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Research paper

Product and Market Observations on Furniture Technological Developments

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Abstract

The purpose of this study was to identify ergonomics aspects, traits and flaws in furniture designs and forecast the future advancements of furniture technology. A market and product analysis were conducted in order to identify technological patterns in furniture design. Based on observations of these furniture designs, recommendations on future developments and advancements are suggested for improved functionality and comfortability in furniture technology. The findings suggested that aspects such as user-centred design, modularity, soft close technology, space-saving awareness, usability awareness and sustainability were among the key ergonomics aspects that designers should emphasise on for the future advancements of furniture technology. This study contributes to the understanding on combinations of consumer preferences, furniture market trends and technological advancements towards creating an indication of how furniture can be designed to adapt with the equivocal change in the furniture market.

Keywords: *Ergonomics; Modularity; Furniture; Design; Functionality*

1. Introduction

According to the Oxford Learner's Dictionary, furniture refers to moveable objects, such as beds, chairs and tables, which are placed in a home or a workplace to make it suitable for living or working in. Due to versatile and increasing demands of furniture, manufacturing firms have begun to emphasise their efforts innovating and developing furniture design with various technologies and ergonomic concepts. In ergonomics and usability engineering, it is essential for designers to evaluate approaches in science, technology and product development not only based on technological trends, but also customer feedback. Hence, with the help of market and product analysis, this study aims to identify ergonomics aspects, traits and flaws in furniture designs and forecast the future advancements of furniture technology.

2. Market Study

According to furniture expert, Abe Abbas, "the top 10 furniture trends of the decade came about the way trends of furniture always do, dictated by who is buying and how they live" [2]. The lifestyle of customers and where they live have been important consideration points for many furniture manufacturers. The American Furniture Industry found that many new houses now feature built-in cabinets and walk-in closets with enough storage room to eliminate the need for dressers and chests [3]. However, it was found that the average apartment size is 982 square feet and shrinking [3]. Studies suggested that smaller living environments have affected consumer choices, where consumers are likely to focus on products with practical, economical and accommodating features which are less extravagant [4].

Many contemporary property developers focus on micro apartments based in metropolitan and urban areas, where space is always at a premium [3]. The target group for many micro apartments are individuals between the ages of 25 to 30 years old. This results in the need for smaller furniture [3].

Abbas [2] suggested the top 10 trends for furniture from the past decade are include environmentally friendly furniture, furniture with a smaller profile, multifunctional furniture, technology driven furniture design, popularity of vintage furniture, globally inspired furniture, the growing importance of outdoor furniture and custom made furniture. These trends are also suggested and developed by The American Furniture Industry: Industry Watch Update which highlights that there is a growing interest for functionality and storage-oriented furniture [3]. Due to space restrictions in these living areas, manufacturers have to re-evaluate their approach to furniture design. The CBI Ministry of Foreign Affairs summarised the key market drivers of the furniture market in Fig. 1 [5].

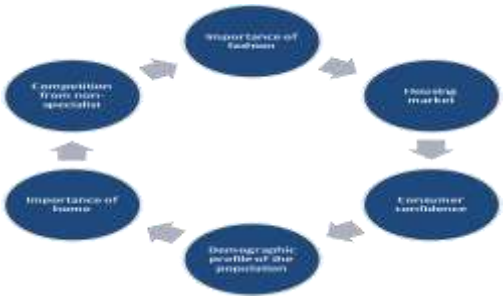


Fig. 1:. Furniture Market Drivers [5]

Besides the contributing factors that drive the furniture market, consumers have their own criterion or preferences for choosing furniture. This ranges from appropriateness and practicality to other personal preferences illustrated in Fig. 2.

Fig. 2:. Factors influencing costumers' furnishing choices [6]

Aesthetics is also an important factor when choosing furniture. In a case study, it was revealed that aesthetics is a crucial factor considered by furniture buyers [6]. It was found that aesthetics has six crucial roles in influencing decisions, namely attention drawing, categorisation, function, ergonomics, aesthetics and symbolic [6].
Daria [6] argues that incorporating these factors into a product would be a challenge, as it would be difficult to optimise all roles. It was illustrated that product value is the most important factor for consumers when purchasing a specific kind of product, and this should be the starting point in the design of the product appearance [6]. Creusen and Schoormans [7] describe aesthetics as a relatively important factor for some types of products such as lamps and furniture, while ease-of-use would be more important for other types of products such as appliances. They also add that aesthetics is probably important for consumers whose appliances are tangibly visible in their home [7]. This suggests that attention drawing and categorisation for visual typicality are more influential for food products than for durables for example.
There is also a trend among consumers when it comes to appearances. These demands depicted in Fig. 3 for a furniture item that is aesthetically appealing have been a focus for designers to create products that can suit or fit these criteria.

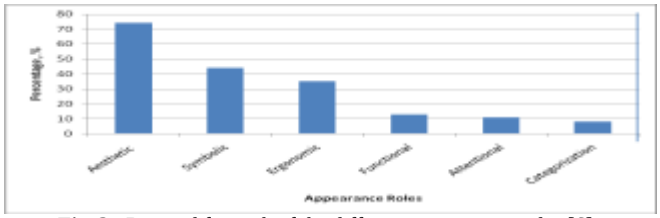


Fig. 3:. Demand for each of the different appearances roles [6]

Considering the change in the market over the past decade, it is challenging to integrate elements of individual preferences into one design. In order to integrate these elements, it is essential to determine the causes of human preferences in furniture. Daria [6] attributes three main issues that contribute to personal preferences, namely culture (fundamental determinant of a person's behaviour), sub-culture (nationalities, religions, geographical regions) and social class (homogenous and enduring divisions in society).
This is especially evident due to the fluctuation of economic environments and restructuring of the spectrum of the urbanisation process due to globalisation. Erinçkan [4] notes that with the impact of capitalism, social classes have become more evident. Erinçkan [4] also adds that this predicament has played an important role in the development of modern cities, lifestyles, enjoyments and the likes of social classes have become influenced by habits of consumption.
Horvat, Domljan and Grbac [21] discuss that a new generation of users are emerging in the market and are different from their predecessors. This new generation of consumers are a product of new living conditions and the contemporary pedagogic and academic system.

3. Product Study

The ergonomics of a product is concerned with its the comprehensibility, usability and suitability to perform and correctly communicate its utilitarian functions [7]. Authors Horvat, Domljan and Grbache [8] mention that design approaches associated to ergonomics should be an integrated body-mind perspective, involving the human, focusing on complex task and activity interaction, posture, movement, emotion, self-concept and cultural values in a practical way.
Scientists in ergonomics, industrial design and computer interface design have begun to explore ways to maximise the positive experience of users [9]. The concept of ergonomics can be seen incorporated in many furniture items, especially in the office furniture. Brand notes that design standards and guidelines relevant to office ergonomics have increasingly taken a user-centred approach, rather than a product-centred approach in order to ensure that awkward postures, and the negative aspects of workload have been optimised for office occupants [10]. Brooks [11] explains that the application of ergonomics is becoming increasingly indispensable in product design, with more companies selling their ergonomic designs. In the context of office furniture, ergonomics has relevance not just to furniture choice and display equipment regulations, but also to communications within the workplace, team working, hot desk policies, layouts, lighting, noise control and many other aspects of working environments [11].
Studies found that poor office ergonomics can have bad effects on comfort, posture and job satisfaction [12]. Physical and cognitive ergonomics constitute comprehensive approaches for workers [9]. Harnessing the importance of ergonomics in furniture in the context of a workplace environment with proper design and training allows workers to be more adaptive and productive in their office environments. Robertson et al. [13] support this idea with a model presented in Fig. 4. The model presents the expectation when an office ergonomics training program is implemented, in which an increase in ergonomics knowledge would motivate workers to modify their working posture and behaviours, such as break patterns and workstation setup [13]. A decrease in symptoms influences job functioning and ultimately contributes to performance in the workplace [13].

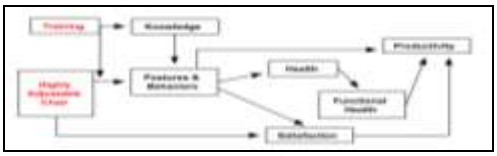


Fig. 4:. Expectations on ergonomics for increased productivity [13]

Researchers of Kansei Engineering highlighted the constants of consumers' preferences in the 1970s and in this present age, where in the 70s, manufacturers often produced a volume of products and people just bought them [14]. At that time, manufacturers designed the products according to their own ideas. Presently, sophisticated consumers desire products that match their feelings of design, function and price [14].
The journal article further highlights that in this current age consumers are more rigid when it comes to choosing products in terms of their own demand and preferences. Kansei Engineering proposes to produce a product based on the market-in strategy which involves the manufacturing of the product to consider the demands and preferences of the consumer. The article also urges manufacturers to change their production and attitude to a more consumer-oriented one. Before proposing this model, the author Mitsuo Nagamachi, explains the terms Kansei and Kansei Engineering. Kansei is a Japanese word referring to a consumer's psychological feeling regarding a new product. Kansei Engineering is

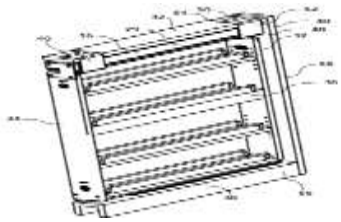
defined as "translating the technology of a consumer's feeling (Kansei in Japanese) of the product to the design element" [14].
Kansei Engineering was developed as an ergonomic consumer-oriented technology for product development [14]. Its flow in Fig. 5 depicts the transition from understanding consumer's preferences to final design.

Fig. 5:. Process of implementing the *Kansei* Engineering system [14]

The implementation of the Kansei Engineering was successful in a new design of TV cameras with rotating lenses and a liquid crystal, which display gave a new trend in the TV camera market [15]. All the products developed by the Kansei Engineering system had good sales in the market because the aim to implement consumers' feelings and images in these new products enticed the customers to buy them [15].
Smith and Smith [16] explained that user-centred design (UCD) products and designs that match the needs of users improve product quality, customer satisfaction and product success. In an article that emphasised on the UCD approach in course design, it was described that by considering the satisfaction of the user, this design approach can increase the use, success and performance of the designed product [17]. Kahraman [17] also added that this design approach allows the user to use the final product with minimal effort and optimum efficiency. The UCD approach incorporates technical, financial and consumer-oriented perspectives [18].
With the emergence of user-centred market trends, the manufacturing industry has acknowledged this paradigm shift from traditional manufacturing to a world of agile manufacturing [1]. Huang [1] states that the complex product markets of the 21st century will demand the ability to rapidly and globally deliver a high variety of customised products. Huang adds that as a measure to rationalise manufacturers' facilities and to produce a large variety of products at a lower cost, modularity is becoming a focus of attention [1]. In association to this, modularity is typically utilised for its ability to rationalise variety through the portioning of product functions and allows for the flexibility of application [19].

4. Advancements in Furniture Technology

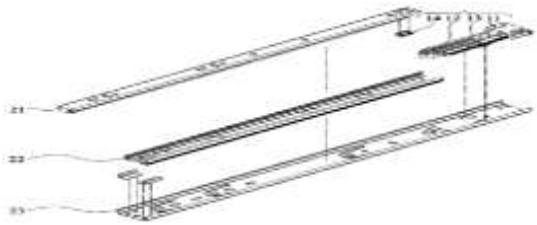
The concern of furniture manufacturers is using new design strategies to enhance functionality, consumer satisfaction and apply modern trends and customer demands to create usable products. For example, German consumers prefer technical functionality in office furniture that broadens use whereas American consumers prefer minimalist, bold colour settings that perform uniquely functional roles [6].
This market of consumers that anticipates the furniture industry needs often drive designers to adopt new strategies. New strategies require the furniture industry to be innovative and recognise the importance of research and development (R&D). Developments such as new motion technology, higher storage versatility, suitable material utilisation and ergonomic designs are in the forefront of the ergonomic advancements.
An advancement in furniture design and functionality can be illustrated in Fig. 6, which presents the Undermount Slide For Pull-out Drawer that utilises a sliding drawer to reveal a larger storage unit to maximise space within the drawer [20].



Remarks: 16- Top portion; 29- Protrusion; 34- Front portion; 36- Shelf; 40- Bracket; 42- Top portion; 52- Vertical portion; 54- Groove; 56, 30- Bottom portion; 32, 58- Back portion; 50,48- Horizontal portion

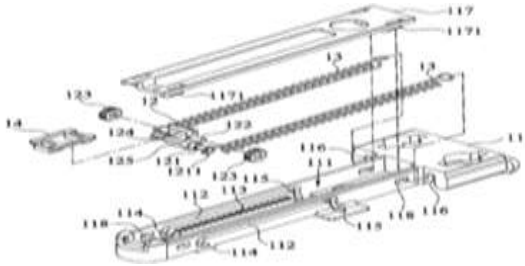
Fig. 6:. Undermount Slide for Pull-out Drawer invention [20]

Another technical advancement in the furniture industry is the soft close technology. As seen in the Soft Close Mechanism in a Drawer Slide Assembly, the inventor utilises a spring damper mechanism [21]. The invention focuses on the sliding bearing assemblies for the mounting drawers in the cabinetry, and emphasises on the drawer sliders with the spring damper mechanism for controlled drawer closure [21].
This advancement is important for reducing impact to prevent damage on the furniture when the slide is closed automatically as asserted by Chen with the Slide Automatic-Closing Buffer assembly invention [22]. Chen's invention as depicted in Fig. 7(a) and Fig. 7(b) consists of a slide automatic-closing buffer assembly and a base, a sliding block, a bump and at least one elastic element [22].



Remarks: 11-Base; 12-Sliding block; 13-Elastic element; 14-Bump; 21-Inner rail; 22-Middle rail; 23-Outer rail

(a)



Remarks: 111-Containing space; 112-Linear guide slots; 113-Buffer rail; 116-Fixing portion; 117-Cover; 118-Snap slot; 123-Buffer rail; 124-Snap groove; 125-Oblique surface; 114, 115-Positioning portion; 121, 122-Protruding shaft; 1171-Snap buckle; 1211-Hook

(b)

Fig. 7:. Parts of the Slide Automatic-Closing Buffer invention [22]

Modularity is also important. It includes components that fulfil various functions through the combination of distinct modules [1] as depicted in Fig. 8. Modularity rationalises variety through the partitioning of functions and enables flexibility in applications [19]. It is used in automotive, aerospace and computer manufacturing industries [19].

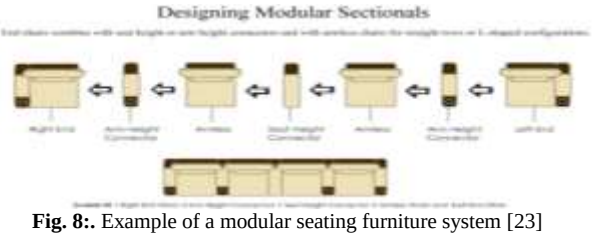


Fig. 8:. Example of a modular seating furniture system [23]

The use of modular attachment methods and standardised components by Xerox made copiers easier to be dissembled, modified and reassembled, resulting in savings of $200 million per year [19]. Modularity offers significant functional and economic benefits over traditional methods [24].

5. Future Developments

So far, this study's contended points include the traditional furniture concept in living spaces versus modern furniture emergence with multifunctionality and aesthetics. Fig. 9 shows the search results from Science Direct with entries on modern and traditional furniture from 2003 to 2014.

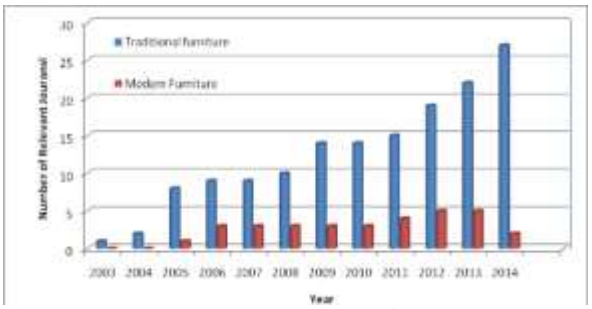


Fig. 9:. Results on modern and traditional furniture: 2003-2014
Source: sciencedirect.com. Keywords: Modern and traditional furniture

According to researchers, product type and market positioning were found to be important considerations for the future development of the furniture industry [25]. Although population growth is predicted to double in the next 50 years, experts suggest a 50% increase to 9 billion with considerations of the typical population growth in the UK to be around 0.3% as compared to the 70% growth over the last two decades in China [26]. Fig. 10 shows the search results from Science Direct. The keywords city planning and population were used from 2003 to 2014. The graph shows that proper city planning is a concern with the growing population in urban areas.

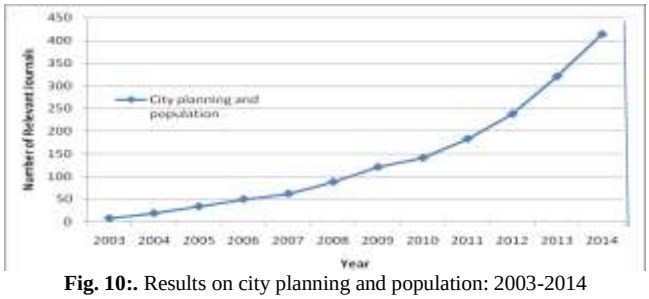


Fig. 10:. Results on city planning and population: 2003-2014
Source: sciencedirect.com. Keywords: City planning, population, 2003, 2014

Utilising various design criteria is essential to completely optimise the use of limited spaces in urban areas. An article entitled Sustainable Population for a Dynamic Singapore highlights the government's efforts to build a sustainable country that accommodates its growing population which will be close to 6.9 million by 2030. The National Research Foundation in Singapore has allocated $135 million for R&D of land and liveability, focusing on creating new cost-effective spaces and optimising space usage. The support for R&D will continually allow growth in discovering new alternatives and solutions to optimise living space areas in urban areas. Fig. 11 shows the search results on Google Patents from 2003 to 2014. The results point out to the searches for patents on modern and traditional furniture invented in the past decade. From 2005 to 2007, modern furniture designs have shown drastic growth. This rise should be a catalyst towards progressing the advancements of modern furniture.

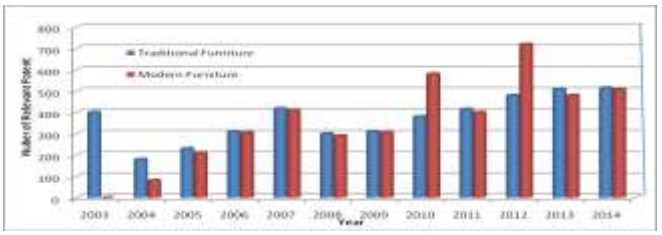


Fig. 11:. Results on modern and traditional furniture: 2003-2014
Source: patents.google.com. Keywords: Modern and traditional furniture

Besides the technical aspects, awareness on the importance of furniture with substance and usability should be promoted along with its challenges in the growing population of urbanites and shrinking living spaces. Consumers should be aware that the furniture industry is advancing in R&D. This growing awareness will allow consumers to shift the conception away from traditional furniture designs to more user-centred designs which allow for improved functionality. The behaviour of consumers, especially those from the urban community, play an important role in igniting this radical change in acceptance of modern furniture designs. Sustainability is also important for manufacturers, especially when it comes to using eco-friendly materials. The design sector has been striving to produce products from materials with high durability, life and low environmental impact. Important factors in sustainable development include the environment, equity and futurity [27].

6. Conclusion

This study suggested that the advancements and future developments of furniture technology should encompass ergonomics aspects such as user-centred design, modularity, soft close technology, space-saving awareness, usability awareness and sustainability. These findings serve as precursory guidelines on essential conditions towards the modernisation of furniture in the 21st century. For future research, studies should be done on how to use certain design innovation methodologies (such as TRIZ, DFMA etc) to increase the level of inventiveness in furniture designs.

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