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A Review of Modular Ergonomic Furniture Patents

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Abstract — This paper identifies weaknesses in the ergonomics and design advancements of household furniture. This paper suggests recommendations to enhance the satisfaction and support of ergonomic furniture. Furniture and interior wares are the chosen products of interest, and are specifically emphasised in the context of home living. This paper includes an ergonomics focus on the engineering and industrial design of household furniture, but does not include an analysis of biomechanics, physiology and anthropometry. Based on evaluations of patents from 1980 to 2013, this paper suggests that a user-centred design would be an ideal choice for designers as it potentially promotes customer satisfaction and simultaneously improves the health and well-being of users. The paper synthesises the consensuses of furniture consumers which include data from trends, demands, complexities and preferences.

Keywords—User-centred design, ergonomics, furniture, design, modular, multifunctional, storage.

I. INTRODUCTION

Furniture is defined as “equipment that is necessary, useful, or desirable such as a movable article used in readying and area (i.e. a room or patio) for occupancy or use” by the Merriam-Webster Dictionary. From a marketing perspective, furniture is a “functional art form” with both physical and aesthetic benefits used to satisfy customers’ needs [1]. Bennington contends that furniture is a combination of “both tangible and intangible” attributes, including design, material durability, processing quality, manufacturers and retailers’ reputation, credit and service [2].

The functionality and purpose of furniture are made with intention to serve the task or to cater for a certain demographic. The North American Classification System (NAICS) categorised furniture and related manufactured furniture products into three general categories [2]:

- Household and institutional furniture and kitchen cabinet manufacturing
- Office furniture (including fixtures) manufacturing
- Other furniture related products

This categorisation of manufactured furniture shows that this form of manufacturing requires specified detailed attention and consideration towards the design of furniture. In this modern age, furniture design incorporates the design of functional spaces, furniture and product design to accommodate different tasks and lifestyles [3] and to fulfil the fundamental necessities of people in everyday life [4]. This indicates a paradigm shift from traditional manufacturing to a world of agile manufacturing [5].

Ergonomics in design is the study and application of ergonomics principles throughout the process of design to make it user friendly, safe and cost-effective with an eventual goal to obtain optimal human performance [6]. This incorporation of ergonomics in furniture design is an important factor that consumers desire. The ease-of-use of the product is an important factor for consumers [7].

Due to the increase in demand for furniture, furniture manufacturers have channelled their focus towards innovative ways to incorporate ergonomics into design [8].

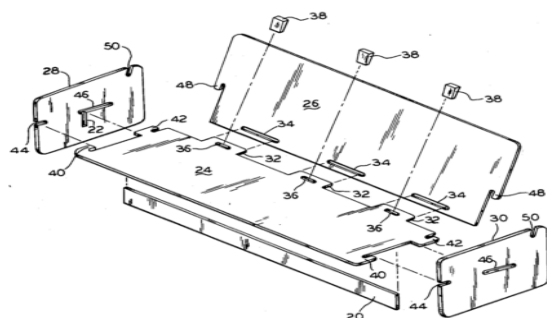
This paper aims to review past ergonomic furniture patents focusing on design aspects which include storage solutions, usability, functionality, consumer demands and trends.

II. PATENT ANALYSES OF MODULAR FURNITURE

The goal of this section is to review previous works in ergonomic furniture products from the past few decades (i.e. years 1980 to 2013). The products featured are patented items and existing products in the market. This article will also examine the shortcomings and advancements based on the item or product's applicability and purpose, ergonomic design, storage solution and market attention.

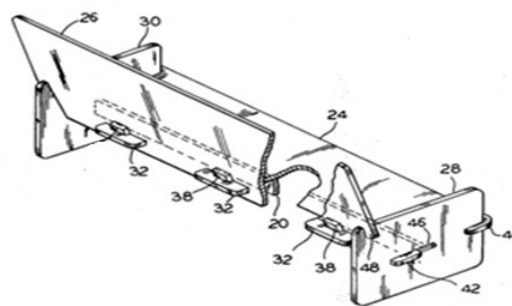
In this paper, the patents of modular furniture are presented. Modular products are manufactured goods, assemblies and components that fulfil various functions through the combination of distinct building blocks or modules [5]. The focus will be entirely on furniture which encompasses the ergonomic design aspects, accessibility and ways storage spaces are incorporated in the design.

Patent 1: US 4140065 A. Chacon [9] describes this piece of modular furniture as a number of relatively wide wooden panels shaped and proportioned to cover all areas of a back, a seat, or the end of a sofa or chair. The panels have tabs or hooks, and mating slots which come together in a proper fit. Simultaneously, the parts are interconnected by wedge-shaped pegs. Figure 1 shows an exploded view of the solid parts of a sofa made by the inventive process. Figure 2 shows an assembled perspective view which is partly in the cross section of the sofa.



Remark: 20- Under-the-seat supporting member; 22- Recess for support bar; 24- Seat panel; 26- Insertion wedge; 28- Two end arm panels; 30- Wooden panel; 32- Connector tabs; 34,36,46,50- Insertion slots for pegs; 38- Wedged-shaped peg; 40,48- Insertion slots for hooks; 44- Insertion slots; 42- Hook members

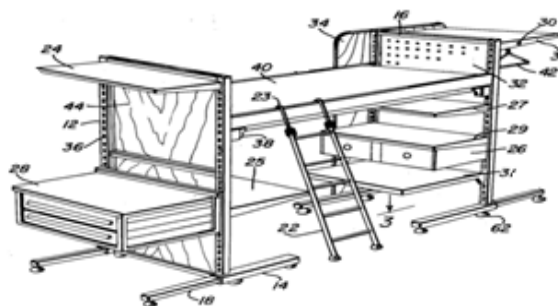
Fig. 1. Exploded view of the modular furniture by inventor Chacon [9].



Remark: 20- Under-the-seat supporting member; 24- Seat panel; 28- Two end arm panels; 26- Insertion wedge; 30- Wooden panel; 32- Connector tabs; 38- Wedged-shaped peg; 40,48- Insertion slots for hooks; 42- Hook members; 46- Insertion slots for pegs

Fig. 2. Assembled view of the modular furniture by inventor Chacon [9].

Patent 2: US 4312086 A. The inventor known as Bianco refers this invention as a living system comprising of plural modular furniture components. These furniture components consist of integral bracket extensions which can be inserted in recesses formed in multiple, substantially parallel, vertically disposed, elongated columns. The telescoping legs at the end of these columns are adjacent to the floor, and this acts as a stable frame for the entire living system. Additionally, it enables the living system to be placed close to a wall to increase usable space in the living environment [10]. Figure 3 shows the perspective view illustrating a living system in accordance with the invention.

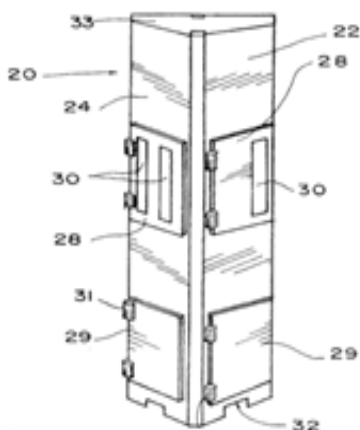


Remark: 12- Vertical column; 14- Telescopic base; 16- Horizontal support; 18- Leg extension; 20- Bed frame; 23- Hooks; 26,33- Storage drawer; 22- Telescoping ladder; 24, 25, 31, 29, 27- Shelf unit; 28- Dresser; 30,42- Clothes rack; 32- Pegboard; 34- Side wall panel; 36- Recess; 38- Metal spring frame; 40- Mattress; 44- Board support; 62- Supporting levelling means

Fig. 3. The perspective view of the modular living system by inventor Bianco [10].

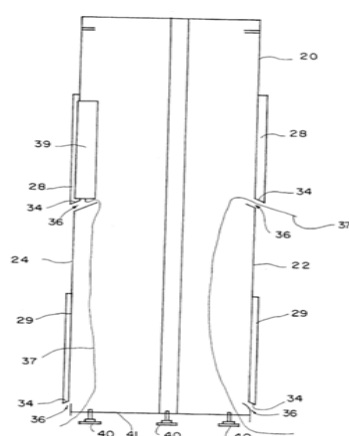
Bianco [10] further explains that the modular unit includes a bed, a plurality of storage components, a clothes rack, a telescoping ladder and may even include side panels to provide privacy and aesthetic value to the living system.

Patent 3: US 5660120 A. Sims [11] describes his invention as a modular furniture system for open-plan offices. This includes a cable tower unit, and several panel screens which are attachable to and detachable from the cable tower unit and a workstation surface. Figure 4 is a plan view of the cable tower unit. Figure 5 depicts the cross-sectional view through the rear face of the modular furniture unit.



Remarks: 20- Top of the tower; 22- Workstation face; 24- Lower end of the workstation; 28- Lower edge of door; 29- Lower door; 30- Connector panels; 31- Lift-off hinges; 32- Cable recess; 33- Lid

Fig. 4. Plan view of the cable tower unit [11].



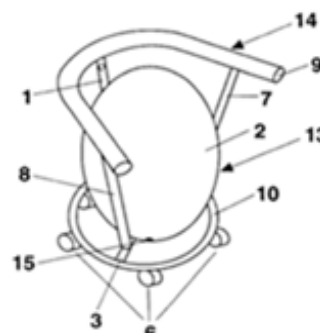
Remarks: 20- Top of the tower; 22- Workstation face; 24- Lower end of the workstation; 28- Lower edge of door; 29- Lower door; 34- Lip; 36- Inclined channel; 37- Cable connector; 39- Mounted connector; 40- Feet; 41- Bottom surface

Fig. 5. The cross-sectional view through the rear face of the cable tower unit [11].

In Sim's modular workstation, the adjacent panel screens define workstation areas. These panel screens are attached to the cable tower unit which supports the workstation surfaces. To allow for versatility, the workstation surface is free-standing from the cable tower unit and the panel screens. In a further embodiment, two cable tower units may be attached together through their respective rear faces to form a single cable tower unit with four workstation areas. Sim's modular workstation would be best utilised in

an open plan office in which individual workstations are separated by panel screens [11].

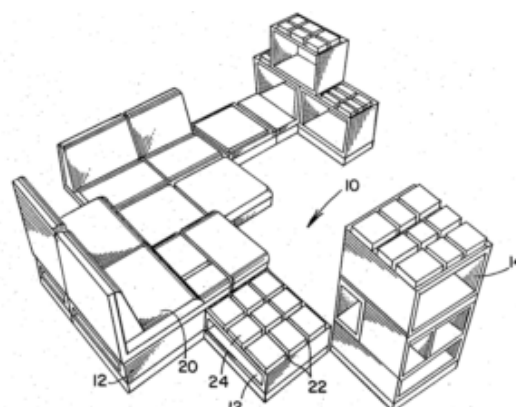
Patent 4: US 6616238 B1. The purpose of Guery-Strahm's Ergonomic Seating Unit is to promote active sitting by eliminating fatigue from sitting for extensive periods of time [12]. Figure 6 is the perspective view illustrating a complete seat unit of the Ergonomic Seating Unit.



Remarks: 1, 7, 8- Connecting tube; 2- Pressure balloon; 3- Traversal tube; 6- Five castors; 9- Pad; 10- Frame; 13- Seating unit; 14- Main frame; 15-Plug

Fig. 6. Perspective view illustrating a complete seat unit of Guery-Strahm's invention [12].

Guery-Strahm further explains that the ergonomic seating unit comprises of an egg-shaped, fluid-filled, deformable balloon which conforms to the shape of the user when sat upon. This flexible balloon can be freely removed or movably wedged into the main frame depending on whether the seat is occupied or unoccupied [12].

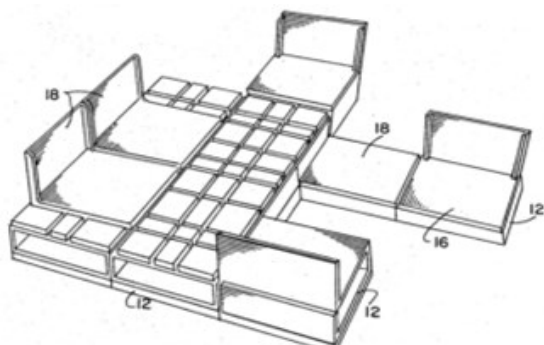


Remarks: 10- Plurality modular element; 12- Base module; 14- Storage module; 20- Cushion; 22- Plurality grooves; 24- Rectangular and/or square plurality element

Fig. 7. Perspective view of the multifunctionality in the modular furniture elements from Redemske's invention [13].

Patent 5: US 3811728 A. Redemske's invention known as the Plastic Modular Furniture is a concept that uses a unique system which combines individual modular components into a variety of combinations of seating, sleeping and storage [13]. Each individually moulded plastic base module has a multiplicity of

grooves on one of their faces. Each shelf has a perimeter ridge suitable for engaging with any of these grooves. This means that this invention is a multipurpose and multifunctional invention, as each different shelf can be used for sitting, sleeping, storage or even as a table top. Figure 7 illustrates the perspective view of the multifunctionality in these modular furniture elements. Figure 8 illustrates a perspective series of combined basic modular bases and shells. Figure 9 is a cross-sectional view of a sleeping unit as embodied by this invention.



Remarks: 12- Base module; 16- Seating shell; 18- Top shell

Fig. 8. Perspective series of combined basic modular bases and shells from Redemske's invention [13].

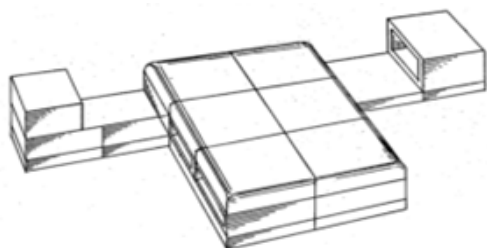
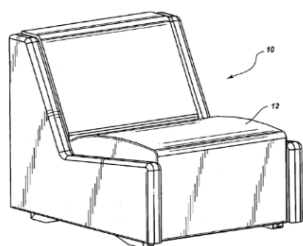


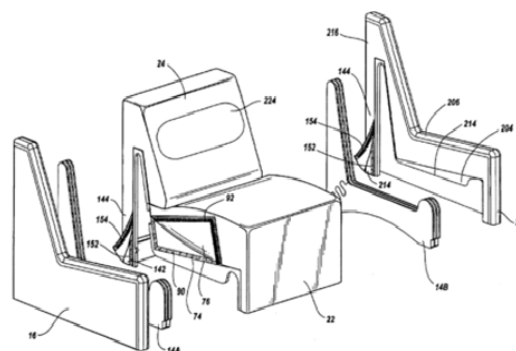
Fig. 9. Cross-sectional view of a sleeping unit as embodied by Redemske's invention [13].

Patent 6: US 6783182 B1. The Modular Furniture Systems and Methods created by the inventor known as Gallagher addresses the problems in traditional furniture (such as chairs and couches) that are usually large, heavy and peculiarly shaped [14]. Figure 10 is a perspective view of a modular furniture system in the form of a chair. Figure 11 is a perspective view of a partially exploded view of the chair from Fig. 10.



Remarks: 10- Modular unit; 12- Chair

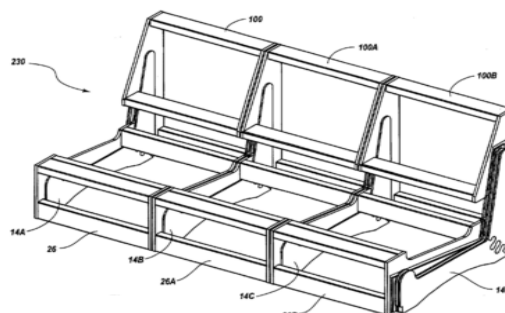
Fig. 10. Perspective view of a modular furniture system assembled in the form of a chair [14].



Remarks: 14A, 14B- Legs; 16- Arm rest; 20- Arm frame; 22- Chair; 24- Back rest; 74- Primary edge; 76- Secondary cover; 90- Loop strap; 114- Side panel; 14B- Legs; 214- Retention edge; 206- Arm cover; 204- Arm frame; 216- Removable securing secondary cover

Fig. 11. Perspective view of a partially exploded view of the chair shown in Fig. 10 [14].

Gallagher's invention also seeks to address shortcomings of conventional modular furniture systems that are limited to the assembly of a single piece of furniture such as a set design for a chair or a couch [14]. Figure 12 shows a perspective view of the modular furniture system assembled in the form of a couch. Figure 13 shows different shapes and set designs achieved by this system if multiple modular chairs were connected.



Remarks: 14A, 14B, 14C, 14D- Legs; 100, 100A, 100B- Back frame; 230- Arm rest

Fig. 12. Perspective view of the modular furniture system assembled in the form of a couch [14].

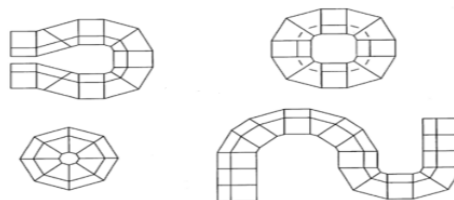
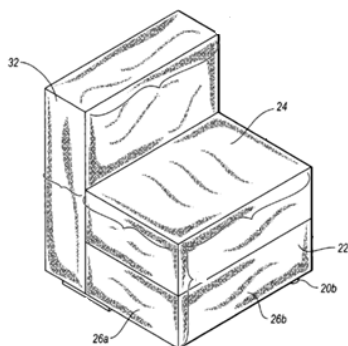


Fig. 13. Top plan views of alternative assemblies for the modular furniture system [14].

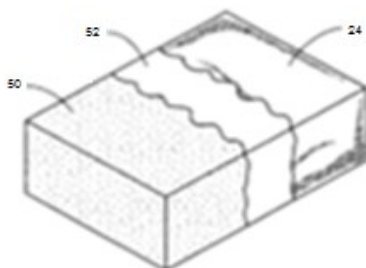
Patent 7: US 7213885 B2. Inventors of the Modular Furniture Assembly known as White, Nelson, Nappi, Underwood and Rich highlight the need of functionality such as seating functions and storage functions. This invention aims to be assembled, disassembled, rearranged, moved and cleaned in a quick and efficient manner with minimal

effort [15]. Figure 14 is a perspective view illustrating a modular furniture assembly having a base coupled to a transverse member to form a chair. Figure 15 is an exploded cutaway view illustrating the base. Figure 16 illustrates a modular furniture assembly in the configuration of a double-seater and deep sofa.



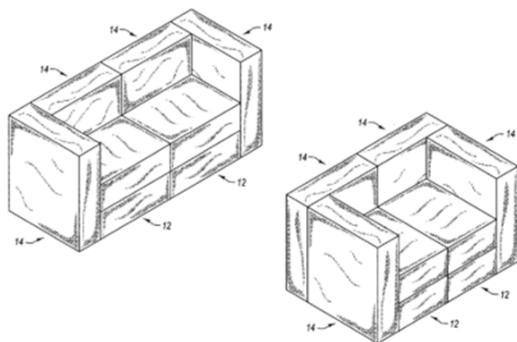
Remarks: 22- Outer liner; 24- Removable outer liner; 26a, 26b- Abutting surface; 32- Removable outer liner

Fig. 14. Perspective view illustrating a modular furniture assembly having a base coupled to a transverse member to form a chair [15].



Remarks: 24- Removable outer liner; 50- Foam piece; 52- Inner liner

Fig. 15. Exploded cutaway views illustrating the base [15].



Remarks: 12- Base; 14- Transverse member

Fig. 16. Modular furniture assembly in the configuration of a double-seater and of a deep sofa [15].

III. MAIN OBSERVATIONS

Referring to the patents in the preceding sections, the commonality appears to be the problem in incorporating functionality and aesthetics into the design. Merging these elements into a single furniture unit for a collective purpose would indeed be a challenge that designers would need to face.

In Patent 1 and Patent 6, the claims suggested by the inventors include creating a piece of furniture that is light and easy to move around. With this advantage in size, the inventors claim that shipping this piece of furniture would be easier, especially in a large volume. The inventors also claim that the inventions are aesthetically appealing, and satisfy usability and comfort demands. With its similar connection in method of assembly, the disadvantage would be the complexity of its installation, which would require a considerable amount of time and precision. The integrity of the product is also questionable, especially from a consumer's perspective if priced high [8, 16].

On the other hand, Patent 3 and Patent 4 suggest modular furniture designs for a niche market and a certain consumer demographic. This type of consumer demographic includes a group of people that look into particular features or concepts in a product. Products from Patent 3 and Patent 4 would have their aesthetic properties taken into higher consideration compared to their functionalities. With this narrow focus in design, the consumer utilisation of the product would be reduced [11, 12].

For Patent 2, the multiple living systems include a table unit, living area and storage unit, which causes the product to appear bulky by design and consist of many assembly parts. The complexity would cause the probability of wear and tear to be higher due to the insufficient support to the frame. The product would also take up a lot of space in the living area, which can be a substantial concern for consumers that have a limited living space in their home [10].

Patent 5 and Patent 7 address the issue of functionality and versatility in design and utilisation. The availability of a sufficient storage area and seating functionality accentuate the highlighted features that consumers would look for. However, in an ergonomics viewpoint, this design may cause some discomfort and stress, especially in a seated position or while utilising the storage area which also seems have limited reach envelopes [13, 15, 16].

IV. CONCLUSION

The combination of several aspects such as special considerations in design, materials and ecology can constitute as an important criteria list to path the way for the future of modern and contemporary furniture. Understanding the combinations of consumer preferences, trends in furniture market, advancements of technology and the relationship between furniture and technology would create an indication of how furniture of the future can be designed to adapt with the fluctuations in the furniture market.

V. ACKNOWLEDGEMENTS

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