DESIGNING FURNITURE BASED ON STUDENT'S LIFESTYLE AND MERGING WITH A SUSTAINABLE CAMPUS

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ABSTRACT

In this paper, we discuss the potential of an emerging form of sustainable design product as a solution to the space constraint problems caused by bulky furnitures. This study presents how students perceive the interior design from convenience and usability aspect for efficient space management. A quantitative research method was chosen to conduct a survey to execute the data analysis. Based on the results delivered from the survey, a series of interviews were scheduled with hostel authorities, architects, material vendors, and carpenters. A detailed analysis was conducted on the re-usability of materials from existing furniture with the addition of sustainable material alternatives in place of costly and not environment-friendly materials. The aim of this study is to discuss the step-by-step approach in design process while developing a new product and provide more defoliated area with ergonomically designed sustainable furniture and theoretically verify its credibility from the furniture design perspective.

Keywords: Design Process, Transformable furniture design - Hybrid Bed Model, Sustainable Materials, Space efficiency

1. INTRODUCTION

Every inch counts when living in a confined space [9] and so the use of transformable furniture has taken the market by storm over the past few years. Zhou and Chen in their paper "Computers and Graphics" have briefly elaborated the need for convertible furnitures [9]. Transformable space saving furniture is a revolution and innovation [7]. The versatile nature of this furniture in storing it in a compact form facilitates the better utilization of space. This space efficiency has fascinated the designers worldwide.

However, due to its intricate transitions, many designers have collaborated with skilled professionals to get acknowledged with the mechanical structures and properties of different materials to make the furniture both aesthetic and functional [7].

Ideation by sketching on paper has been replaced by 3D modeling on software. Therefore, computer-assisted furniture design systems have attracted a lot of attention in the area of computer graphics for decades [9]. The software modeled graphics well anticipated the design, leading to the creation of furniture with superior usability characteristics.

Thus, in this paper, we support the argument by Zhou, Jie, and Xuejin Chen on "Convertible Furniture Design" about the potential of an emerging form of sustainable design product as a solution to the space constraint problems caused by numerous bulky furnitures [9].

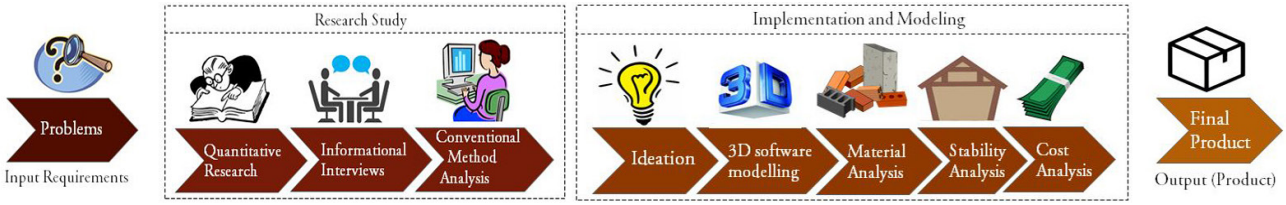
Thus, our perspective in this paper will make two contributions:

i.Emphasize on the design procedure for the development of a new design.

ii.Propose a new furniture design for efficient space management.

2. DESIGN PROCESS

Design-based implementation research can help [5] find a better solution without neglecting any structural, technical, material and financial aspect of the design. The design process is shown in figure 2.



[Figure 2] *A step –by- step approach from a raw unfurnished input problem to a functional and aesthetically appealing output via an orderly approach of a design process*

2.1. Research:

The first step toward developing a design-based implementation research is a systematic form of inquiry to comprehend the problems faced by existing furniture designs [5]. A quantitative research method was chosen with a survey as a form to execute the data analysis. The questionnaire was delivered through an intramail system of IIT Gandhinagar's current students and nearly 70 respondents participated in the survey. The inferential analysis was employed to interpret the collected data. Its results implied that there were great concerns related to space allocation in the room after housing the basic requirement of furniture (chair + table + bed). Nearly 70% of the students were unhappy either with their perspectives towards movement or storage space in the room.

2.2. Problem Statement:

i. *Space Constraint:*

The standard furniture sizes together lead to a shortage of space due to which there was space constraint for additional appliances or households like water cooler, plant pot, shoe-rack etc.

ii.*Scantiness of shelves*

Organization of personalized daily use items was rather difficult with no handy shelves or drawers.

iii.*Difficult to dig out dust from the interiors*

The dust allergic students and the cleaning staffs found it strenuous to clean the corners and the interiors of the rooms, lifting the heavy, immovable and bulky furnitures to reach the interiors, especially when things kept falling down.

2.3. Informational Collection and Conventional Method Analysis:

To understand the real issues associated with the existing furniture, types of materials and processes used, a series of interviews were scheduled with hostel authorities, architects, material vendors and carpenters. As a part of our design research activities, we designed a survey form comprising a questionnaire and conducted a survey within the students' community. Also, a research was conducted on how to reuse material from existing furniture of IIT Gandhinagar campus and improvise the new design with an addition of sustainable material alternatives in place of costly and not environment-friendly materials and processes.

3.IMPLEMENTATION PROCESS

3.1.Ideation

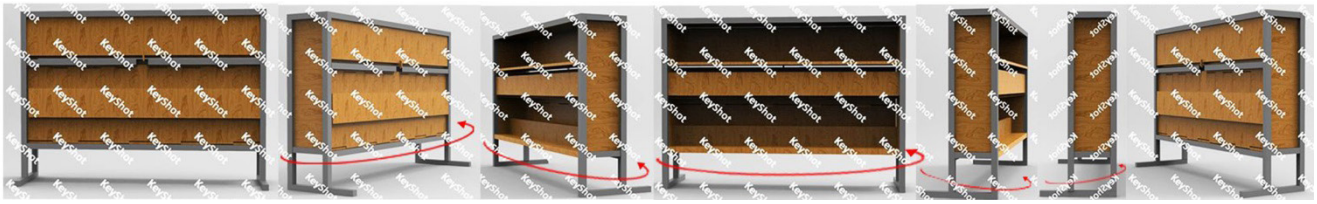
Technologies used in the newly developed products were explored to research on the consumer psychology, advanced sciences, hazardous effect of designs on the environment, to stimulate generation of new ideas, techniques, material and forms to be used in this process. Consumers preferred the goods that were easy to use and convenient to store. One such admirer of transformable furniture was a person living in a small room who liked doing yoga and exercise on the ground. He needed space that could be later used for some other purpose.

3.2.Software modeling and designing

Computational implementation of the design is essential for having transparency in thoughts. It provides a better judgement on the dimensions and volume occupied by the model. This model of a hybrid bed was modeled using Rhinoceros software and rendered using Keyshot software. As a result of brainstorming with research outcome and conventional ideation process, the proposed design of a hybrid bed was conceptualized and presented to Institute authorities.

4. HYBRID BED

The hybrid bed is an innovative furniture design involving structural changes as per user convenience. It is a combination of the traditional architectural design of a bed, bench and table sealed in a small cuboidal area that expands when needed (as shown in figure 4). Its main approach was to solve the space constraint problem by reusing the materials of conventional designs. In 'closed position', it occupies a volume of 6'-11" X 1'-4" X 5'-6" (L x W x H) while in 'open position', 6'-11" X 4'X 5'-6" (L x W x H).



[Figure 4] A 360 degree view of hybrid bed in closed compact position

Other features of the hybrid bed are shown in Table 4.

General Features and Specifications: Hybrid Bed	
Particulars	Description
Size of entire structure	6'-11" X 1'-4" X 5'-6" (L x W x H)
Size of metal frame	Wall thickness 1.2mm CRC Square Tube Size: 1" X 1", extracted and fabricated as per desired the size from existing furniture
Wood/alternative to be used	Nutshell board section or wood composite sheet
Metal Coating	Powder Coated
Ply	18mm Thick, 3'X6'6" ISI Ply Oil Painted on both sides
Powder Coating	Black or as per selection
Wood Furniture Polishing	French Polishing
Minimum Thickness of powder coating	7 Micron
Platforms and shelves	Plastic wood

[Table 4] Features of Hybrid Bed

5.KEY ELEMENTS OF HYBRID BED:

5.1.Bed and Mattress

The structure of the bed is held by a knob. To unfold the bed, the knob is first rotated by 90 degrees and then the stands are first pulled out from the structure after which the bed is gently tilted to stabilize in a horizontal position (as shown in figure 5.1). The mattress in 'closed position' lies vertically inside the hybrid bed structure and in 'open position is titled along with the unlatched structure.

[Figure 5.1] A systematic approach to unlatch the bed in The Hybrid Bed

5.2. Bench/Chair

The stands of the bed are folded inside the structure to divide the bed into two halves, outermost acting as a stand for this bench position (as shown in figure 5.2). The mattress in this situation is kept vertical like in the 'closed position' of the bed to act as a back support.

[Figure 5.2] A systematic approach to transform the bed into a bench

5.3. Table

In this model, the table is suspended with the use of hydraulics on both sides, one attached to the top of the table and other attached to the inner side of the bed on each side in line with above hydraulic. The table drops down from the top, that was initially acting like the shelf cover (as shown in figure 5.3), to stabilized at a convenient height using hydraulics for better ergonomic stability. In the 'not in use' position, the table is supported by a knob that also holds the bed in its 'closed position'.

[Figure 5.3] A systematic method to unfold the table from a cover of the upper shelf

[Note: All the above images were extracted from a video that was previously rendered using unlicensed Keyshot software due to which while rendering the above Keyshot watermarks remained]

6.SUSTAINABLE ELEMENTS:

We plan to reuse the materials from the existing conventional designs of beds, tables, and benches to present more comfortable and economic solution. For example, the wood used in making the bed can be reused for making this structure. In order to further strengthen the sustainability element, it is suggested to use below-mentioned materials alternative to wood.

i. *Nutshells*

It is a recyclable material made out of crushed almonds, hazelnuts, and walnut shells. The innovative process of producing nutshell boards is unique and the most environment friendly approach to produce furniture without cutting down a single tree.

ii. *Wood and waste paper composites*

As the name suggests, composite materials combine wood with recycled plastics or other components. A study depicts that when the wood particle is blended with waste paper and made into a composite, the mechanical properties of the composite could meet the particle board for furniture [2].

iii. *Plastic wood*

A study by S. Mehmood, A. Khaliq and S.A. Ranjha clearly indicates that the wood wastes such as the primary and secondary wood wastes, municipal solid waste, paper waste, paper sludge and the agricultural crop waste can be processed into a usable form by mechanical milling and chemical treatments [3]. The waste materials can be formed into composite boards and used for making furniture and other applications.

iv. *Bamboo*

Bamboo is often considered wood, but this grass is really a wood alternative. It is a very trendy option as furniture, flooring or structures. It is proved that the bamboo is extremely renewable material compared to other hardwood species which are growing for at least 50 years. Bamboo grows quickly (6 months to 2 years) to its mature height and can be harvested after 3 to 5 years [1].

v. *Hemp*

According to the research conducted by DeeDee De Miranda, Colorado State University, it is suggested that hemp is a viable fibre used in furnishing applications. Among the facts concluded in the study, it is claimed that hemp is stronger and more absorbent than cotton. It also possesses UV protecting properties, superior to any other fibre [4].

7.ANALYSIS:

i. *Stability Analysis*

An exhaustive study was conducted to estimate the approximate strain and moments of force acting on the bed when the bed is in use and at its closed position. Parameters such as Young's modulus of the wood, stress, an approximate distribution of force and center of mass distribution in each position were considered. Mechanical properties and basic physical formulae were used to calculate the result. Unpredictable disturbances in surrounding, like the lateral force acting on the top of the furniture, were taken into consideration to improve the yield of the result.

ii. *Cost Analysis*

The qualitative and quantitative analysis of materials were conducted to ensure maximum productivity for the given price range. The outcome of the study stated that the material cost of the furniture was quite less.

8.ADVANTAGES OF THE PROPOSED DESIGN:

i. *Greater Space efficiency:*

The fact that everything fits in a small cuboidal area helps in fruitful usage of space outside the cuboidal area. When not in use, the structure can be easily folded to consume minimal space of less than one-third of its total volume, thereby, ensuring a larger effective area of the room.

ii. *Dust-free surrounding:*

A healthy mind strengthens in a cleaner environment. Our productivity increases when our surrounding is clean. But often, due to the large shape of beds, it becomes hard to dig out dust from the corners and the center of the space occupied by the bed. The foldable mechanism ensures easy reach to every bit of land without disturbing the major setting of bed. Thereby, proposing a more hygienic atmosphere.

iii. *More Organized Room:*

The provision of many scattered multipurpose shelves ensures efficient utilization of space. Space provided can be creatively used as per user requirements like frequently used items such as bottles or pen stands can be kept on the shelf in line with the bed while the books can be kept on topmost shelf and shoes can be organized below the bed.

iv. *Better Cost Efficiency:*

According to the statistics of cost analysis, the manufacturing cost of the structure is comparable to the cost of a well-polished bed as this structure focuses on the use of cost-efficient and reusable raw materials. So Hybrid bed will be sold at an affordable price with high degree of quality that will fit within the budget of the user without burning a hole in their pocket.

v. *Aesthetically Appealing*

Transformable furnitures are usually very trendy and catchy due to their stylish nature. Hybrid bed also possesses all those qualities along with its simplicity in using the natural texture of the materials used as its aesthetic element.

9.CONCLUSION AND FUTURE WORK:

In this paper we have presented our perspective of the design process with its implementation and execution shown in the new design of space efficient and sustainable model of a hybrid bed. We are optimistic about the potential of this new design of Hybrid Bed and believe that the current space problems can be eliminated, providing a larger defoliated area for productive use. We plan to work more on the aesthetics of the design to reduce the use of raw materials and yet present a sustainable product. Also, the mattress can be resigned for more ergonomic convenience along with newly introduced sustainable materials.

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