension	1	S	S	S	S
Made for Indoors	2	S	S	S	S
Includes Resting Area	3	S	+	-	S
Includes Cleaning Area	3	-	+	-	-
Includes Product Showcase	3	+	+	-	-
	TOTAL (+)	+1	+ 4		
	TOTAL (-)	- 3	- 1		
	TOTAL	- 2	+ 3		

Fig. 6. The Pugh Method table

From the table shown above, the honeycomb has a total of +3, whereas the I-bulb has a score of -2. The Hive has a - on its contemporary, although the design is up for subjectivity with the comparison to the datum, specifically the Hold the Line sculpture, The Hive visually lacks the contemporary element.

By using the HOQ and Pugh's Method, we are ensured to bring forward the right design that fits best with the needs of users. Hence, the final design that was chosen is The Hive since it has the best score in both evaluations. Figure 7 shows the final chosen concept for this project.

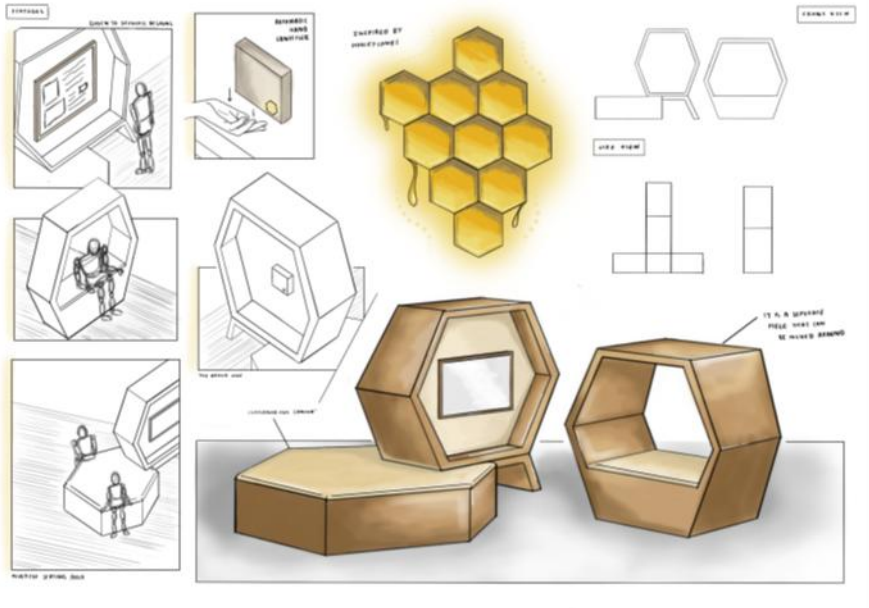


Fig. 7. Final chosen concept sketch

3. Results

3.1 Final Design

The sculpture's body can be separated into 3 pieces, which are shown in Figure 8 shows the 3D drawing below which has been done using Autodesk Inventor, and its measurements are based on the anthropometric data shown in the research section. Figure 9 shows the render design using Blender software.

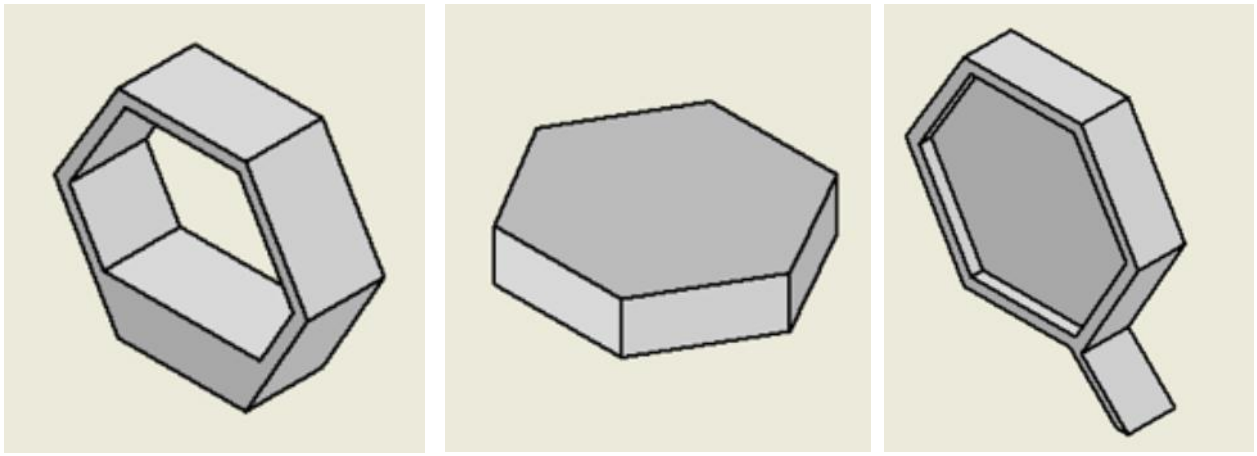


Fig. 8. 3D drawing

Fig. 9. 3D model made using Blender to simulate its actual size compared to a human model

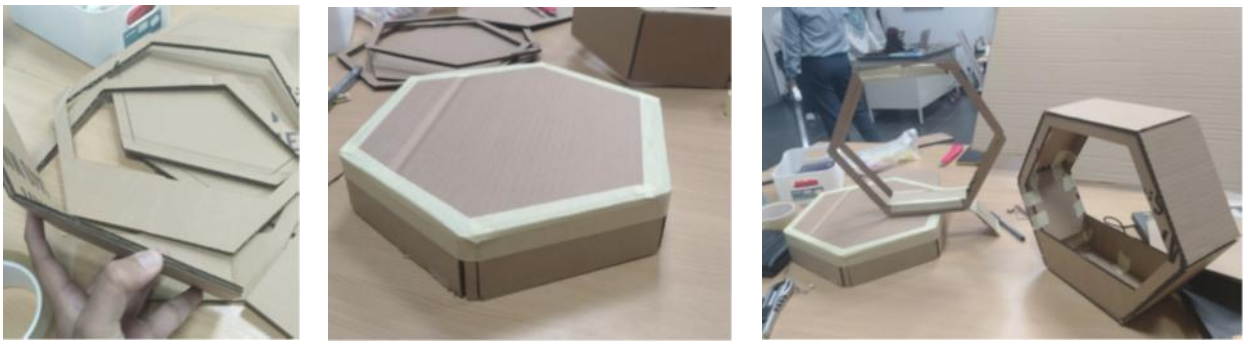
For the smart system, the only focus is on the mechanism for the hand sanitizer dispenser because a smartphone display will be used to represent the tv as it can display products for a better visual representation. The flow of the C++ code is quite straightforward, when the IR sensor senses any presence within its proximity, it will activate the servo motor to start the mechanism for hand sanitizer.

3.2 Preliminary Prototypes

The first prototype is a 3D printed 1:60 scale model using PLA+ filaments on a Creality K1 Max, to help visualise the form of the sculpture and its proportions. This allows us to see if there needs to be any adjustment in terms of its measurement. From the results shown in Figure 10, it is an appropriate size.

Fig. 10. 3D printed 1:60 Scale Model

For the rough prototype, as it is a low fidelity prototype the materials used are just supposed to represent the final prototype i.e. cardboard to show the wood. The pieces are cut using a laser cutter and joined by using masking tape as well as glue. The rough prototype is to see how it would look like with the scale we want to present, as well as to test out the smart system. Figure 11 (a), (b), and (c) show the rough prototypes being cut, the assembly of the connected seating piece, and the body of the sculpture respectively.



Cutting the cardboard (a) | Assemble the cardboard (b) | Cardboard arrangement (c)

Fig. 11. Rough prototypes

As for the cushion, it is made with a cardboard base filled with cotton and covered with leather fabric. The whole body of the sculpture is spray painted black, just to create a unison and complete look for the prototype as shown in Figure 12 and 13.

Fig. 12. Sculpture with LED screen

Fig. 13. Sculpture with the hand sanitiser

3.3 Final Prototype

Like the previous prototype, a 3D model plan was used as a guide to cut parts of the model but this time using 3mm plywood instead of cardboard to improve both its quality and durability, as well as to execute a much better finishing in terms of its smoothness and colourings. Figure 14 shows the prototype made from plywood.

Fig.14. Seat section that is being joined after cutting

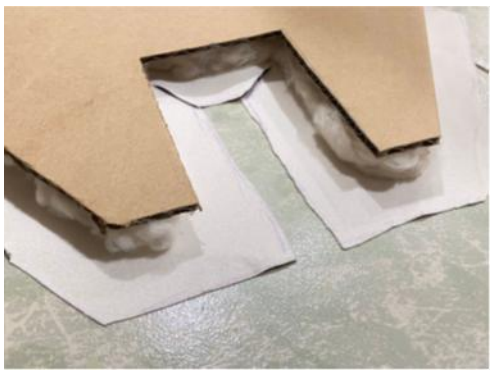
Before any sort of joining method, a quality control check is done on the plywood that had been cut by doing proper prepping on its surface and corners. Using a sanding machine with 1500 grit sandpaper attached to it to both remove excess wood as well as to smooth its surface to deem it worthy for wood glue and joining as shown in Figure 15. A pillar was also added between each corner to ensure a strong joint as well as to make a support for a more stable base. This is further strengthened with putty as shown in Figure 16. A similar process is done to the independent seatings in Figure 17.

Fig. 15. Sanding process

Fig. 16. Corner pillar

Fig. 17. Independent settings

The cushion consists of 3 layers, the cardboard base, the cotton filling, and the leather fabric cover. The leather is then stapled to the cardboard base to secure it with the cotton inside. Once done, it is finally glued on the wooden model. The process is shown in Figure 18 (a), (b), and (c) below.



Carboard base
(a)

Cotton filling
(b)

Leather fabric cover
(c)

Fig. 18 The process of cushion making

3.4 Final Assembly

Figure 19 shows the final assembly for the overall The Hive design. The prototype was ready to be tested and validated.

Fig. 19. The overall assembly of The Hive

3.5 Validation Testing

Once the sculpture was completed, a testing survey was conducted to determine whether the functionality and appearance were up to the expectations needed. A few people volunteered to test out the sculpture and were then briefed on the sculpture and its functions, then had them scan a QR Code to gather their opinion on the experience of using it as shown in Figure 20.

The majority of the respondents find the sculpture to be visually appealing and is very easy to understand how it works. All respondents were able to successfully use the sculpture function thus rating the effectiveness as excellent. The durability of the sculpture was also rated as Good, and the functions made fulfils the intended purpose. The artistic design also complements the sculpture's function as voted by all the respondents.

Fig. 20. Volunteer quality testing of the sculpture

4. Conclusions

In conclusion, the prototype of the sculpture is well executed in terms of the build. Such as the neatness of some features, and the look. Based on the survey, the overall sculpture is well received and well-liked because of its visual design and function that it offers., it still successfully shows the user the functions and intent of the functional sculpture. The sculpture's relevance towards the school of design remains needed to this day in terms of both a resting place or waiting area, and a display to showcase product design projects for visitors and other students to see. the hive will also be a great addition aesthetically to the faculty whilst blending with its surroundings.

Acknowledgement
The author would like to express our deepest gratitude to all those who provided support and guidance throughout the development and completion of this research project, especially to the School of Design (Product Design) Universiti Teknologi Brunei (UTB) for providing facilities. This research was not funded by any grant.

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